FACTORS AFFECTING SOW AND GILT EFFICIENCY IN COMMERCIAL PIGGERIES IN ZAMBIA

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by

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DECLARATION

I hereby declare that this thesis does not contain any material previously submitted for the award of any other degree or diploma in any university and that, to the best of my knowledge, the thesis contains no material previously published or written by any other person, except where reference is made in the text. I declare that all work in this thesis was carried out by myself, except where stated in the text.

I consent to this thesis being made available for photocopying and loan if accepted for the award of the degree.

Sally Crafter

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ABBREVIATIONS

CD	cold-dry season
cdw	cold dressed weight
E. coli	*Escherichia coli*
GRZ	Government of the Republic of Zambia
FCR	feed conversion ratio
FAO	Food & Agriculture Organisation
FI	farrowing index
H&E	Haemotoxylin and eosin
HD	hot-dry season
HW	hot-wet season
IMF	International Monetary Fund
kg	kilogram
LH	luteinising hormone
LW	Large White
LR	Landrace
MAWD	Ministry of Agriculture and Water Development
n	number
n.s.	not significant
NA	not available
NMC	National Milling Company
SRC	sow record card
U.K.	United Kingdom
U.S.A.	United States of America

WCI	weaning to conception interval
WM	warm-moist season
WSI	weaning to service interval
ZAPP	Zambia Pork Products

SUMMARY

1. Zambia, a land locked country in Southern-Central Africa, achieved independence in 1965. At this time the United National Independence Party inherited a healthy economy based on the mining and export of copper. During 1975, copper prices dropped to below the cost of production. This had a marked affect on all agricultural industries as foreign exchange allocations to import agricultural chemicals, livestock, seeds and machinery were reduced. The pig industry in particular suffered from lack of investment and by the time this study commenced was plagued by low productivity and reducing profitability resulting in a loss of confidence in the industry.

2. This research resulted from the author's observation that many problems in animal production in Zambia were often due to ignorance of correct of management techniques and born of a general ignorance of the industry. Therefore the research was designed to look for simple answers to simple problems in the Zambian commercial pig industry. Due the logistical difficulties of working in a developing country it was designed to be a project that could be carried out in the third world and which did not involve reliance on sophisticated machinery or techniques.

3. At the time of commencement of the study there was no baseline data available on the pig industry of Zambia, therefore a survey of pig farmers was carried out to determine production levels, management techniques and areas of inefficiency in the commercial pig industry. Approximately 50% of identified piggeries were visited and piggery staff interviewed. A summary of the Zambian commercial pig industry was generated covering production parameters, management levels and identification of areas of major inefficiency. Estimated average production figures were 13.6 pigs weaned and 12 pigs sold/sow/year, a farrowing index of 1.7 litters/sow/year, preweaning mortality at 20% and grower feed conversion ratio of 4.7. Major problems with the industry were poorly designed farrowing pens, low quality and expensive feed, poor marketing, lack of good breeding stock and inadequate extension services.

4. Data from actual sow record cards was collected from three farms with reliable records. The estimate of overall productivity was 14.5 pigs weaned and 13.2 pigs sold /sow/year; farrowing index was 2.02 (weaning to conception interval = 18.3 days, gestation length = 115 days, lactation length = 46 days), 8.8 piglets were born alive and pre-weaning mortality was 21%. There was a discrepancy between the two surveys in farrowing index which was higher

and in litter size which was lower in the sow card survey. No seasonal infertility was established; gilts were found to have a lower fertility than sows.

5. An abattoir survey was used determine if physical abnormalities were the cause of the low productivity observed. This was the first such survey to be carried out in Zambia. Tracts of 139 female swine (107 finishers and 32 cull breeders) were collected from various abattoirs and examined for genital abnormalities, ovulation rate, reproductive status and bacterial contamination. The study found a high percentage of some congenital abnormalities but these were not thought to influence fertility. Overall, 13% of tracts were likely to be infertile. A bacteriological examination was carried out; organisms cultured were generally opportunistic and ubiquitous. A seasonal influence on puberty attainment was established.

6. A small on-farm experiment was carried out to assess the effect of translocation and partial boar exposure on the attainment of puberty in gilts. No treatment effect was seen but more stringent gilt management could be used by Zambian farmers to improve effeciency.

7. Analysis of the data collected has enabled a good estimate to be made of the actual position of the commercial pork industry in Zambia. Recommendations for the improved management of commercial pigs in Zambia were advanced.

CHAPTER 1. INTRODUCTION

Zambia is a central African country of 752,000 sq km and 7.3 million inhabitants with an average population growth rate of 3.4% *per annum* (Government of the Republic of Zambia (GRZ), 1987). Figure 1.1 shows her to be a landlocked country, with eight neighbours, and divided into 9 administrative provinces. A tropical country, Zambia lies between 8°S and 18°S with altitudes ranging from 1030 ft to 7100 ft (Davies, 1971). Despite some climatic variation across the country, most rain falls in the hot, summer months, from October to April, while the remainder of the year is dry (Figure 1.2).

Formerly the British protectorate of Northern Rhodesia, Zambia gained her independence in 1964 and from then until November 1991 was governed by Kenneth Kaunda and his United National Independence Party. The economy is based on the exploitation of copper reserves which accounts for 90% of export earnings (George, 1988). At independence the new government inherited a healthy economy but during the seventies copper prices dropped by 50% and external political events cut all major export routes (through Angola, Mozambique, South Africa) necessitating the development of a route through Tanzania. These factors, combined with extensive borrowing and gross economic mismanagement, resulted in a failing economy and the adoption of International Monetary Fund (IMF) economic restructuring programmes in 1978 (Good, 1989). Shortages of foreign exchange reduced importation of spare parts for farm and industrial machinery, feed ingredients and agricultural chemicals. As a result the agricultural sector declined and, for example, in 1985 only 30% of the country's tractors were operational (George, 1988). Thus these geographical, political and international economic forces all contrived to lead Zambia into her present poor economic position.

Zambia's agriculture is administered by the Ministry of Agriculture and Water Development (MAWD). Its extension services to farmers were severely curtailed by the IMF directive to reduce government spending. For the Zambian pig farmer, MAWD's effort was directed towards peasant farmers on the assumption that commercial piggeries were self supporting (pers. comm., Snr. Livestock Officer, MAWD, Lusaka 1984).

Commercial swine are inherently prolific breeders and efficient converters of feed; they therefore have the potential to provide inexpensive animal protein to the developing world (Chidebew & Amadi, 1990). A well run commercial swine industry could therefore have a role in Zambia and this study was designed to investigate the Zambian industry with special reference to reproductive problems. As very little was known or written about the industry at the commencement of this study, it can be considered a baseline study of the industry.

This study was designed to be carried out in the developing world by using methods appropriate to the area (i.e. no reliance on sophisticated techniques) and to suggest simple management changes appropriate to the level of sophistication of the Zambian pig farmer. This work arose from an observation that the level of knowledge in many animal industries in Zambia was of a very low standard and farmers often made simple mistakes through ignorance. In Chapter 2 the literature relevant to the study is reviewed. Chapters 3 and 4 characterise the reproductive performance and status of Zambian piggeries by a general survey of pig farmers and a detailed analysis of piggery records respectively. Chapter 5 describes an abattoir study of female genital tracts to investigate genital abnormalities and reproductive parameters. An experiment to investigate the induction of puberty is found in chapter 6. A general discussion and conclusion follows in chapter 7.

Figure 1.1 Zambia, showing its geographical position and administrative divisions

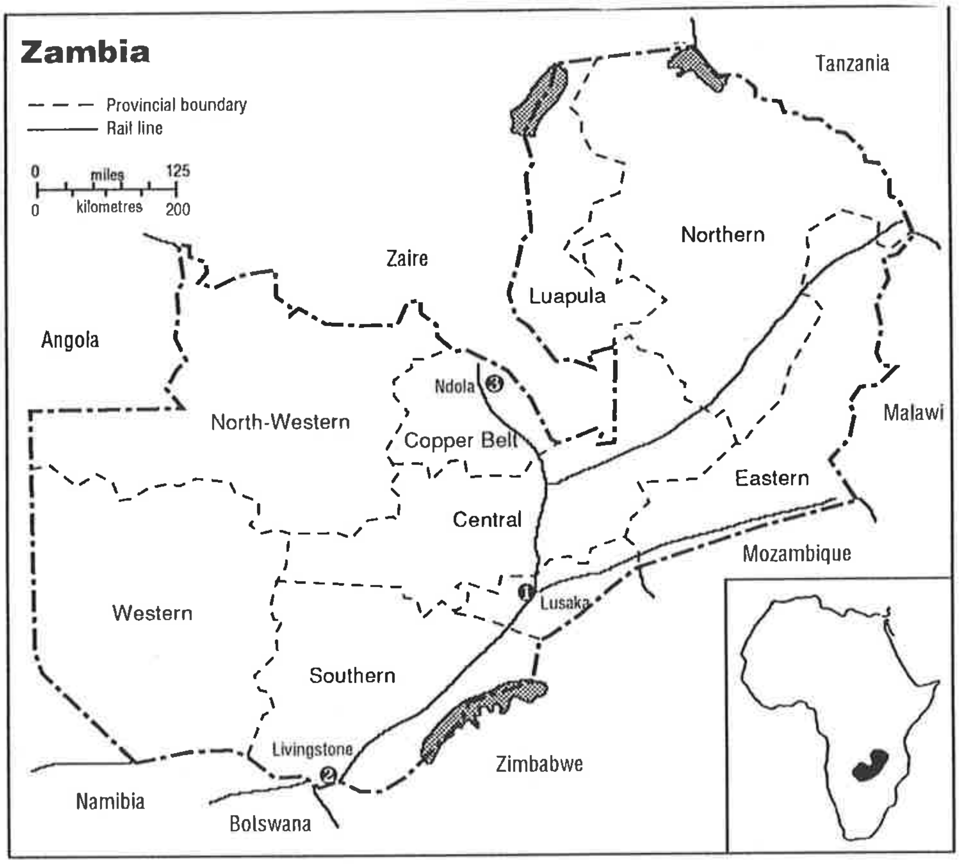
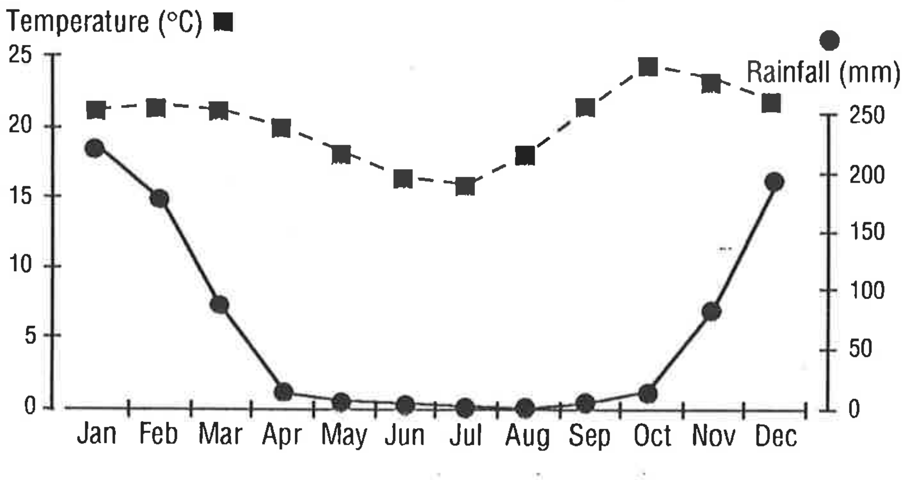


Figure 1.2 Mean monthly temperature and rainfall in Lusaka, Zambia



Source: Meteorological Dept, Lusaka, Zambia

CHAPTER 2. LITERATURE REVIEW

2.1 THE ZAMBIAN COMMERCIAL SWINE INDUSTRY.

The commercial swine industry, with most other agricultural and industrial developments, is centred along the line-of-rail (see Figure 1.1) in Central, Copperbelt, Lusaka and Southern Provinces.

The commercial swine industry in Zambia is small. Its size was estimated to be 6,735 and 5,200 breeding sows in 1973 and 1982 respectively (GRZ, 1973 & 1985). Pig feed comprised 5% of total stock-feed milled while 85% was used by the poultry industry (GRZ, 1983a) and in 1983-4 pig farmers received 0.24% of agricultural loans compared with 82.73% for the cropping sector (GRZ, 1986). Pig meat comprised 9.8% of total meat consumption in 1973, and by 1980 this percentage had dropped to 7%, or 0.5 kg *per capita* (Ncube, 1983). By contrast, consumption of pig meat in a developed country, Australia, was 11.6 kg *per capita* in 1971 (Aust. Govt., 1972).

Information on the Zambian swine industry is scant and, following the resignation of the pig adviser in 1983, there is currently no MAWD officer experienced in the industry. An estimate of overall productivity by the outgoing pig adviser was 12.8 pigs weaned/sow/year (Lynch, 1983). A survey carried out in 1973 identified 236 farms with over one sow, 46.6% of which held less than 5 sows and none held over 300 sows (GRZ, 1973). Peak pig slaughterings occurred in 1975/1976 but then progressively declined due to maize shortages, declining stock-feed quality and unfair pricing structures. The stock-feed industry was affected by restricted import of feed ingredients and outdated and poorly maintained machinery. Local feeds were of poor quality; the true crude protein level of locally produced oil seed cake was 25% instead of the stated 43% and trypsin inhibitor in soya meal was often incompletely denatured. Declining feed quality resulted in a 25% increase in the feed conversion ratio (FCR) of the poultry industry between 1975 and 1980 (GRZ, 1983a). Farmer's complaints of poor quality stock-feed often appeared in the press (Times of Zambia, 21/3/1988 & 2/2/1989) and pig farmers complained to the Prime Minister about the quality of stock-feed produced by the National Milling Company (NMC) (Commercial Farmers Bureau of Zambia, pers. comm., 1984)

Most pig meat marketing was carried out through the parastatal (government owned company) Zambia Pork Products Ltd (ZAPP) which, in the early eighties, tried to recoup losses by increasing the consumer price and reducing the producer price of pig meat. The profitability of pig farming was compromised; between 1975 and 1983 the producer price of pig meat rose by 276% while stock-feed price rose by 373% (ZAPP, NMC pers. comm., 1984). The high consumer prices reduced demand and ZAPP's liquidity problems resulted in delayed payments to producers (GRZ, 1983b). Increasing sales to private butchers occurred so that ZAPP, which held the majority of the market in the seventies and early eighties, had less than 50% of the market by 1983 (GRZ, 1983b).

Pig meat in Zambia is usually sold as a manufactured product. In the ZAPP pricing structure heavy hogs (75-100 kg cold dressed weight (cdw)) are paid a 40% premium over porkers (30-55 kg cdw) (ZAPP, pers. comm., 1990). It is usual, in developed countries, for a premium to be paid for porkers to compensate for the higher per kilogram production costs (Whittemore, 1980).

Financial losses caused many pig producers to leave the industry and, in 1985, it was recommended that the government try to reverse this trend by investing in the commercial swine industry (GRZ, 1985). However this advice was not followed.

Foreign exchange restrictions prevented the importation of breeding stock. During the early 1980's only 15 gilts were imported into the country (D. Dewer, pers. comm., 1984). Properly run nuclei of breeding stock are uncommon in developing countries (Pathiraja, 1986) and Zambia is no exception. Zambia's only breeding unit consisted of 15

Landrace sows and 9 Large White sows which sold pure stock to farmers. No new stock had been imported since the seventies and the stud was obviously lacking in genetic diversity.

In 1979, a postal survey of 1868 commercial Zambian farms attempted to determine agricultural baseline data, including numbers and sales of livestock and livestock products. The authors admitted that the data collected was marred by the respondent's poor understanding of questions. For instance, pig farmers reported keeping 3.6 times as many breeder males as females and slaughtering 4.8 times as many females as males (Kulwa *et al.*, 1983). These results must be viewed with suspicion as the usual male:female ratio in breeding stock is 1:15 to 1:25 (Hughes & Varley, 1980) and the sex ratio of slaughtered stock would be approximately equal. In addition, the average number of sows per farm was reported to be 529 when only one piggery of over 300 sows existed in Zambia at that time (G. Lynch, pers. comm., 1984). There were such obvious problems with this survey that the results were probably of questionable use.

2.2 GENERAL PIGGERY MANAGEMENT

While every piggery is different and requires different management techniques and production targets, some generalisations from the literature can be related to the Zambian swine industry. In this study developed and developing countries are categorised according to FAO guide-lines (FAO, 1990).

Most countries have extension programmes directed towards their primary producers which aim to improve financial and physical efficiency but in developing countries these are often inadequate (Payne, 1981). The value of extension advice was demonstrated in Australia where a three year extension programme improved piggery productivity and profitability (Mercy & Buddle, 1990).

Studies show growth rates of 120 kg in 8 months in UK. (Whittemore, 1980), 70-80 kg in 5 months in Australia (Gardner *et al.*, 1990) and 90 kg in 7 months in Kenya (N. Kabare, pers. comm., 1991). FCR for baconers was quoted as under three (N. Kabare, pers. comm. 1991) and between three and four in the U.K. (Whittemore, 1980).

The most common European pig breeds are Large White and Landrace, usually employed in crossbreeding programmes (Hill & Webb, 1982). Large Whites adapt well to the tropics (Smith, 1982) and are used, with Landrace, extensively in the developing world (see Tables 2.1 and 2.2). Crossbreeding programmes are commonplace in the developed world but lack of exploitation of heterosis is a common cause of low productivity in piggeries in developing countries (Pathiraja, 1986). Inbreeding results in delayed puberty, irregular breeding, low litter size and decreased piglet survival (English *et al.*, 1982; Hill & Webb, 1982).

Pigs may be housed in degrees of environmental control ranging from fully extensive (all pig kept outside) to fully intensive (all pigs housed inside). Designs which retain heat are common in the temperate regions but in the tropics it is common to use natural ventilation for cooling.

2.2.1 Stock replacement.

2.2.1.1 Sow replacement.

The average productive lifetime of sows in developed countries was found to be approximately 3.5 litters (Pomeroy, 1960a; D'Allaire, 1987; Bhatia, 1989) while annual culling rates varied from 33% (Hughes & Varley, 1980) to 49.6% (D'Allaire, 1987). In general, 33% of all sows were culled for reproductive reasons, 8% to 14% because of old age, 9% to 32% for locomotor problems; 8% to 12% of sows died (Pomeroy, 1960a; Hughes & Varley, 1980; English *et al.*, 1982; D'Allaire, 1987; Bhatia, 1989). Some piggeries cull routinely after a maximum parity as older sows have a higher maintenance cost, increased numbers of still-born piglets and decreased numbers weaned compared with younger sows (English *et al.*, 1982).

Gilt selection is an essential part of the sow replacement programme. They are usually selected from the weaner pool and managed appropriately; selection guide-lines should take into account the performance of dam and sire, FCR, carcass composition and physical conformation (English *et al.*, 1982).

2.2.1.2 Boar replacement

Piggeries import boars to increase the genetic diversity of the herd, for the heterosis affect of crossbreeding and to introduce improved genetic traits. Boars are usually purchased at less than 12 months of age, are gradually introduced to work until they reach the age of full fertility at 12 to 18 months and continue working for two to five years (Hughes & Varley, 1980; Whittemore, 1980). A recent study of Canadian piggeries indicated that the average working lifetime of boars was 20 months and the annual replacement rate was 59.4%. The majority of boars (47%) were culled because they were considered too old or heavy, 18% for poor reproductive performance and 12% for locomotor problems (D'Allaire & Leman, 1990). Inbreeding increases and genetic gain decreases with increasing culling age (Gardner *et al.*, 1990).

2.2.2 Mating policy.

The boar:sow ratio should be planned to avoid over- and under- working boars. While variation exists in the recommended weekly matings per boar, in general the boar:sow ratio varies from 1:15 to 1:25 (Hughes & Varley, 1980; Whittemore, 1980).

For individual mating, litter size increased and return rate decreased when the number of matings per heat was increased from one to three (English *et al.*, 1982; Clarke *et al.*, 1988). In group mating, several sows and one or more boars run together and it is assumed that every sow will eventually be mated. However unmated sows are difficult to detect and the performance of individual boars cannot be assessed.

Without veterinary advice, many piggery diseases could not be diagnosed by the pig farmer. Therefore only common and easily recognised diseases were included in this study.

2.2.3 Common piggery diseases

2.2.3.1 Piglet scours.

Scours may affect 70% of piglets with mortality approaching 100% (Taylor, 1981; English *et al.*, 1982). Overall, scours are a small but significant contributor to pre-weaning piglet death (Cutler *et al.*, 1989). They are usually caused by *Escherichia coli* (*E.coli*) infection from the sow or environment and affected piglets produce watery diarrhoea and appear dehydrated and listless. The chance of infection is reduced by attention to hygiene, a warm piglet environment, adequate intake of colostrum at birth and reducing the chance of introduction of new strains (English *et al.*, 1982). Vaccination of sows prior to farrowing with pathogenic strains has had some success (Cutler *et al.*, 1989) and antibiotic treatment is useful (Taylor, 1981).

2.2.3.2 Internal parasites.

Diagnosis of nematode infestations is usually made at slaughter when adult worms are found in the intestines or from larval migrations in offal. Infection rates may be high; in Australia 79% of piggeries surveyed had internal parasites (Mercy *et al.*, 1989). In Zambia, Ascaris infection (*Ascaris suum*) is the most common but whip worm (*Trichuris suis*) and nodular worm (*Oesophagostomum dentatum*) also occur (D.Shandomo, pers. comm., 1984). Infection occurs by direct ingestion of infective larvae passed in the faeces of affected animals and is usually controlled by the use of antihelminthics and slatted floors in intensive housing. Adult pigs tolerate a population of worms but a large worm burden in young pigs results in reduced growth rates, diarrhoea and increased FCR (Taylor, 1981). The chance of infection is reduced by treating sows with antihelminthic prior to farrowing and good hygienic practices (Taylor, 1981; English *et al.*, 1982).

2.2.3.3 Mange

Mange is caused by the mange mite *Sarcoptes scabei var suis* which burrows into the skin causing irritation and skin lesions. In the U.K., the incidence is 20% of breeders and 45% of growers (Taylor, 1981). Irritation by mange mites causes stock to become restless, lose condition and increases FCR. Most adult pigs can tolerate some mites but malnutrition, infection and stress may increase mite numbers. Mange is treated with chemical washes (Taylor, 1981; English *et al.*, 1982), pour-ons + ivomectins.

2.2.3.4 Thin sow syndrome (TSS).

TSS is a nutritional disorder occurring when sows lose weight over successive lactations and pregnancy and eventually leads to infertility (Taylor, 1981). Adequate feeding in pregnancy and lactation and attention to weight changes in sows can prevent the condition.

2.2.3.5 Mastitis, metritis and agalactia (MMA)

MMA is caused by a combination of metabolic, bacterial, hormonal and stress factors. It is a complex of symptoms including increased respiration, fever, tachycardia, depression, inappetance, mastitis, agalactia and vulval discharge (English *et al.*, 1982). One or more of these symptoms may appear 12 to 72 hours after birth and may resolve spontaneously within a further 72 hours, by which time the litter may have died (Taylor, 1981). The condition is possibly idiopathic and may affect most of the herd or a few sows but is most common in confined herds and in old, fat sows (Taylor, 1981; English *et al.*, 1982).

2.3 SOW PRODUCTIVITY

The aim of a piggery is to sell a maximum number of pigs with minimum costs. The efficiency of a piggery is influenced by fertility of breeding stock, survival of growing pigs and feed conversion. Production, the number of piglets weaned/sow/year, is determined by:

(1) sow fecundity (litters/sow/year),
(2) sow prolificacy (litter size) and
(3) loss between birth and sale.

These parameters influence the profitability of piggeries by determining the efficiency of utilization of feed and facilities (English *et al.*, 1982), therefore the literature relevant to production is reviewed below.

2.3.1 Fecundity

Fecundity, expressed either in days (farrowing interval) or as the number of litters/sow/year (farrowing index), is determined by the sum of herd average days of gestation, lactation and weaning-to-conception interval or may be calculated by dividing total farrowings by sows-on-hand.

Table 2.1 shows mean fecundity to be over 2 litters/sow/ year and, generally, to be higher in developed than developing countries.

Hereafter farrowing index, sow-record-card, weaning-to-service interval and weaning-to-conception interval will be abbreviated to FI, SRC, WSI and WCI respectively.

2.3.1.1 Gestation Length

Of the parameters comprising farrowing interval, gestation length has been shown to have the least variation. A large commercial herd reported mean gestation length as 115 days with 92% of values falling within two days of the mean (English *et al.*, 1982). In a summary of available literature, swine mean gestation length ranged from 113.6 to 116.4 days (see Table 2.1) and little variation between breeds of pigs and countries was reported (Hughes & Varley, 1980).

Hughes and Varley (1980) believed that gestation length was not affected by external stimuli or litter size unlike other polytocous species. However longer gestations were found

Table 2.1. Indicators of fertility: Fecundity

Country	Breed	Number	G.L. (day)	WSI (day)	L.L. (day)	F.Int. (day)	FI	Author
<u>Temperate and developed countries</u>								
Holland	National average						2.18	Ogink, 1989
U.K.	National average						2.10	Ockerman & Reese, 1981
U.K.	National average			23.0	29.0		2.20	English et al., 1982
Australia	38 farms						2.13	Gardner et al., 1990
Australia	mixed	7 farms		12.4	37.2	167.9	2.17	Hubbard et al., 1976
Australia	LW, LR LWxLR	9519 sows		8.2		149.9	2.43	Paterson et al., 1980
Australia	LW	43 sows	113.5	12.0	37.0	163.0	2.20	Henry, 1969
<u>Tropical and developing countries</u>								
Malaysia	range of 4 farms		114.4 -116.4	14.24* -28.67*		157.2 -171.3	2.30 -2.13	Shanmugaveu et al., 1988
Kenya	LW	3 farms		21.0*	56.0	194.0	1.88	Kabare, 1991
Cuba	NA	694 sows	115.2			170.0	2.10	Rico, 1988
Nigeria	LW HS	70 sows 55 sows	114.6 114.4					Adebambo, 1986
Phillipines	mixed	50 sows	115.1					Reyes, 1985
India	LW	12 sows	114.2					Mishra et al., 1985

TITLES; G.L. = gestation length; WSI * denotes WCI
L.L. = lactation length; F. Int. = farrowing interval
FI = farrowing index

BREEDS; LR = Landrace, LW = Large White, HS = Hampshire, SB = Saddleback
NA = not available

from July to September in Cuba (Rico, 1988) and an inverse relationship between litter size and gestation length was reported (English *et al.*, 1980; Tomes & Neilsen, 1982).

2.3.1.2 Lactation Length

Reduction of lactation length can influence the overall productivity of the herd by decreasing FI. In traditional six to eight week lactations, most sows returned to service within five days of weaning and a FI of two was achieved. Today, many piggeries use shorter lactations to gain an increase in 0.1 in the FI for each week reduction of lactation (English *et al.*, 1982; Tomes & Nielsen, 1982). Often lactations of less than 35 days have compromised fecundity by concomitant increased WSI and reduced subsequent litter size (Cole *et al.*, 1975; English *et al.*, 1982; Varley, 1982; Jea, 1989).

The adoption of early weaning depends on excellent management and reliable supplies of creep feed based on milk powder (English *et al.*, 1982). In the developing world, management is often less efficient, stock-feed quality unreliable and milk powder a scarce or expensive commodity; hence more conservative lactation lengths are employed. Recent studies in India reported lactations of 8 to 9 weeks with no creep feed (Rai & Desai, 1985; Singh *et al.*, 1986) compared with lactations of less than 37 days in the developed world (Table 2.1).

2.3.1.3 Weaning to Conception Interval

The WCI, mean time from weaning to oestrus plus returns due to conception failure, is a non-productive period for sows and should be minimised for herd efficiency (English *et al.*, 1980). The majority of sows should return to service within five days of weaning but anoestrus, missed heats and conception failures all contribute to mean WCI being much greater (Phillips & Zeller, 1941; Aumaitre *et al.*, 1976; Fahmy, 1981). Table 2.1 shows WSI and WCI as less than 12.4 days and 28 days respectively for lactations longer than 30 days.

WSI was reduced by adequate feeding levels in lactation and post weaning, increased lactation length, use of crossbreed sows, increased parity number and post- weaning boar exposure (Meredith, 1979; Fahmy, 1981; Henderson & Hughes, 1984; King and Williams, 1984a; King, 1987; Jea, 1989). Sows were considered to be anoestrus when no heat was detected within 10 days of weaning (Meredith, 1979) and they comprised 4% to 42.5% of breeding sows (Henry 1969; Wrathall, 1971; English *et al.*, 1982; Tarocco, 1989). The percentage was higher for primiparous than multiparous sows (Paterson *et al.*, 1980; Hurtgen & Leman, 1981) and was one of the major factors contributing to the reduced fertility of primiparous sows (Brooks, 1982). Anoestrus was more common in the hotter months (Tomes & Nielsen, 1979; Fahmy, 1981; English *et al.*, 1982), especially in gilts (Hurtgen & Leman, 1981) and delayed oestrus was associated with a shorter standing heat and lower subsequent litter size (Tomes & Nielsen, 1982).

To maintain herd fertility, Hughes and Varley (1980) recommended culling sows which were in anoestrus 35 days after weaning.

Conception is influenced by the timing of mating, boar fertility and behaviour, season, nutrition and previous lactation length (Hughes & Varley, 1980; English *et al.*, 1982). In a well run pig unit, over 90% conception is possible but, in general, under 75% of sows conceive within 14 days of weaning (Fahmy, 1981). Non-detection of returns may affect 15% to 20% of sows (Love, 1981) and may be caused by silent heat or early embryonic loss delaying returns to outside the expected period (Glossop & Foulkes, 1988).

Lower FI during periods of high temperatures, mainly affecting gilts, was related to delayed WSI, prolonged returns to service, increased abortions, increased incidence of silent heat (Hurtgen & Leman, 1981) and may be associated with reduced boar fertility (Stone, 1983).

2.3.2 Prolificacy

Table 2.2 compares litter traits for pigs in the developed and developing world. The number born alive and weaned were higher and losses between birth and weaning were lower in developed than undeveloped countries.

2.3.2.1 Litter Size

Maximization of numbers born alive is of primary importance to the pig farmer and a significant contributor to farm profitability (Hughes & Varley, 1980). Although litters of 15 to 25 are theoretically possible (Hughes & Varley, 1980), Table 2.2 shows that, with European breeds actual litter sizes are much lower.

Ovulation and fertilization rates were not believed to limit litter size in sows by some authors (Hughes and Varley 1980) but ovulations of less than 23 ova were considered limiting by others (King & Williams, 1984b). Far more important in determining litter size is embryonic death, fetal death and perinatal losses. The major area of loss occurs during early pregnancy, accounting for up to 40% of fertilized ova, and is influenced by nutrition, uterine infection, management, environmental temperature and breed (Hughes & Varley, 1980; Dzuik, 1987). Breed differences for litter size range from 4.6 to 17 piglets in the wild boar and

Table 2.2. Indicators of fertility: Prolificacy and Loss

Country	Breed	Number	Litter size Alive (Pig)	Dead (Pig)	Total (Pig)	Wean (Pig)	Loss Pre-wean %	Author
Temperate and developed countries								
Australia	38 farms		9.9	0.8	10.7	8.6	13	Gardner et al., 1990
Holland	National average		10.5			9.0	14.0	Ogink, 1989
U.K.	National average		10.4	0.6	11.0	8.8	17.3	Hughes & Varley, 1980
Holland	mixed	126 farms	10.4			8.9	14.5	Dijkhuizen
		145 farms	10.3			9.1	12.0	et al., 1989
U.K.	SB	18 farms	9.4	0.9	10.2	8.4		Morton, 1978
Australia	mixed	7 farms	9.7	0.5	10.2	8.4		Hubbard et al., 1976
Australia	LW, LR, LWxLR	9519 sows	8.7	0.6	9.2	7.5	13.6	Paterson et al., 1980
Australia	LW	43 sows	10.4			8.2	20.4	Henry, 1969
Tropical and developing countries								
Kenya	LW	3 farms	9.8			8.1	17.3	Kabare, 1991
	LR		8.8			7.5	14.9	
	HS		7.1					
Cuba	NA	694 sows	7.4	0.4	7.8	6.2	16.2	Rico, 1988
Brazil	LW, LR	682 sows	9.0	0.7	9.8			Irgang & Robison, 1984
Nigeria	LW	289 sows	8.9	0.4	9.3	7.0	21.4	Steinbach , 1976
	LR	167 "	9.2	0.7	9.9	7.2	22.2	
India	LW	125 sows	8.1	1.6	9.7	5.3	23.8	Rai & Desai, 1985
Nigeria	LW	70 sows	8.1	1.5	9.6	8.7	28.2	Adebambo, 1986
	HS	55 "	7.3	0.9	8.2	7.9	17.8	
	LWxHS	85 "	7.9				22.8	

Table 2.2. (Cont.) Indicators of fertility: Prolificacy and Loss

Country	Breed	Number	Litter size Alive (Pig)	Dead (Pig)	Total (Pig)	Wean (Pig)	Loss Pre-wean %	Author
<u>Tropical and developing countries</u>								
India	LW	50 sows	6.9			5.5	21.0	Chatterjee et al., 1988
India	LW	12 sows	6.8			5.8		Mishra et al., 1985
Sri Lanka	NA	10 sows	10.6			8.4		Goonewardene et al., 1984

BREEDS; LR = Landrace, LW = Large White, HS = Hampshire, SB = Saddleback
NA = not available

Chinese Meishan respectively (Mauget, 1982; Legault, 1985).

Litter size was affected by number of matings (Clarke *et al.*, 1988) and breed of dam (Adebambo, 1986) while the breed of sire was reported to influence litter size in one study (Adebambo, 1986) but not in another (Bittante *et al.*, 1990). Total and still-born litter size increased with parity but the number born alive increased from the first to the fifth or sixth litter, declining thereafter (Henry, 1969; Paterson *et al.*, 1980; English *et al.*, 1982; Reyes, 1985; Singh *et al.*, 1986).

Seasonal effects on litter size were documented in the developing world (Mohanty & Nayak, 1986; Singh *et al.*, 1986) while reports from the developed world were conflicting; a Swedish study showed smaller litter sizes in autumn (Jørgensen, 1989) while no seasonal effect was found in Denmark or Australia (Tomes & Nielsen, 1979). Total litter size includes both numbers born alive and dead. Table 2.2 shows that still-births account for approximately 0.8 piglets per litter. Randall (1972) demonstrated that 25% and 75% of still-born piglets died before and during parturition respectively. Still-born piglets accounted for 4% to 8% of total litter size; the percentage varied with total litter size (Phillips & Zeller, 1941; Flint *et al.*, 1982) and was influenced by sire (Chhabra *et al.*, 1983).

Fetal anoxia was the most common cause of death, the majority of which occurred during the last third of parturition and involved piglets from the anterior parts of the uterine horns (Randall, 1972). Successive contractions of a protracted labour and piglet movement through undilated uterine tissue caused reduced placental blood flow, ruptured umbilicus and detached placenta reducing blood supply to the fetus and causing anoxia (English & Wilkinson, 1982; Taverne, 1982). A positive correlation between the number of stillborn piglets, duration of parturition (Leman *et al.*, 1979; Randall, 1972) and parity was established (Paterson *et al.*, 1980; Chhabra *et al.*, 1983), possibly due to increased fatigue and decreased muscle tone in older sows (English *et al.*, 1982).

Table 2.2 shows that the percentage of piglets born dead was lower in the developed world than in the developing world. High ambient temperature was suggested as having a role as more still-births occurred in the warmer months in Nigeria (Steinbach, 1976).

Intrapartum deaths were reduced by attendance during farrowing and therefore the sows could be assisted when required (English *et al.*, 1982). Reducing parturition time, and thus the probability of anoxia, with parasympathomimetic drugs reduced the numbers of piglets still-born (English & Wilkinson, 1982).

2.3.3 Piglet loss

The piglet is born with sparse hair covering, little subcutaneous fat, limited energy reserves and a high surface to volume ratio. To survive it needs colostrum immediately after birth, a warm environment and adequate appropriate feed.

Table 2.2 shows that pre-weaning losses are significant and approach 30% in the developing world. Over 50% of deaths were attributed to crushing and starvation while genetic abnormalities, disease and savaging caused 12%, 6% and 6% of deaths respectively (English *et al.*, 1982). Most deaths (over 50%) occurred within the first two days of a piglet's life and were related to events during parturition (English & Wilkinson, 1982). Piglets born with low liver glycogen (associated with anoxia and low birth-weight) had less control of their body temperature, could compete less well with their litter-mates for milk and were more likely to die of starvation or overlying than litter mates with adequate glycogen (English *et al.*, 1982). In the developing world, most pre-weaning losses occurred during the colder months (Singh *et al.*, 1986). Perhaps tropical housing did not adequately protect piglets from cold temperatures.

Management strategies to improve the piglet's chance of survival were reviewed by Cutler and others in 1989. Access to a creep area heated to 30°C, which conserved piglet energy reserves and attracted piglets away from the sow, reduced mortality and increased growth rate. Deaths from weakness and starvation were minimised by ensuring that all piglets suckled immediately after birth and by supplementing small piglets with milk. Fostering was used to correct extremes in litter size and litter weight thereby reducing bullying. Well designed farrowing accommodation minimised the chance of overlying by an uncomfortable or clumsy sow. Cross- breeding increased piglet vigour and improved survival (English & Wilkinson, 1982). The provision of fresh, easily digestible creep-feed improved piglet growth rate, survival and adjustment to solid food at weaning (English *et al.*, 1982).

Post-weaning loss represents the most expensive loss to the pig farmer but is usually so low that figures are not given in pig production texts (Hughes & Varley, 1980; English *et al.*, 1982). Losses are most likely to occur in early weaned and light litters or those where piglets were unaccustomed to solid food before weaning.

2.3.4 Piglet weights.

Piglet birth weights ideally vary from 1.3 to 1.5 kg (Hughes & Varley, 1980). In developing countries most authors quoted birth weights lying within this range (Reyes, 1985; Goonewardene *et al.*, 1984; Chhabra *et al.*, 1989) although birth weights of 0.8 kg have been reported (Mishra *et al.*, 1985). Weaning weight depends on many factors especially lactation length. In Europe, piglet weaning weights ranged from 4.5 to 4.7 kg for 21 day lactations and from 12.2 and 14.5 kg for 49 day lactations (Hill & Webb, 1982). In the developing world, weaning weights were often lower, despite lactation lengths of 49 to 56 days, and ranged from 6.5 to 10.3 kg (Goonewardene *et al.*, 1984; Nambudiri & Thomas, 1984; Rai & Desai, 1985; Adebambo, 1986; Chatterjee *et al.*, 1988; Rico, 1988).

2.4 PUBERTY

Puberty is the onset of reproductive capabilities and the stage when a gilt becomes part of the reproductive herd. As the gilt matures, plasma oestrogens rise due to their positive feedback effect on the hypothalamus. A surge of oestrogen from the ovary triggers a surge of luteinising hormone (LH) from the hypothalamus which causes the first ovulation and the commencement of cyclic activity (Elsaesser *et al.*, 1982).

The age at puberty has been reported to range from 102 to 350 days (live weights range from 55 to 120 kg) with a mean age for spontaneous puberty of 205 days (Hughes, 1982). Breed differences in pubertal age may exist but considerable within-breed variation and environmental influences have made useful conclusions difficult (Hughes, 1982). Chinese Meishan gilts reach puberty between two and four months under European management (Legault, 1985). Cross breeding reduces pubertal age (Willeke, 1986).

It has been common practice in piggeries to mate gilts at the third natural oestrus at approximately 8.5 months of age (English *et al.*, 1982). However, the efficiency of a breeding herd may be improved by stimulating early puberty in gilts thereby reducing their unproductive days between selection and mating and thus overall FCR. To maximise productivity gilts should be mated at approximately 200 days (6.6 months) of age, 100 kg live weight and at the second oestrus; to reach this target they must be stimulated to reach puberty by six months of age (Paterson, 1989). This may be effected by combining management techniques including boar exposure, nutrition and stress associated with transport, relocation or mixing unfamiliar gilts (Hughes, 1982).

Often work on the influence of early puberty on the reproduction of the gilt confounded chronological age, sexual age, live weight and growth rate. While it was accepted that ovulation rate and litter size increased with oestrus number after puberty, the different contributions of these factors were not isolated (Brooks, 1982; English *et al.*, 1982; Paterson 1989). Although delayed mating resulted in increased first litter size, over a number of parities both early and late mated gilts showed similar productivity with less feed consumed by the early mated gilts (Brooks & Smith, 1980; Young *et al.*, 1990).

Work on the role of nutrition on puberty attainment produced equivocal results as restricted feeding both delayed and stimulated puberty (Hughes, 1982). More recently, both long-term and short-term feed restrictions were shown to delay the onset of puberty (den Hartog & Noordewier, 1984; King, 1989a) and gilts fed *ad lib.* reached puberty earlier than restricted controls (Friend *et al.*, 1986). Nutritional influence may be mediated by body weight and/or body composition. A decrease in pubertal age with increased body weight at 170 days was demonstrated (King, 1989b) but others showed that pubertal age was independent of live weight in confined gilts (Knott *et al.*, 1984) and when adequate energy is fed (den Hartog, 1984).

Whittemore and co-workers, in 1980, suggested that current gilt selection and feeding regimes for lean carcasses may adversely effect subsequent productivity as gilts begin reproductive life with diminished fat reserves.

Kirkwood and Aherne, in their 1985 review, proposed that a threshold of live weight or a minimum fat-to-lean ratio was required for attainment of puberty. King (1989b) showed that gilts with higher backfat at boar introduction were older at puberty than those with lower backfat. Yet others showed that high backfat was associated with reduced pubertal age and found no evidence of thresholds for backfat, backfat-to- live weight ratio or age (Young *et al.*, 1990; N. Lundeheim, pers. comm., 1985). In a recent study gilts were tested and selected for early or late puberty and high or low backfat. High-fat gilts reached puberty earlier than low-fat gilts. Early-puberty gilts were fatter and farrowed more (and heavier) piglets than late-puberty gilts. More late-puberty gilts showed abnormal cycling patters suggesting that late puberty may be indicative of future reproductive disorders (Nelson *et al.*, 1990). The authors shared Whittemore and co-worker's (1980) concern that selection for lean gilts could lead to reproductive problems.

Perhaps backfat and live weight *per se* are not important but dynamic changes in these parameters, resulting in the mobilization of reserves, may predispose gilts to puberty. Changes in plasma substrates influence gonadotrophin release in monkeys and in the nutritionally restricted lamb, hence a change in metabolic status may influence gonadotrophin release and steroid metabolism release in the gilt (Booth, 1990).

The most powerful stimulus to induce early puberty is the exposure of gilts to the olfactory, auditory, visual, tactile and behavioural cues of the mature boar. While all these cues act synergistically to induce puberty, the role of pheromones 5α-androstenone and 3α-androstenol (present in the saliva and urine of mature boars) has been shown to be a major part of the boar effect (Booth, 1984). It has been postulated that the boar induces increased plasma oestradiol *via* increased secretion of gonadotrophin in the gilt. Release of cortisol, associated with the stress of boar introduction, may influence the pattern of LH secretion; other stress related managements (mixing, transport and relocation) have stimulated puberty or potentiated the boar effect (Hughes *et al.*, 1990).

For maximum stimulation the adult boar must have full contact with the gilts (Deligeorgis *et al.*, 1984; Hughes *et al.*, 1990). While some workers showed that fence line or limited contact resulted in some stimulation (Hemsworth *et al.*, 1988; Hughes *et al.*, 1990) others showed no stimulation by fence-line contact (Eastham *et al.*, 1986a). There appeared to be little difference in stimulation between gilts housed continuously with a mature boar or those given limited daily contact (Hughes, 1982; Hughes *et al.*, 1990) even with exposures less than 20 minutes (Paterson *et al.*, 1989b). While limited boar contact of 10 days only or two to five days per week stimulated puberty, daily contact was more effective (Paterson *et al.*, 1989a). Daily boar exposure for two weeks followed by exposure every second day induced puberty (Malayer *et al.*, 1988). From a management point of view, daily exposure is difficult and time consuming (Hemsworth *et al.*, 1988) and it would be convenient if a minimum level of contact could be established.

Confined housing may increase pubertal age (Rampacek *et al.*, 1981), possibly due to the synchronising affect of cycling gilts on pre-pubertal litter mates (den Hartog & Noordeweir, 1984). The age of the gilt at stimulation is relevant. Poor responses are seen with gilts less than 4 months old or in the immediate pre-pubertal period. The best response was found in gilts aged between 150 and 170 days at first stimulation (Hughes, 1982) however Eastham and her co-workers (1986b) found similar intervals to puberty when age at simulation was 160 and 180 days.

2.5 ABATTOIR SURVEYS OF COMMERCIAL SWINE

Many abnormalities of the porcine female genital tract may adversely affect fertility. Abattoir surveys have provided data on the physical condition of genital tracts and thus have been used to investigate infertility (Warnick *et al.*, 1950; Nalbandov, 1952; Teige, 1957). Surveys were carried out on infertile or subfertile sows and gilts (Warnick *et al.*, 1949; Nalbandov, 1952; Silveira *et al.*, 1987) or culled sows and gilts (Perry & Pomeroy, 1956; Keenan, 1980). Fewer studies have collected female pigs on a random basis (Wiggins *et al.*, 1950; Teige, 1957; Das *et al.*, 1986).

2.5.1 Reproductive potential

2.5.1.1 Maturity of animals at slaughter

Table 2.3 summarises the percentage of post-pubertal tracts in slaughtered female pigs from several abattoir surveys. The reported incidence of mature animals was lowest (1.8%) in a French study of gilts (Denmat *et al.*, 1981) and highest (98.7%) in a study of infertile sows and gilts in America (Nalbandov, 1952). Many studies did not mention pre-pubertal animals, probably because none were found (Warnick *et al.*, 1949; Perry & Pomeroy, 1956; Nath *et al.*, 1982).

Table 2.3. Puberty Attainment

Country	Number	Breed	Type	Mature (%)	Author
Canada	6927	mixed	gilts 100-115 kg	90.0	Krishnamurthy et al., 1971
USA	2967	NA	nonpregnant gilts	<75.0	Wiggins et al., 1950
Sweden	1000	NA	nonpregnant gilts 85-110 kg	20.4	Einarsson & Gustafsson, 197
France	389	mixed	gilts 100 kg	1.8	Denmat et al., 1981
India	301	mixed	sows and gilts	98.7	Das et al., 1986
UK	273	mixed	gilts 6.5-8.5 months	47.0	Pomeroy, 1960c
Norway	188	NA	gilts 85-90kg	A 4.3 B 20.3 C 44.9	Forland, 1980
USA	79	NA	infertile S & G	98.7	Nalbandov, 1952
Taiwan	66	NA	anoestrous gilts	10.6	Koh et al., 1985
Brazil	64	LW & LR	anoestrous gilts	14.1	Silveira et al., 1987
Sweden	54	NA	anoestrous gilts 10.8 months	64.8	Einarsson et al., 1974
UK	27	mixed	sows	92.6	Pomeroy, 1960a

NOTE: for TYPE column S = sows, G = gilts, liveweights given in kg
for BREED - LW = Large White, LR = Landrace, NA = not available

In a Swedish study, the mean age of pre-pubertal gilts was found to be lower than that for postpubertal gilts and a relationship was suggested between delayed puberty and subsequent poor sexual function (Einarsson *et al.*, 1974). Heavy gilts were more likely to be cycling at slaughter than lighter ones (Wiggins *et al.*, 1950).

The domestic pig is descended from the wild boar whose spring-born gilts mature earlier (Signoret, 1980 in Hughes, 1982). There is conflicting evidence for the effect of season on the attainment of puberty (Hughes, 1982); some workers found that spring-born gilts reached puberty earlier than those born in winter and autumn (Pomeroy, 1960c; Einarsson *et al.*, 1974; Scanlon & Krishnamurthy, 1974) while others reported that spring- born gilts reached puberty later compared with those born in other seasons (Wiggins *et al.*, 1950b). Photoperiod and temperature may be antagonistic as the stimulatory effect of increasing photoperiod on puberty may be inhibited by reduced feed intake at high temperatures (Steinbach, 1976; Hughes, 1982).

2.5.1.2 Ovulation rate.

Mean ovulation rate for gilts and sows of mixed breeds was 13.5 and 21.5 (Hughes & Varley, 1980) or 13.9 and 16.5 respectively (Pomeroy, 1960c). In an extensive review of the literature, Van der Lende and Schoenmaker (1990) gave the non-induced ovulation rate as 10.7 and 9.46 for gilts and 16.43 and 15.09 for sows (the two figures correspond to animals examined 17 to 35 days and after 35 days *post coitum* respectively; breeds were not stated). The high figures for Hughes and Varley (1980) may have been due to the inclusion of hormone induced females. The authors of a survey of 67 gilts and 571 sows, carried out in Australia found mean ovulation rates of 9.4 and 13.3 respectively and concluded that low productivity in Australian pig herds was related to low ovulation rate (Penny *et al.*, 1971).

There is a genetic component to ovulation rate. The Large White has a higher ovulation rate than Landrace while Chinese prolific breeds are significantly higher than European breeds (Legault, 1985).

Mean pubertal ovulation rate ranged from 9.8 to 11.3 in the United Kingdom and Australia (Hughes & Varley, 1980; Paterson *et al.*, 1980). Ovulation rate increases from the pubertal oestrus and is influenced more by sexual than chronological age (Hughes & Varley, 1980; Brooks, 1982). The results of studies on the influence of live weight on ovulation rate have been conflicting and difficult to interpret due to the confounding of body weight and age (Hughes & Varley, 1980).

Most workers have shown no influence of season on ovulation rate (Hughes & Varley, 1980). Penny and co-workers (1971) found that ovulation rates were highest in summer and lowest in winter; a surprising finding as summer is usually a period of reduced fertility in swine (Tomes & Nielsen, 1979 & 1982) and anoestrus in the wild boar (Mauget, 1982).

2.5.1.3 Pregnancy

The slaughter of pregnant culls results in loss to the pig industry as these animals could have been retained for the duration of the pregnancy and pregnant fattening stock give reduced dressing percentage as weight gain is divided between the conceptus and maternal growth. Pregnancy rates of 3.7%, 3.8%, 11.1% and 1.5% were reported in samples of culled sub-fertile sows and gilts (Einarsson *et al.*, 1974; Keenan, 1980; Nath *et al.*, 1982; Koh *et al.*, 1986), presumably as a result of incorrect pregnancy diagnosis or emergency culling. Penny and co-workers (1971) showed that while ovulation rate was higher in the left ovary than the right, this disparity was not reflected in the implantation of embryos in the uteri. Pre-implantation migration of embryos between the two uteri resulted in approximately equal numbers of fetuses in the two horns. Mean fetal loss averaged 34.8%; most of which occurred within the first 29 days of pregnancy.

2.5.2 Congenital abnormalities of the genital tract

Congenital abnormalities of swine are frequently reported in the literature, a summary of which can be found in Tables 2.4a and 2.4b. They occur in any part of the genital tract and may impair fertility by either reducing litter size or preventing conception. Malformations of the female genital tract most commonly occur because of a developmental inhibition, are often genetically based (Teige, 1957) and may be detected by rectal examination (Silobad, 1972).

With the exception of the vestibule, which arises from the *sinus urogenitalis*, the female genital tract is formed from the embryonic Mullerian ducts, the caudal extent of which is represented by the hymen (Teige, 1957). Hymenal fragments have been covered in other studies but will not be discussed here.

2.5.2.1 Hermaphrodites

Hermaphroditism is relatively common in the pig (Teige, 1957; Keenan, 1980). Table 2.4a shows that its occurrence ranged from 0.3% to 7.58% ; surveys of large numbers of randomly selected female swine showed the incidence to be under 1.8% (for references see Table).

Table 2.4a. Congential abnormalities of swine

Country	No.	Type of female	Paraovarian cysts (%)	Hermaphrodite (%)	Author
U.K.	62	sterile sows		1.6	Pomeroy, 1960b
Taiwan	66	anoestrous gilts		7.58	Koh et al., 1985
Yugoslavia	180	infertile sow & gilts	3.0		Vrbanac et al., 1975
U.K.	200	random females		1.5	Scofield et al., 1969
India	301	sows and gilts	1.32		Das et al., 1986
Ireland	812	cull sows & gilts	12.2	0.6	Keenan, 1980
U.K.	863	cull sows and gilts	0.12		Perry & Pomeroy, 1956
Sweden	1000	nonpregnant gilts	14.1	0.3	Einarsson & Gustafsson, 1970
Poland	1600	abattoir collection		1.05	Pejak & Kozaczynski, 1983
Yugoslavia	2911	infertile sows & gilts	23		Silobad, 1972
Australia	4000	random sows & gilts		0.48	Pfeffer & Winter, 1977
Canada	6927	random gilts		0.53	Krishnamurthy et al., 1971

Table 2.4b. Congential abnormalities of swine - the Mullerian ducts and *sinus urogenitalis*

Country	No.	Type of female	Aplasia (%)	Duplic-ation (%)	Hydro-metra (%)	Hydro-salpinx (%)	Author
India	45	Adult females	8.9			2.2	Nath et.al., 1982
U.S.A.	63	hard to settle sow and gilt	11.1	-	0	33.0*	Warnick, Grummer & Casida, 1949
Brazil	64	anoestrus gilts			4.7		Silveira et al., 1987
U.S.A.	79	infertile females	10.1			21.5*	Nalbandov, 1952
U.K.	165	gilts >10 months	0.6	0.6			Reed, 1970
India	301	random females	2.3		1.7¦	2.9	Das et.al., 1986
Ireland	812	cull gilts & sows	0.5		1.2		Keenan, 1980
U.K.	863	cull gilts & sows	0.4			0.4*	Perry & Pomeroy 1956
Sweden	1000	nonpregnant gilts	0.8	1.9	3.3		Einarsson & Gustafsson, 1970
U.S.A.	5088	random females	0.7	0.1		1.4*	Wiggins, Casida & Grummer, 1950
Denmark	9726	random sow & gilt	0.8	0.2		0.1#	Teige, 1957

* indicates both hydrosalpinx and pyosalpinx.
# indicates both hydrosalpinx and bursitis
¦ indicates hydrometra in association with cystic ovaries

Ambiglandular hermaphrodites have both ovarian and testicular tissue. Testicular pseudohermaphrodites have testes but the external genitalia appear female; ovarian pseudohermaphrodites have ovaries only with masculinised external genitalia (Pfeffer & Winter, 1977). The ambiglandular hermaphrodite was reported as the most common form by some authors (Krishnamurthy *et al.*, 1971; Pfeffer & Winter, 1977; Keenan, 1980; Pejsak & Kozaczynski, 1983) and testicular pseudohermaphrodite by others (Gerneke, 1967). Detailed microscopic examination showed that most hermaphrodite testes may be ovotestes with very small amounts of ovarian tissue (Pfeffer & Winter, 1977). The majority of hermaphrodites had complete female secondary sexual organs which varied in normality. In some cases an epididymis formed ipsilateral to a testis. Often the clitoris was enlarged allowing external diagnosis of the condition (Pfeffer & Winter, 1977). Hydrometra often indicated a blockage in the cervix (O'Reilly, 1979).

Most hermaphrodites were infertile as the ovarian tissue was often inactive, cystic or atretic (Krishnamurthy *et al.*, 1971) but some have been reported with normal ovaries, regular oestrous cycles and pregnancy (Gerneke, 1967; O'Reilly, 1979) but high embryo mortality (Hunter *et al.*, 1985). There were no recorded ovulations from an ovotestis. Testicular tissue was devoid of spermatogenesis, had increased Leydig and Sertoli cells, had excessive lipid droplets (Pfeffer & Winter, 1977; O'Reilly, 1979) and a vacuolated appearance (Keenan, 1980). The epididymis appeared normal but without sperm (Scofield *et al.*, 1969; Keenan, 1980).

Economic loss attributed to hermaphrodite pigs has been demonstrated by its occurrence in pigs selected for breeding (see Table 2.4a) and their reduced reproductive ability. At slaughter, the carcass quality may be affected by boar taint (Pfeffer & Winter, 1977.

2.5.2.2 Paraovarian cysts

Paraovarian cysts arise from vestiges of the Wolffian duct system, lie in the mesosalpinx or mesovarium and vary in size from a few millimetres to 5 cm in diameter, (Jubb & Kennedy, 1970). They have been infrequently reported in the literature of porcine genital abnormalities as they are not usually considered to influence fertility (Keenan, 1980). However, as Table 2.4a indicates, in those studies in which they are noted cysts are relatively common and their incidence has been reported to range from 7.8% to 23%. Perry & Pomeroy (1956) reported only one large fimbrial cyst but made no comment on smaller cysts. The majority of cysts occurred unilaterally or bilaterally (Keenan, 1980) and in the infundibulum (Einarsson & Gustafsson, 1970). While they may reduce litter size by interfering with the passage of ova to and down the oviduct (Einarsson & Gustafsson, 1970), their presence has not been correlated with subfertility (Keenan, 1980).

2.5.2.3 Developmental abnormalities of the Müllerian ducts and *sinus urogenitalis*

2.5.2.3.1 Aplasia and hypoplasia

Table 2.4b shows that the occurrence of segmental aplasia varied from 11.1% (Warnick *et al.*, 1949) to 0.3% (Perry & Pomeroy, 1956). It was more common in gilts than in sows (Warnick *et al.*, 1949; Nalbandov, 1952; Teige, 1957; Keenan, 1985), presumably due to early culling for infertility.

Unilateral aplasia varied in severity from the absence of one entire uterine horn, fallopian tube and ovary to a small aplasia constricting the uterus; left and right sides were affected with equal frequency. Bilateral malformations ranged from localised aplasias in both uteri to the absence of the entire tract anterior to the vestibule (Teige, 1957). Unilateral aplasia was more common than bilateral aplasia (Warnick *et al.*, 1949; Wiggins *et al.*, 1950; Einarsson & Gustafsson, 1970).

Aplasia of the oviduct was considered to be rare by Scandinavian workers (Teige, 1957; Einarsson & Gustafsson, 1970) but others have reported incidences of 2.2%, 1% and

0.12% (Nath *et al.*, 1982; Keenan, 1985; Das *et al.*, 1986). *Uterus unicornis* was recorded in 0.6% and 0.12% of infertile female pigs (Wiggins *et al.*, 1950; Keenan, 1985); pregnancy and parturition has been reported with this condition but with low litter size (Nalbandov, 1952). The unilateral blind uterus, with parts distal the aplasia distended with fluid, was the most common malformation encountered in American studies. While pregnancy was theoretically possible in such animals it rarely occurred (Warnick *et al.*, 1949; Nalbandov, 1952).

2.5.2.3.2 Duplicated segments

Duplicated segments arise during fetal development by incomplete fusion of the Müllerian ducts (Teige, 1957; Einarsson & Gustafsson 1970). It is a rare event and the majority of authors report no duplication of the genital tract in swine (Warnick *et al.*, 1949; Nalbandov, 1952; Perry and Pomeroy, 1956; Nath *et al.*, 1982; Keenan, 1985; Das *et al.*, 1986). Table 2.4b reports a lower incidence of duplicated parts than aplasia, with the exception of the study by Einarsson and Gustafsson (1970). Duplication commonly involved the cervix and vagina (Wiggins *et al.*, 1950) or uterine horn (Teige, 1957; Einarsson & Gustafsson, 1970). Doubling of the genital tract did not preclude pregnancy (Wiggins *et al.*, 1950) but often led to abortion or dystocia (Teige, 1957).

2.5.2.3.3 Hydrosalpinx and hydrometra

Occlusion of the fallopian tubes and cervix respectively causes hydrosalpinx and hydrometra by accumulation of fluid and distension of tubal parts distal to the occlusion. Table 2.4b shows that, with the exception of Das and others (1986), hydrometra and hydrosalpinx were not reported concurrently. This is an interesting observation but the reasons for it are not known.

Nalbandov (1952) reported that bilateral hydrosalpinx caused permanent sterility and was the major cause of infertility in swine. It occurred in nulliparous females and was bilateral in 97% of cases. The occlusion was always found at the same point in the oviduct. A bacterial role was experimentally eliminated in its etiology and hydrosalpinx was assumed to be caused by obstruction of the oviduct by remnants of the Wolffian duct system (Warnick *et al.*, 1949; Nalbandov, 1952; Teige, 1957).

Contrary evidence points to non-congenital factors in the etiology of hydrosalpinx as its incidence was influenced by season and body weight (Wiggins *et al.*, 1950). It was associated with cystic ovaries (Perry & Pomeroy, 1956; Das *et al.*, 1986) and ovary or uterine adhesions (Perry & Pomeroy, 1956; Nath *et al.*, 1982; Das *et al.*, 1986). In cattle, hydrosalpinx was assumed to be caused by infection following parturition (Rowson, 1942; Al-Dahash & David, 1977). However the consistent appearance of hydrosalpinx and hydrometra in immature and virgin gilts suggests that this theory is not appropriate for swine (Wiggins *et al.*, 1950; Keenan, 1980).

It would thus appear that hydrosalpinx could be the result of several unrelated factors and may be influenced by pubertal or endocrine events. While purulent material and adhesions have been found in conjunction with hydrometra and hydrosalpinx, infection may be opportunistic rather that causative.

Hydrometra was recorded by fewer workers with a lower incidence than hydrosalpinx (see Table 2.4b) and may be caused by a non-bacterial and transient occlusion of the cervix resulting in distension of the uterus with yellow fluid (Teige, 1957). Hydrometra, like hydrosalpinx, occurs almost exclusively in nulliparous or prepubertal animals (Teige, 1957; Einarsson & Gustafsson, 1970, Keenan, 1980). A similar condition reported in sows was due to the pathology of the endometrium (Teige, 1957). The reason for the disappearance of hydrometra with puberty is unclear but it may be due to the opening of the cervix during oestrus.

2.5.2.4 Other

Aplasia of the ipsilateral ovary was often associated with aplasia of the oviduct or uterus (Teige, 1957). Three cases

(1%) of missing right ovary in otherwise normal tracts was reported (Das *et al.*, 1986).

2.5.3 Acquired abnormalities of the genital tract

2.5.3.1 Disorders of the ovary

Genital tumours are considered to be rare but, in old cull sows, may be present in 4-5% of animals (Akkermans & van Beuseken, 1984). Multiple haemorrhage of the ovary was reported in gilts (Pomeroy, 1960c) and fibrosclerotic ovaries were present in 18% and 3.1% of cull females (Silobad, 1972; Keenan, 1980). Hypoplasia of the ovary was reported in 2.7% of tracts (Das *et al.*, 1986).

2.5.3.1.1. Follicular ovarian cysts

Cystic ovarian degeneration is one of the most common reproductive disorders of swine (Perry & Pomeroy, 1956) and cattle (Jubb & Kennedy, 1970). The incidence of ovarian cysts reported in the literature is summarised in Table 2.5. The highest incidences were reported from infertile sows (Perry & Pomeroy, 1956; Thain, 1965) while the lowest incidences were from randomly selected females (Green & Nalbandov, 1948; Wiggins *et al.*,1950; Nath *et al.*, 1982; Das *et al.*, 1986;) and cull gilts (Keenan, 1985). Higher figures of 41.1%, 43.8% and 72% for Sweden, Yugoslavia and U.S.S.R. respectively, were cited by Keenan in his

Table 2.5 Incidence of follicular ovarian cysts

Country	Number of Tracts	Type of female	Minimum diameter	Percentage Sow	Gilt	Total	Author
U.S.A.	5088	random females	25mm			1.7	Wiggins et al., 1950
U.S.A.	1752	nonpregnant	10mm			6.5	Green & Nalbandov, 1948
	436	nonpregnant				4.1	
		pregnant				8.0	
Ireland	812	sterile sows	12mm	8.5		6.8	Keenan, 1985
U.K.	733	nonpregnant	11mm	25.6	1.1	26.7	Perry & Pomeroy, 1956
	130	pregnant		5.4	1.5	6.9	
Australia	571	sow pregnant	10mm			1.7	Penny et al., 1971
	137	sow nonpregnant				2.3	
Indian	301	non pregnant				2.7	Das et al., 1986
U.K.	62	sterile sows		34.8		34.8	Pomery 1960b
	24	inbred sows		50.0		50.0	
U.S.A.	79	sterile cull	14mm	5.1	5.1	10.1	Wilson et al., 1949
Taiwan	66	infertile gilts			6.1	6.1	Koh et al., 1985
India	45	sows & gilts		2.2		2.2	Nath et al., 1982
Australia	22	sterile empty sows	11mm	36.0		36.0	Thain, 1965

dissertation (1980). The large variation in the reported incidences of ovarian cysts between authors and countries was possibly due to different criteria used to define ovarian cysts.

The incidence of cystic ovaries has been related to parity (Keenan, 1980), age and live weight (Wiggins *et al.*, 1950; Perry and Pomeroy, 1956), presence of cystic endometrium (Thain, 1965), short lactations (Hays *et al.*, 1978; Peters *et al.*, 1969; Keenan, 1980; Kunavongkrit *et al.*, 1984a) and season (Wiggins *et al.*, 1950; Perry & Pomeroy, 1956). Kökelsum (1988) found a higher incidence in gilts than sows.

Nalbandov (1952), in his pioneering work, defined cysts as any follicle "substantially larger than the largest follicle of ovulatory size". Normal follicles were not observed to exceed 10mm in diameter and the swollen *corpora haemorrhagica*, which form 5 to 6 days after ovulation, were excluded. The granulosa of cysts may vary from apparently normal to entirely absent and different degrees of luteinisation or degeneration may occur in granulosa and/or theca. Large cysts may regress and reform over successive cycles, reach 30mm in diameter and always occur in numbers less than the expected ovulation rate. Small multiple cysts occur in numbers much higher than the expected ovulation rate (Nalbandov, 1952; Thain, 1965; Jubb & Kennedy, 1970; Liptrap & McNally, 1977; Wrathall, 1980; Cook *et al.*, 1990).

External diagnosis of cystic ovaries is difficult but, in swine, they have been associated with irregular oestrus cycles and heat duration, low litter size, infertility and anoestrus (Wilson *et al.*, 1949; Keenan, 1980; Wrathall, 1980; Miller, 1984); cystic sows may mount other females in heat (Wilson *et al.*, 1949). Clitoral enlargement, which was recorded in 50% to 60% of cystic animals by some authors (Wilson *et al.*, 1949; Nalbandov, 1952) was not seen in other studies (Keenan, 1980; Perry & Pomery, 1956). Ovarian cysts may be palpated *per rectum* in swine (Silobad, 1972; Wrathall, 1980; Ogasa *et al.*, 1983; Kokelsum, 1988).

Cystic ovaries were found in pregnant animals by some workers (Nalbandov, 1952, Perry and Pomeroy, 1956; Thain, 1965; Penny *et al.*, 1971) but not others (Keenan, 1980). Cysts do not always prevent other follicles from ovulating as they were often found in conjunction with normal *corpora lutea* (Warnick *et al.*, 1949; Wilson *et al.*, 1949; Pomeroy, 1960b) but may cause ovulation out of sequence with oestrous behaviour (Pomeroy, 1960b).

While initial fertility is not impaired, the cystic condition gradually worsens until the ovary is dominated by cystic follicles. It is a progressive, degenerative disease which may result in permanent sterility (Pomeroy, 1960b; Keenan, 1985. The oestrogen and progesterone content of cysts was reported as both higher and lower than in normal follicles (Nalbandov, 1952; Close & Liptrap, 1975; Keenan, 1985) and elevated plasma progesterone was associated with cysts by some authors (Close and Liptrap, 1975; Kokelsum, 1988) but not by others (Babalola & Shapiro, 1990). Rising progesterone levels reduce luteinising hormone (LH) output from the pituitary which ends cyclic activity (Wrathall, 1980).

Induced cysts normally resolve after cessation of treatment with pregnant mare serum gonagotrophin (PMSG) or progesterone (Nalbandov, 1952; Wrathall, 1980; Malmgren *et al.*, 1983) suggesting that the uterus is involved in the regression of luteinized cysts by luteotrophic activity similar to the regression of *corpora lutea* in the non-pregnant animal (Liptrap & McNally, 1977). It can be postulated that uterine infection may interfere with this activity and an association has been reported between uterine infection and cystic ovarian disease in dairy cows (Bosu & Peter, 1987).

Despite the common occurrence of ovarian cysts, factors leading to their formation are not properly understood. The cystic condition originates in complete or partial failure of ovulation. An insufficiency of LH was proposed as the causative agent of ovarian cysts in swine (Pomeroy, 1960a; Wrathall, 1980) and dairy cattle (Refsal *et al.*, 1988).

Stress has been implicated in cyst etiology (Wrathall, 1980; Kunavongkrit *et al.*, 1984b), especially during the follicular stage of the cycle (Liptrap, 1973; Close & Liptrap, 1975; Liptrap & McNally, 1977; Scholten & Liptrap, 1978). In dairy cattle, stress was shown to disturb the preovulatory LH surge (Nanda *et al.*, 1990). Others proposed that individual follicles fail to ovulate because of an intraovarian, or follicular defect (Coleman *et al.*, 1984). In the gilt, manipulation induced cystic follicles, possibly due to the disruption of locally acting substances involved in ovulation (Hall *et al.*, 1989).

Unluteinised and luteinised cysts were not found in the same ovary by some workers (Keenan, 1980; Babalola & Shapiro 1990) but were by others (Pomeroy, 1960c).

2.5.3.1.2 Cystic *corpora lutea*

References are scare to cystic *corpora lutea* which originate from follicles which have ovulated. Perry and Pomeroy, in 1956, coined the term cystic *corpus luteum* for a cystic structure which had ovulated; *corpora haemorrhagica* could be distinguished from cystic *corpora lutea* because the former were larger, blood filled and occurred four to six days after ovulation. A cystic *corpus luteum* is morphologically similar to a normal *corpus luteum* but is distended by a fluid (not blood) filled lacuna, has a flabby appearance (Perry & Pomeroy, 1956); it is usually accompanied by normal *corpora lutea* (Keenan, 1980).

The reported incidence in the literature of cystic *corpora lutea* shows variation similar to that for follicular cysts. They were reported in 2.1% and 4% cull sows (Cowan & MacPherson, 1966; Einarsson & Gustafsson 1970), 16.8% of cull gilts (Keenan, 1980).

Some evidence of pathogenesis was suggested by Perry and Pomeroy (1956); although the condition was found in pregnant sows it appeared that pregnancy could not be maintained if the ovary contained one follicular cyst and several cystic *corpora lutea.* Keenan (1980), suggested that cystic *corpora lutea* were an early stage of the cystic condition, were related to age and lactation length but had no influence on fertility. It is possible that they are related to the follicular heterogeneity described by Hunter and Weisak (1990). The syndrome has been shown not to be pathological in cattle (Donaldson and Hansel, 1968). The only authors to attribute any pathogenicity to cystic *corpora lutea* are Einarsson and Gustafsson (1970) who cited them as a major cause of infertility in swine. However as the structures were not defined they may have actually been luteinised follicular cysts. The pathogenicity of cystic *corpora lutea* remains equivocal.

2.5.3.2 Disorders of the uterus

2.5.3.2.1 Cystic endometrium.

One of the highest incidences of cystic endometrium was 45% of a small sample of infertile sows in Tasmania. The author suggested a similarity between these findings and hyperoestrogenic clover disease in sheep (Thain, 1965). Other incidences were reported to be 19% in Yugoslavia, 0.12% in Ireland and 3.3% and 2.2% in India (Vrbanac *et al.*, 1975; Keenan, 1980; Nath *et al.*, 1982; Das *et al.*, 1986).

2.5.3.2.2. Abnormal uterine epithelium.

Teige (1957) found a condition in sows which appeared similar to hydrometra in gilts. Yellowish fluid was found distending flaccid uteri but the condition was related to abnormal endometrium.

2.5.3.3 Disorders of the oviduct

2.5.3.3.1 Diverticulum

Diverticula are pouches which develop in the oviduct wall and remain connected to the oviduct lumen. Einarsson and Gustafsson (1970) found single diverticula in the oviduct in 1.4% of cases and suggested that fertility may been impaired. In Ireland, diverticula were found in 0.9% of tracts examined (Keenan, 1985).

2.5.3.3.2. Blocked oviduct.

Keenan (1980) tested the patency of oviducts of 812 cull gilts and sows with no evidence of hydrosalpinx and found unilateral and bilateral occlusions in 0.6% and 2.9% of samples respectively. The obstruction usually occurred near the utero-tubal junction. A significant association between oviduct abnormalities and age or parity of sows was established. The utero-tubal junction in the ewe has a valve-like sphincter action to prevent movement of ova into the uterus during oestrus and for a few days after oestrus (Edgar & Adsell, 1960) which may prevent the movement of dye in a patency test.

2.5.4 Bacterial infection of the urogenital tract.

2.5.4.1 The Genital tract.

Gross bacterial infection of the genital tract was recorded in 0.46%, 1.71% and 2.6% of abattoir-collected tracts (Perry & Pomeroy, 1956; Keenan, 1980; Das *et al.*, 1986). The role of infective agents in swine infertility has been covered extensively in the literature. For this study and with the exception of *Brucella* - an obligate pathogen of pregnancy - only facultative pathogens from the pig's environment will be discussed. These correspond to Wrathall's (1980) Group 3 and Group 1 pathogens respectively.

Brucella suis is not ubiquitous but has an almost world-wide distribution. It is associated with endometritis and vulval discharge and leads to stillbirth, abortion and infertility (Taylor, 1981; Meredith, 1986).

For some time it was thought that the sow uterus was sterile under normal conditions (Roberts, 1971 & Wrathall, 1975 cited in Keenan 1980). Evidence of gross infection was lacking in early abattoir surveys (Wilson *et al.*, 1949; Wiggins *et al.*, 1950; Nalbandov, 1952) but high incidences of infection were found when endometrial swabs were cultured for bacterial contamination. In the pregnant gilt, 42% of uteri were contaminated (Scofield *et al.*, 1974) as were 30% of anoestrus sows and 69.7% of cull females (Einarsson *et al.*, 1974; Keenan, 1980). Bacterial burden could not be linked to time *post partum* in the sow (Keenan, 1980) but has been described in the cow (Griffin *et al.*, 1974).

Table 2.6 shows the large range of bacterial flora isolated from the uteri of swine. The presence of bacteria in the uterus was considered to be abnormal and pathological by Meredith (1986) and was common in subfertile sows (Brummelman, 1980). Scofield and co-workers (1974) showed that while pregnancy was compatible with a bacterial presence in the uterus, embryo survival was compromised; others could not relate bacterial contamination of the uterus to infertility (Einarsson *et al.*,1974; Keenan, 1980).

Table 2.6. Microbial contamination of the pig uterus

Country	Number	Type	Infected %	Ae.	Act.	Bac.	Cory.	Citr.	Ent.	E.coli	Prot.	Past.	Lact.	Pseud.	Staph a.	Staph.	Strep.	Other	Author
U.K.	14	VDS sows			x	x	x			x	x		x		x	x			Taylor, 1984
U.S.A.	24	sows								x						x		x	Ross et al., 1981
U.S.A.	25	VDS gilts					x			x	x			x		x	x		MacLachlan & Dial, 1987
U.K.	38	preg gilts	42				x												Scofield et al., 1974
Holland	63	sows		x	x	x	x			x		x	x	x		x	x		Brummelman, 1980
U.K.	110	breeding herds					x			x	x	x				x	x		Muirhead, 1986
Ireland	812	cull females	70				x	x	x	x	x		x	x	x		x	x	Keenan, 1980

VDS= vulval discharge syndrome

Bacteria code: Ae.= *Aerobacter* sp., Act. = *Actinobacillus* sp., Bac.= *Bacillus* sp., Cory. = *Corynebacterium* sp., Citr. = *Citrobacter* sp., *Ent.*= *Enterobacter* sp., E.coli = *Escherichia coli*, Prot.=*Proteus* sp., Past.= *Pasteurella* sp., Lact. = *Lactobacillus* sp., *Pseud.* = *Pseudomonas* sp., Staph. = *Staphlococcus* sp., Staph.a. = *Staphlococcus aureus*, Step.= *Streptococcus* sp.

Table 2.7. Effects of genital tract infections on reproduction in swine

Infective agent	Reduced concept'n	Embryo death	Abortion	Endo-metritis	Still birth	Piglet death	VDS	High WSI	Author
<u>Group 1</u>									
Actinobacillus			X	X		X			Proctor et al., 1986
"	X							X	Brummelman & Gunnick, 1976
Aerobacter sp			X						
Campylobacter sp			X	X					Pointon et al., 1990
Corynebacterium pyogenes	X		X	X	X		X	X	Taylor, 1984
Corynebacterium suis			X		X				
E. coli			X	X	X				
Klebsiella sp			X	X	X				
Pasteurella multiocida			X	X	X				
Pseudomonas sp			X	X	X				
Streptococcus sp	X		X	X	X				
Staphlococcus sp	X		X	X	X				
<u>Group 3</u>									
Brucella suis	X	X	X	X	X	X			

Other references also used; Muirhead, 1990; Keenan, 1980
Sadtler & Schimmelpfennig, 1990

VDS = vulval discharge syndrome

Reflux of urine during post slaughter handling contaminated the uterus in cattle (Bane, 1980) and scalding liquid may also contaminate the uterus of swine (Meredith, 1986). However, laparotomy studies of uterine infection mirrored post mortem findings (Keenan, 1980) and prevention of urine reflux did not affected the percentage of contaminated uteri found (A. Pointon, pers. comm., 1990), thus this mode of contamination in swine remains unestablished.

A summary of the effect of specific uterine bacteria on reproduction is shown in Table 2.7. Reduced conception, abortion, endometritis and still-birth are mentioned but some authors suggest caution in relating the results of bacterial culture to observed infertility (Dial & MacLachlan, 1988b). Bacteria may enter the uterus by ascending the genital tract during parturition, at mating or during periods of reduced immunity. In the sow, 90% of normal parturitions were followed by bacterial invasion of the uterus and bacterial endometritis after parturition was often related to the inability of the uterus to resolve the infection naturally (Bane, 1980).

A post- mating and opportunistic invasion of bacteria from the environment or the lower urogenital tract was postulated as the cause of a vulval discharge syndrome affecting fertility of UK herds (Muirhead, 1986). The observation that a low level of vaginitis or cystitis may have preceded endometritis (Meredith, 1986) and that a positive correlation existed between vaginal and uterine flora (Nikolic, 1968) was evidence for an ascending infection. However, outbreaks of a cyclic vulval discharge and endometritis in virgin gilts indicated that coitus is not the only source of organisms causing endometritis and contamination may have occurred via the relaxed cervix during oestrus (MacLachlan & Dial, 1987; Dial & MacLachlan, 1988a).

The resistance of the bovine uterus to infection during oestrus has been established (Rowson *et al.*, 1953). Endometritis becomes quiescent in oestrus and proestrus as, under the stimulation of oestrogen, the uterus is more able to resist infections. Pyogenic exudate accumulates in the uterine lumen during diestrus and is released into the vagina in proestrus when the cervix opens and uterine motility increases (MacLachlan & Dial, 1987; Pointon *et al.*, 1990). Poor farm hygiene was often implicated in outbreaks of endometritis as faeces contaminated the sow's vulva and vestibule in poorly drained and dirty pens. Other predisposing factors includedlack of exercise, infrequent urination and low water intake (Dial & MacLachlin, 1988).

2.5.4.2 The bladder.

Evidence of bacterial contamination of the bladder was found in 17% and 41% of cull sows (Colman et al., 1988; Kökelsum, 1988). Endemic cystitis leads to inappetence, poor performance and is associated with reduced fertility (Akkermans & Pomper, 1980 cited in Madec, 1984; Both *et al.*, 1980; Dial & MacLachlan, 1988a; Kokelsum, 1988). In a study of urinary infections in France, bacteria, mostly of faecal origin, were often found in the urine of swine. Increased incidence of cystitis was related to poor hygiene, lack of exercise, reduced water intake (Madec, 1984), lameness and increased parity (Kökelsum, 1988).

2.6 CLOSING REMARKS

The Zambian swine industry suffers from isolation and a lack of inputs needed for an efficient industry.

Large White and Landrace breeds are used in the tropics but breeding programmes are often lacking and these breeds perform better in developed that in developing countries. When piggeries are well managed production approaches 20 pigs sold/sow/year but in developing countries numbers sold are much lower.

The attainment of puberty is influenced by age, live weight, season, nutrition and environment. There is an advantage in overall efficiency of the piggery if gilts are mated as early as possible. This can be achieved by many management techniques, the most effective is the use of a mature boar.

Abattoir studies can be used to investigate causes of infertility, pregnant wastage, ovulation rate, and puberty attainment. With the exception of paraovarian cysts, congenital abnormalities are rare but often cause infertility. Acquired abnormalities are more common and are related to reproductive history, age and parity.

Bacterial contamination of the urogential tract may influence fertility.

CHAPTER 3. SURVEY OF THE COMMERCIAL SWINE FARMERS OF ZAMBIA

3.1 INTRODUCTION

Tables 2.1 and 2.2 indicate that production levels of over 19 pigs weaned/sow/year were reported from the developed world (Paterson *et al.*, 1980; Ogink, 1989) while levels of 13 to 14 pigs weaned/sow/year were reported in the developing world (Rico, 1988; Kabare, 1991). Most indicators of fertility were lower in the developing world.

The task of this part of the study was to estimate the production level of the Zambian industry and to detail some aspects of management. As very little was known or written about the commercial swine industry of Zambia, the study below was devised to collect baseline data on the industry. As a postal survey on Zambian agricultural data was of limited value because of the poor level of understanding of questions by the respondents (Kulwa *et al.*, 1983), it was decided to conduct the survey in person. In this way the meaning of questions could be explained to the respondents.

3.2 MATERIALS AND METHODS

The survey took the form of a pre-coded questionnaire schedule, of 83 questions, which was completed by the author with information from the respondent, usually the piggery manager. Whenever possible the piggery records were consulted. The schedule was pre-tested on two small piggeries in Lusaka.

Commercial piggeries were classed as having more than two sows and selling weaned pigs to ZAPP or private butchers; they were identified by consultation with pig abattoirs, private butchers, pig farmers, MAWD personnel and the Commercial Farmer's Bureau of Zambia. Piggeries were then selected for this study if they had capacity for five or more sows, when accurate directions to the farm were available, if they could be easily reached from Lusaka, Livingstone or Ndola and where the author could be guaranteed access. As telephone contact was impossible with most piggeries, a letter was sent which advised the manager of the approximate date of the intended visit and explained the purpose of the survey and the type of information required.

The results were analysed with Ddase IV (Ashton-Tate) on a personal computer.

3.3 RESULTS

3.3.1 General

The interviews were carried out between mid and late 1984 and covered the 1983-1984 financial year. They each took between 30 minutes and three hours to complete, depending on the quality of the piggery records and the understanding of the questions by the respondent. Of the 82 piggeries identified, 42 (51.2%) were selected and successful interviews were carried out with 34 (41%) of them. Interviews did not take place with eight piggeries as five no longer kept pigs and three declined to be interviewed. The survey covered a total of 2842 sows. Twenty-one piggeries were in Lusaka and Central Provinces, five were in the Copperbelt province and eight were in the Southern Province.

Unfortunately most farmers did not receive the introductory letter and were unprepared for the visit. Despite trying to word the questionnaire in the simplest terms, many questions were not understood. The concept of average and percentage figures proved difficult to explain and many farmers guessed the answers. When the farmer was suspected of guessing (this was difficult to assess but the author was made suspicious by "text book" answers and when contradictions were apparent) figures were cross checked with the records. If this was not possible, the given response was accepted. Some questions, such as percentage of gilts culled before producing a litter, percentage of piglets still-born, WSI, return rate and oestrus number at first mating for gilts were so regularly misunderstood that the responses have not been analysed.

Farmers did not answer all questions, therefore total responses to questions are indicated.

When assessing responses it must be borne in mind that the majority of farmers answered questions from memory thus the survey results must be viewed as a guide rather than hard data. For this reason, and because numbers of responses were often small, statistical analysis would have been meaningless and therefore has not been performed.

The survey was hampered by poor record keeping and utilisation. Of all piggeries visited, 18% (6/34) had no records at all, 50% (17/34) used sow record cards (SRC) and the remainder used notes or books. Records were updated weekly, between weekly and monthly and less often than monthly by 68% (19/28), 14% (4/28) and 18 % (5/28) of farmers respectively. Often they were not summarised any useful way.

When possible, the piggery was inspected at the time of the interview. Photographs of typical piggeries showing designs, levels of management and stocking can be seen in figures 3.1 to 3.10 displayed at the end of this chapter. Figures 3.1 and 3.2 show poorly managed piggeries with low litter size, dirty pens and unsorted pigs. Figure 3.3 shows a typical, open sided piggery of good management although pigs can be seen sleeping in a poorly designed feed trough. Farrowing accommodation is shown in Figures 3.4, 3.5, 3.6. A very thin sow can be seen in figure 3.4. The open style of piggery design commonly used in Zambia can again be seen in dry sow accommodation in figures 3.7 and 3.8 while examples of semi-extensive piggeries are shown in figures 3.9 and 3.10.

The majority, 65% (22/34), of piggeries were privately owned, 24% (8/34) were owned by large companies and 12% (4/34) were part of large institutions. Only 6% (2) were the sole farm enterprise, the remainder combined pig breeding with other agricultural activities.

3.3.1.1 Piggery size.

The average piggery size was 113 sows (range 5 to 500) sows. The majority of piggeries housed less than 100 sows; 32% (11/34) housed less than 50 sows, 26% (9/34) housed between 50 and 99 sows, 21% (7/34) housed between 100 and 199 sows, 12% (4/34) housed between 200 and 299 sows and 9% (3/34) housed over 300 sows.

3.3.1.2 Occupancy levels.

Piggery capacity was under-utilised. Mean sows-on-hand were 83.5 sows and 78.9 sows for 1983-84 period and 1984 onwards respectively. In 1983-84, 26% of capacity was not utilised and 65% (22/34) of all farms were running under capacity, one farm held no pigs. From 1984 onwards, occupancy had fallen so that 30% of the capacity was not utilised and 62% (21/34) of farms were running below capacity; 3% (1/34) farm had increased its capacity from 1983-84 and a further two were in the process of destocking.

3.3.1.3 Extension.

Farmers were asked about visits from government extension officers or private veterinarians during the past year. No management advice was received from any source by 18% (6/34) of farms. A government adviser visited 38% (13/34) of farms one to three times annually, 21% (5/34) were visited four or more times a year and 42% (14/34) of farms had not been visited at all. Private veterinarians visited 29% (10/34) of piggeries and all but two of these farms were not visited by government extension officers.

3.3.2 Piggery management

3.3.2.1 Age and weight at sale

Table 3.1 shows the average live weights and age of slaughtered stock. Porkers were sold by 25% (8/32) of farms while the remainder 75% (24/32) produced primarily baconers or heavy hogs. The age and live weight at slaughter was estimated to be 7 months and 51 kg for porkers and 8.4 months and 88 kg for baconers and heavy hogs.

3.3.2.2 Feed conversion ratio

The mean herd FCR of 5.8 was estimated from four farms. For grower FCR, five estimates were available, one for porkers of 3.1 and four for baconers and heavy hogs of 4.7 (see Table 3.1).

3.3.2.3 Feed.

Commercial millers were the sole source of pig feed for 59% (19/32) of piggeries while 28% (9/32) combined purchased and home mixed feed and 13% (4/32) mixed all of their feed requirements on the farm. Farmers tried to improve the feed in 53% (17/32) of cases with vitamins, premix, minerals or soyabean. Pig feed was supplemented in 40% (13/32) farms with vegetable matter, poultry manure or brewers grain. Only 25% (7/28) of farmers were satisfied with the quality of commercially available feed while 64% (18/28)

Table 3.1. Summary of production parameters

Parameter	Unit	Mean	Range	n
All types				
Slaughter weight	kg	77.1	45 - 112	33
Slaughter age	month	7.6	5 - 11	33
FCR:	ratio			
weaning to slaughter		4.4	3.1-5.6	6
Overall		5.8	4.1-7.0	4
Porkers				
Slaughter weight	kg	51	40 - 65	8
Slaughter age	month	7	4 - 8	8
FCR:	ratio			
weaning to slaughter		3.1		1
Baconers & Heavy hogs				
Slaughter weight	kg	88	70 - 112	24
Slaughter age	month	8.4	6 - 11	24
FCR:	ratio			
weaning to slaughter		4.7	4.1-5.6	4

were not satisfied and 10% (3) were satisfied with some brands only. Of farmers who mixed their own pig feed, none were happy with the availability of feed ingredients.

Creep-feed was given to piglets regularly by 59% (20/34) of farms, 9% (3/34) used it occasionally and 32% (11/34) not at all. Specially formulated creep feed was used in 78% (16) of these farms. Mean consumption was estimated by seven farms to be 13.1 kg/hd (range 8 to 18 kg).

3.3.2.4 Marketing.

The largest share of the market went to ZAPP with 42% (13/31) of farmers selling all of their pigs to ZAPP, 32% (10/31) to private butchers and 26% (8/31) to a combination of outlets. A firm sale contract for 1984-85 was held by 45% (14/31) of farmers.

3.3.2.5 Breeding stock sources.

Piggeries usually purchased boars from a combination of sources. The majority of farms, 65% (22/34), purchased boars from other piggeries, 59% (20/34) regularly purchased from a recognised boar stud, one farm (3%) always selected boars from his own herd and one farm occasionally purchased stock from outside the country.

3.3.2.6 Breeds.

A combination of Large White and Landrace breeds were used on 97% (33/34) of farms while the remaining farm kept only Large Whites. One farm imported Durocs for use in a crossbreeding programme.

3.3.2.7 Housing.

No fully extensive farms were visited; the majority 59% (20/34) of piggeries were fully intensive while 41% (14/34) were semi-intensive.

No specially designed farrowing accommodation was provided in 29% (9/31) of farms and 13% (4/31) provided crates or rails in some of the farrowing pens. Of the remaining 18 farms which provided farrowing accommodation, rails and crates were used by 32% (10/31) and 24% (8/31) respectively.

Non-heated creep areas were provided in 27% (9/33) of piggeries while in 49% (16/33) they were heated or insulated, 24% (8/33) had no creep areas. Bedding was provided in the farrowing pen in 88% (30/34) of farms.

3.3.2.8 Stock replacement

3.3.2.8.1 Gilt and sow replacement

Table 3.2 shows that sows were culled at a mean maximum of seven litters. Estimates of both sow and boar replacement

Table 3.2. Summary of reproduction parameters

Parameter	Unit	Mean	Range	n
Fecundity				
Lactation length	day	45.8	35 - 63	34
FI	l/sow/yr	1.7	1.3-2.2	20
Prolificacy				
Litter size				
born alive	pig	10.0	7 - 13	34
weaned	"	8.0	7 - 13	32
sold	"	7.3	3 - 10	30
Number born alive (Gilt)	pig	7.9	6 - 10	23
Pre-weaning loss	pig	20.0	7 - 35	27
Productivity				
pigs sold/sow/year (MI)	pig	13.2	3 - 23	30
pigs sold/sow/year (MII)	pig	11.0	4 - 20.8	26
Other				
Gilt				
Age at first mating	month	8.8	7 - 12	26
Weight at first mating	kg	92.0	55-120	24
Parity when culled	litter	7	4 - 10	21
Boar:sow ratio	ratio	13.6	5 - 26	28
Piglet birth weight	kg	1	1	5
Piglet wean weight	kg	10.9	7 - 15	16

rates were complicated by those piggeries reducing stocks. Sow replacement was calculated from the number of sows on hand and the number of replacement gilts selected or purchased per year (Method I) or from number of sows on hand and number of sows sold (Method II). Method I showed mean replacement to be 36% (range 6% to 100%, n=21) and Method II showed mean replacement to be 33% (range 1% to 100%, n=25). The 100% replacement rates were for the piggery with 5 sows.

The results of asking farmers how frequently they used various criteria for culling sows are displayed in Table 3.3. Low litter size was the most commonly used reason for sow disposal, while the incidences of culling for low milk supply, physical problems, age and infertility were similar. Culling for abnormal behaviour was a rare event.

When farmers were asked how often they used different attributes in selecting a gilt, physical appearance (conformation, legs, teats) was the most commonly used trait. Pedigree and growth rate were used to a similar, but lesser, extent. Five farms regularly used all three criteria.

The mean live weight and age at first mating was 92kg and 8.8 months (see table 3.2). Many farmers could not distinguish between first mating and puberty.

Table 3.3. Stock culling and replacement decisions

Item	Frequency of use Often	Rarely	Never	n
Sow replacement				
Litter size	25	1	0	26
Milk supply	11	7	5	23
Locomotor, health	10	6	7	23
Fertility	7	8	8	23
Age, weight, parity	10	4	10	24
Behaviour	1	5	18	24
Gilt selection				
Physical attributes	21	0	1	22
Pedigree	15	3	4	22
Growth rate	16	2	3	21
Boar replacement				
Age, weight	16	6	4	26
Fertility, fecundity	14	3	7	24
Locomotor, health	12	5	7	24
Behaviour	3	2	17	22
Genetic traits	2	4	26	32

3.3.2.8.2 Boar replacement.

A boar was considered to be fully mature at 12.5 months (range 8 to 18 months, n=22) of age . The majority of farms, 66% (17/26), kept their boars in service for two or three years, 27% (7/26) for four years or more and 8% (2/26) for one year.

Mean culling rate, calculated from number of boars sold and number of boars on hand, was 52% (range 17% to 100% n=15). Data from two piggeries which reported selling more boars than they had on hand was not included. Table 3.3 shows that age and weight was the most frequently given reason for culling boars while reproductive failure and physical problems were quoted to a similar degree. Abnormal behaviour and undesirable genetic traits were rarely used in culling boars.

3.3.2.9 Mating policy

Mean boar:sow ratio was 1:13.6. Piggeries with less than 50 sows had a mean ratio of 1:11 (n=14) while those of 50 and over sows had a ratio of 1:15 (n=14). Those piggeries which mated twice per heat had a ratio of 1:15 (n=9) while those mating thrice or more had a ratio of 1:13 (n=4).

Group matings were used by 30% (9/30) of farms, individual matings by 70% (21/30). Of those farms which used individual mating, 4% (1/21) mated once, 48% (10/21) mated twice, and 24% (5/21) mated three or more times per heat; 24% (5/21) left the sow and boar together for 12 hours.

3.3.2.10 Farrowing attendance.

Someone always attended farrowing in 68% (23/34), occasionally in 20% (7/34) and never in 12% (4/34) of farms.

3.3.2.11 Piggery hygiene and common diseases.

Chemical disinfectant was the most commonly used method of piggery hygiene and was employed by 71% (24/34) of farms; 32% (11/34) white washed the pens, 3% (1/34) provided footbaths and 15% (5/34) had a tyre dip for vehicles which visited the farm. Five piggeries used none of these methods and seven piggeries combined three methods of hygiene.

Table 3.4 shows that scours and mange were the most commonly encountered diseases. Worms, TSS and MMA were rarely a problem. When asked about disease problems in general, 18% (6/34) said that there was no major disease. Scours were said to be a major problem in 80% (4/5) piggeries which used no form of pen hygiene while it was a problem in 39% (9/23) of piggeries using chemical disinfectants.

Table 3.4 Occurrence of common diseases

Disease	Frequency of occurrence Often	Rarely	Never	n
Scours	21	12	0	33
Worms	4	23	6	33
Mange	14	14	5	33
Thin sow syndrome	8	16	10	34
MMA complex	8	20	4	32

Table 3.5 Occurrence of causes of piglet death

Cause of death	Frequency of occurrence Often	Rarely	Never	n
Overlying	16	15	0	31
Disease	16	7	8	31
Starvation	9	16	5	30
Chilling	7	9	15	31
Born weak	7	18	5	30

3.3.3 Productivity

3.3.3.1 Fecundity.

The overall FI was estimated to be 1.7 litters/sow/year, with a mean lactation length of 45.8 days (Table 3.2). It could only be estimated from 59% (20/34) of farms.

3.3.3.2 Prolificacy.

Mean litter sizes at birth, weaning and slaughter were 10.0, 8.0 and 7.3 respectively while number born alive to gilts was 7.9 piglets (Table 3.2). Pre-weaning mortality, calculated from the difference between litter size born alive and litter size at weaning, averaged 20% (range 7% to 35%, n=27).

Average production, calculated by multiplying mean piglets sold per litter by mean FI (Method I) was 13.2 pigs sold/sow/year. When the number of pigs sold per year was divided by mean sows-on-hand (Method II), the production was 11 pigs sold/sow/year. In seven cases, Method II gave a much lower estimate than Method I and records could not be consulted to determine the correct figure. On the three occasions that records could be consulted, Method II gave the better estimate of productivity.

3.3.3.3 Piglet losses.

The most common causes of piglet death were overlying and disease (see Table 3.5). Death from starvation or congenital weakness was a rare event while chilling was not considered a problem by the majority of farms.

Overlying was said to be a significant cause of piglet death in 50% (5/10) of farms with farrowing rails and 56% (5/9) of farms with no farrowing accommodation. By contrast, 12.5% (1/8) of farms using farrowing crates mentioned crushing as a significant cause of piglet death. Farms with incomplete farrowing accommodation (4) were not assessed.

3.3.3.4 Piglet weights

Birth weights were estimated by five piggeries, all of which gave mean birth weight as one kg. Weaning weights were given by 47% (16) of farms and averaged 10.9kg (range 7 to 15 kg) for a mean lactation length of 44.5 days. Estimated weaning weight increased with lactation length; lactations of less than 40 days, 40 to 49 days and over 50 days gave mean weaning weights as 8.75 kg (n=4), 11.6 kg (n=8) and 54.2 kg (n=4) respectively.

3.3.4 Pig industry problems

3.3.4.1 Profits.

The majority of farms, 47% (15/32) made a loss over the 1983/84 financial year, 44% (14/32) broke even or made a small profit and only 9% (3/32) made a reasonable profit. However 66% (19/29) expected an improvement in the profitability of pig farming in the 1984-85 year.

3.3.4.2 Problems.

Feed was highlighted as a major problem in pig production by 78% (25/32) of farms. While feed quality, price and supply were mentioned, the former was the major problem. Marketing was mentioned by 66% (21) of respondents, in particular low producer prices, delayed payment and a small market. Lack of breeding stock and veterinary supplies were mentioned by 9% (3) of farmers. Single respondents said that high transport costs, building costs, limited feed ingredients and inadequate extension contributed to their economic woes. One respondent did not mention any problems.

3.4 DISCUSSION

3.4.1 Zambian commercial piggeries

The survey of Zambian commercial swine farmers covered 41% of identified commercial piggeries and 56% of estimated total sows (GRZ, 1985).

While this survey summarised the Zambian pig industry for the first time, results were hampered by a lack of precise information. Records were often badly kept, not utilised or nonexistent so that, except in a few cases, they were difficult to consult. Despite pre-testing the questionnaire, the author was unprepared for the farmer's lack of understanding of questions. The survey became very long and difficult when time had to be spent explaining questions or searching for information in the records. However, the poor understanding, while frustrating for the author, did pin-point a real problem in the industry - the lack of understanding by the average pig farmer of many aspects of pig production.

For questions which required answers extracted from raw data, it may have been better for the author to extract that information directly from records. While the survey was not designed to assess the accuracy of the respondent's memory, it appeared that managers did tend to overestimate their production by ignoring bad results. Hence, when the author calculated figures, managers were genuinely surprised by the poor performance.

Poor record keeping and utilisation was a serious problem and despite the means being available, there was often no monitoring of production. The 20% of farmers with no records guessed answers, although the actual percentage of guessing was probably much higher. Approximately half of the farmers could not refer to SRCs for the culling of sows on fertility or gilt selection on performance of the dam. Whittemore (1980) states that record keeping and monitoring can improve the financial and productive status of a piggery but that often too many records are kept and too little done with them. The Zambian pig industry would benefit from education in the use of simple record keeping in management.

Pig farmers received little extension advice with the majority of farms having one to three visits per year and 20% of farmers having no advice at all. It is possible that more extension advice would improve the industry by giving farmers the information to tackle their production problems (Mercy & Buddle, 1990).

Compared with the earlier study (GRZ, 1973), piggery size appeared to have increased as farm number decreased, in common with other countries (Gardner *et al.*, 1990). While these two studies were not strictly comparable, as the current one actively selected larger piggeries, the reduction in the number of small piggeries was confirmed by others (G. Lynch, pers. comm., 1984). Between 1983 and 1984 the size of the pig industry declined and there was no evidence that this trend would abate.

3.4.2 Piggery management

3.4.2.1 Age and weight at sale

Growth rate was slow compared with other studies. Pigs reached 120 kg at 8 months in the UK (Whittemore, 1980) and in Kenya weighed 90 kg at 7 months (N. Kabare, pers. comm., 1991). The slower growth rate in Zambia resulting in mean slaughter weight of at 88 kg at 8.4 months may be due to poor feed quality.

3.4.2.1 Feeds & FCR.

The survey reflected known problems in the stock-feed industry; poor feed quality, due to low quality feed ingredients and outdated machinery (GRZ, 1983), was recognised by Zambian pig farmers. FCR in the poultry industry was known to increase in the seventies (GRZ, 1983a). No comparative figures for swine FCR in Zambia could be obtained but in tropical Australia herd FCR was 4.78:1 for 61.2 kg cdw pigs (Alcock, 1982), in the UK grower FCR was under four for pigs of 80 to 100 kg live weight

(Whittemore, 1980) and in Kenya grower FCR of under three was found up to 80 kg live weight (N. Kabare, pers. comm., 1991). The Zambian figures were between 19% and 36% higher and indicated poor feed utilisation.

Several farmers used additives of dubious value such as vegetable waste and brewers grain. In Nigeria, slow growth rates were considered to be due to austere feeding programmes (Smith, 1982) and it may have been the case in Zambia that under feeding occurred as farmers tried to economise. Although it was not specifically covered by the survey, most farmers mentioned that privately milled feed was of better quality than that from NMC, this choice was later denied farmers when the Government nationalised the milling industry in 1986. Those farmers trying to improve existing feed or mixing their own feed were hampered by lack of ingredients and were doing so with minimum extension advice.

The high percentage of farmers using formulated creep feed was surprising as it was mixed by only two private companies and NMC had the bulk of the stock-feed market (NMC, pers. comm., 1984). It seems likely that there was a misunderstanding during the survey; farmers were asked if they used specially formulated creep feed which they may have misinterpreted as commercial feed and so most piglets were actually given grower feed.

3.4.2.3 Marketing.

The estimated market share of ZAPP was less than 50% in 1983 (GRZ, 1983b); this was confirmed in the survey which indicated that 41% of farmers sold exclusively to ZAPP and 25% did so occasionally. ZAPP's financial policy of low producer price and high consumer price was felt by 66% of farmers who mentioned marketing as a major problem in pig production. A personal observation was, as a consequence of this, the number of private manufacturers increased during the course of this study.

ZAPP's pricing policy, shadowed by private butchers, discriminated against pork production. Therefore, most piggeries produced baconers or heavy hogs, although the economics of the latter would have been compromised by the lack of price bonus to offset costs of a higher FCR for heavier pigs (Whittemore, 1980).

3.4.2.4 Breeding stock sources

Piggeries tried to increase the genetic diversity of their herds by purchasing boars from many different sources. However, due to the size of the Zambian herd and the lack of new blood, inbreeding may have reduced the value of this practice. The one farm which used its own boars held only 200 sows and did not breed separate lines. Thus inbreeding must have occurred.

3.4.2.5 Breeds.

The choice of breeds available to pig farmers was limited as the country depended on Landrace and Large White almost exclusively. The Large White adapts well to the tropics (Smith, 1982) and importation of new stock of this and other breeds would increase genetic diversity of the national herd and allow Zambia to take advantage of recent breeding advances.

3.4.2.6 Housing.

No fully extensive farms were visited but the ratio of intensive to semi-intensive farms found was similar to that found in a study in Nigeria (Chidebew & Amadi, 1990). Despite the tropical climate, suckling pigs would need supplementary heat, especially in the cool dry season. As only 47% of piggeries provided an insulated or heated creep area (actual percentage of heated creeps was not determined), piglets may have been temperature stressed to the detriment of growth and survival in most farms (Cutler *et al.*, 1989).

3.4.2.7 Stock management

3.4.2.7.1 Gilt and sow management.

The mean maximum parity for sows would be considered too high by farms where sows are culled after the 5th or 6th litter (English *et al.*, 1982). Zambian piggeries therefore have a high number of older sows with the expected problems of higher feed cost and lower numbers weaned per litter.

The mean sow replacement rate was within the rate cited by others although the lower rates of 1% to 6% were far too low to represent a serious culling programme (English *et al.*,, 1982). Although the methods used to estimate replacement were crude and Method II did not account for sows which had died, the estimates made were similar to that cited by Hughes & Varley (1980) but lower than that of D'Allaire (1987). The study confirmed that reproductive failure was the most common reason for culling sows but, in contrast to other workers, low litter size was more frequently used than infertility (Bhatia, 1989; Dunne *et al.*, 1990). Perhaps culling for infertility required better use of record keeping than was available or farmers did not take anoestrus seriously. The latter seems quite likely as farmers were unable to estimate mean WSI.

All three attributes were used with similar frequency in gilt selection but as only 15% of farms used all three criteria regularly, most gilts were not selected on a scientific or competent basis (English *et al.*, 1982).

The age and weight at gilt first mating was another example of the poor growth rate of Zambian pigs. As early puberty has been induced and gilts mated at 6.6 months and 100 kg live weight (Paterson, 1989), better gilt management to provide a younger and heavier gilt at puberty, could improve herd productivity.

3.4.2.7.2 Boar replacement.

It was not clear from the literature when farmers should start working their boars and how long they should be kept in service (Hughes & Varley, 1980; Whittemore, 1980). The survey suggested that Zambian boars start earlier and work longer than in other parts of the world (D'Allaire & Leman, 1990) which may have been an economy measure by Zambian farmers.

There was little difference between the frequency of use of different boar culling criteria. From the work of D'Allaire and Leman (1990) it was expected that age/weight would be the most frequently used category but, as Zambians keep older and therefore heavier boars than elsewhere, age/weight was not considered a culling priority.

3.4.2.8 Mating policy.

Hughes and Varley (1980) stated that 1:25 was the maximum boar:sow ratio to preserve boar fertility when double matings were used; at 1:13.6 the Zambian herd had a much lower ratio. This would be expected with smaller herds as they must keep at least one boar but larger herds also showed a low ratio. As anticipated, herds using three matings per heat kept more boars than farms using double matings. However the overall ratio does appear low and suggests that too many boars were being kept in Zambian piggeries, contributing to higher feed costs. Zambian farmers, however, may have deliberately lowered the ratio to rest boars in the hot season.

While group matings require less husbandry than individual matings, labour availability is not usually a problem in the developing world. The use of group mating gives less control over mating; subfertile boars are not isolated and WSI is often high as unmated sows are not easily located. An improvement in efficiency of these herds would be expected if they changed to individual mating.

3.4.2.9 Farrowing.

While 79% of farms had someone attending farrowing in most cases these were night guards, whose main job was to guard the piggery against theft, and not trained pig personnel. It is unlikely that these workers had much influence on piglet survival and a programme to train them in piglet welfare and farrowing assistance could improve piglet survival; properly trained personnel have been shown to reduce periparturient piglet death (Cutler *et al.*, 1989).

3.4.2.10 Piggery hygiene and common diseases.
Most piggeries relied on chemical disinfectants for pen hygiene. However these chemicals were expensive and the supply erratic.

Scours were considered to be the most common health problem by 62% of piggeries. The majority of piggeries which used no method of hygiene perceived scours to be a serious problem while this was not the case with those using chemical disinfectants to clean pens. Chemical disinfection of pens may have prevented scours (Taylor, 1981) or those piggeries using disinfectants may have had a higher level of management than those which used none.

The fact that mange was seen as a frequent problem by 41% of farmers which was not surprising as chemicals were not available in the country at the time of the survey. It is usually a minor problem (Taylor, 1981) and may be again when chemicals become available.

Internal parasites are usually an insignificant problem in intensive piggeries and this was confirmed in the survey. TSS and MMA were predictably rare events but the former may worsen if feed quality declines.

Generally Zambia has little serious disease (K. Stafford, pers. comm., 1989) and farmers did not complain unduly of disease problems.

3.4.3 Productivity

The estimate of the number of pigs sold/sow/year varied from 11.0 to 13.2, depending on the method used. While it was not the purpose of this study to examine the difference between farmer's methods of estimating their productivity, it seemed that Method II was the better estimate as farmers were more able to remember the total number of pigs sold and sows-on-hand than to deal with the concept of averages. The real figure may lie in between the two estimates at approximately 12 pigs sold/sow/year which agrees well with Lynch's 1983 estimate. This turnoff is much lower than figures from Australia, Holland and Kenya of 17.2, 19.6 and 14.9 respectively (Henry, 1969; Ogink, 1989; Kabare, 1991) but more similar to the 13 pigs sold/sow/ year reported from Cuba (Rico, 1988). Low FI accompanied by high pre-weaning mortality resulted in low numbers weaned and sold/sow/year. The low productivity may be related to possible inbreeding of the Zambian herd (Pathiraja, 1986) or to abortion and reduced litter size due to porcine parvo virus (K. Stafford, pers. comm., 1989).

3.4.3.1 Fecundity.

Information on gestation length was not requested and data on WSI could not be analysed, thus lactation length was the only component of FI assessed. Mean lactation length, at 45.8 days, was longer than that generally reported in the developed world (Henry, 1969; Hubbard *et al.*, 1976; English *et al.*, 1982) but similar to that in the developing world (Rai & Desai, 1985; Singh *et al.*, 1986; Kabare, 1991). These longer lactations are consistent with countries which cannot provide the piglet care needed with short lactations (Rai & Desai, 1985; Singh *et al.*, 1986; Kabare, 1991).

Mean FI was estimated to be 1.7 litters/sow/year. Only 3 farms reported a FI of 2.0 or more and nearly half of all farms could not make an estimate. The estimate was lower than that shown for both the developed and developing world (Table 2.1) and well below the accepted target of over 2.0 (Whittemore, 1980; English *et al.*, 1982). An FI of 1.7 corresponds to a farrowing interval of 214 days; if mean lactation and gestation was 46 and 115 days respectively then mean WCI was 53 days, a very high figure and indicative of serious reproductive problems. As FI is an important component of sow productivity (Hughes & Varley, 1980), this low figure should be addressed by Zambian farmers.

3.4.3.2 Prolificacy.

Total litter size of 10.0 piglets born alive was higher than reports from some developed countries and was higher than that of other developing countries (see Table 2.2). Litter size at birth appeared not to be a serious problem in Zambian piggeries, although there is no reason why Zambian farms should have higher litter sizes, using European stock, than well run European piggeries. The level of pre-weaning loss was serious at 20% and brought the weaned litter size to lower than developed countries and in line with other developing countries. While this loss was not uncommon in the developing and even the developed world (Table 2.2), it represents a significant wastage.

3.4.3.3 Piglet loss

Overlying and disease were the most commonly mentioned causes of piglet death which was partly consistent with other authors (English *et al.*, 1982) who named overlying and starvation as the most common causes of death. A superior role of farrowing crates in preventing death by crushing was suggested by the data, although numbers were small. However piglet death is a complex issue and overlying can be associated with chilling, starvation and parturition events (English & Wilkinson, 1982). Disease is usually a minor problem but its importance in Zambia may be due to inadequate hygiene, insufficiently heated creep areas or lack of veterinary chemicals. It may also be due to farmer's inability to correctly diagnose cause of death; in the USA, farmers were only 68% correct in estimating the cause of piglet death (Vaillancourt *et al.*, 1990) and they would have a higher level of competence than the average Zambian farmer. Post weaning loss was calculated from Table 3.2 to be 8%, it is usually considered negligible.

3.4.3.4 Piglet weights

The estimates of piglet birth weight, all at one kg and suspected to be guesses, were lower than that given for both developed and developing countries (Hughes & Varley, 1980; Reyes, 1985; Goodewardene *et al.*, 1984; Chhabra *et al.*, 1989). While piglet weighing at birth is not an essential part of piggery management, reduced variation in piglet weight in litters can improve piglet survival (English *et al.*, 1982). A programme of piglet weighing at birth, with the aim of reducing within litter variation, is recommended. Mean weaning weight was lower than that of the developed world (Hill & Webb, 1982) but of a similar value to Kenya where 56 day lactations gave weaning weights of 9.6 kg (Kabare, 1991). Low Zambian weaning weights may have resulted from lack of appropriate creep feed. Weights increased with lactation length, as would be expected (Hill & Webb, 1982).

3.4.4 Pig industry problems

The economics of the Zambian commercial swine industry was adversely influenced by feed quality and pricing structures (GRZ, 1983a) and this was recognised by the majority of farmers. However the extremely low growth and productivity can be only partly be blamed on feed quality and piggery management should also be tackled. It is likely that, due to the poor extension services, pig farmers did not have the knowledge to innovate and improve their management techniques. Most piggeries were not the sole income earner thus other farm enterprises may have subsidised an inefficient piggery.

The general lack of confidence in the industry was apparently contradicted by the beliefs of farmers that their economic prospects would improve in the future. However, it should be taken into account that many of these farms expected a better financial future because of reduced pig numbers.

EXPLANATIONS FOR FIGURES 3.1 TO 3.6

Figure 3.1. Litter of two piglets in filthy pen.

Figure 3.2. A pen of unsorted pigs.

Figure 3.3. Farrowing pen with heated creep; note very thin sow.

Figure 3.4. Typical open-sided piggery; clean but with pigs sleeping in the feed troughs.

Figure 3.5. Farrowing pen with no crates or rails.

Figure 3.6. Multi-suckling pens with farrowing crates.

Figure 3.1

Figure 3.2

Figure 3.4

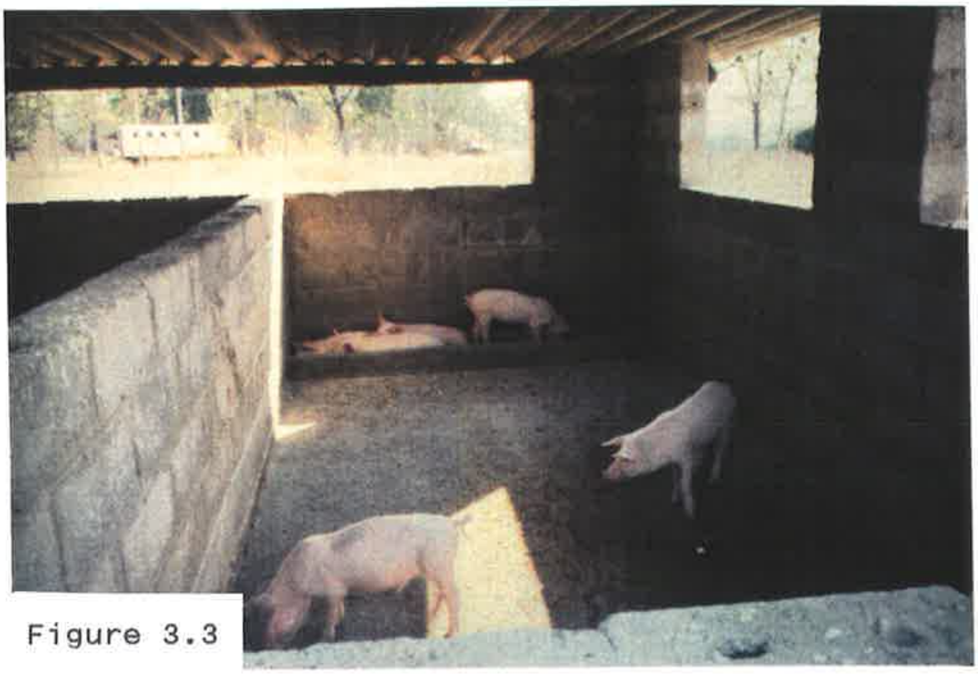


Figure 3.3

Figure 3.5

Figure 3.6

EXPLANATIONS FOR FIGURES 3.7 TO 3.10

Figure 3.7. Typical dry sow accommodation, note mixture of Large White and Landrace characteristics.

Figure 3.8. Dry sow accommodation with individual stalls to reduce sow fighting.

Figure 3.9. Semi-intensive system, weaners raised on earth floor.

Figure 3.10. Semi-intensive system, poor dry sow accommodation with badly maintained watering point.

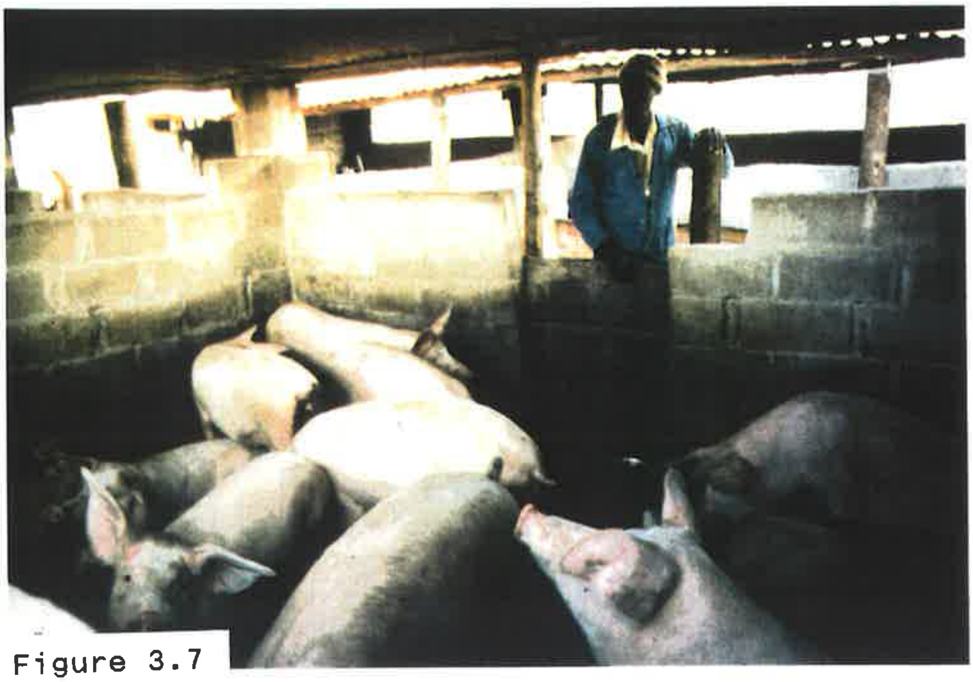


Figure 3.7

Figure 3.8

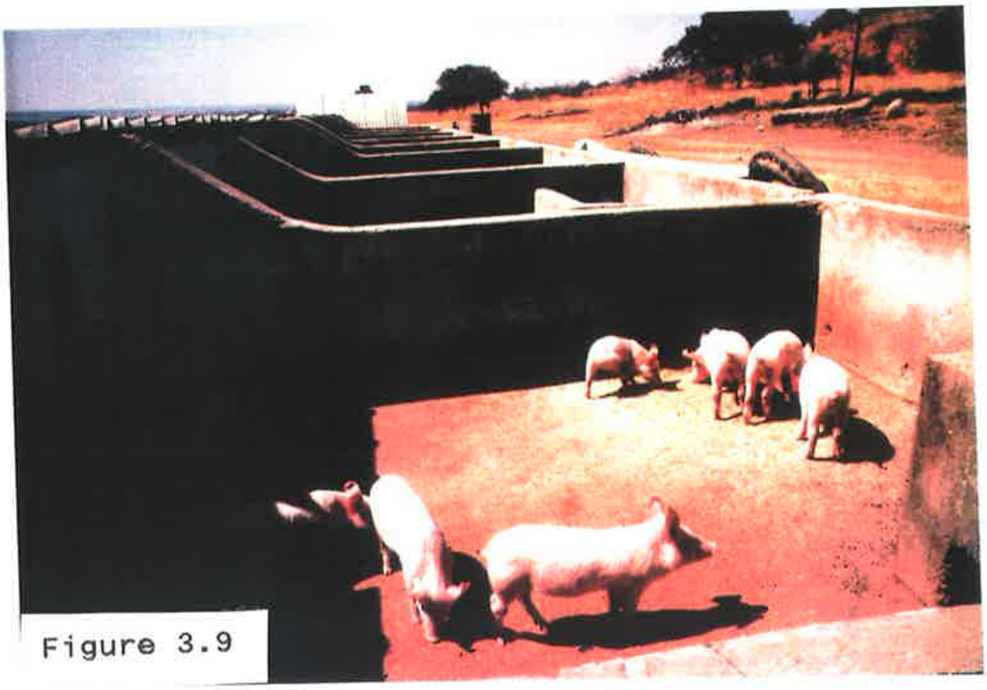


Figure 3.9

Figure 3.10

CHAPTER 4. ANALYSIS OF SOW-RECORD-CARDS (SRC)

4.1 INTRODUCTION

The farmer survey, as discussed in the previous chapter, highlighted the problems in using such a method to estimate productivity, much of the data was derived from guesses therefore it was difficult to come to any concrete conclusions. There was an obvious need to collect information directly from piggery records for a precise estimate of productivity.

This study used actual piggery records to determine the efficiency of Zambian piggeries and to compare estimates gained in this way with those in the previous chapter. Only the reproductive data recorded on sow-record-cards (SRCs), except post-weaning loss, is analysed in this chapter.

4.2 MATERIALS AND METHODS

In early 1989, data on gestation, lactation, WSI, services, litter size and pre-weaning loss were collected from SRCs of three farms in the Lusaka area. Records from up to four parities per sow, covering 1986 to 1989, were used to estimate production levels of the piggeries. SRCs were randomly selected and data from 227 parities, some incomplete, were collected. The farms, referred to as T19, U31 and N14 for anonymity, were not randomly selected as they were the only ones to which transport was available and which used SRCs for data recording. The level of management of these piggeries was considered to be relatively good compared with other Zambian piggeries. Data was collected over a period of two hours for farms T19 and N14. Computer generated SRCs, used for U31, did not display some seasonal and service data. A female pig was classed as a gilt until she was pregnant with her second litter (Hughes & Varley, 1980).

No information from culled sows or unfarrowed gilts was included in the study as two piggeries destroyed SRCs on culling and in each farm unfarrowed gilts were inconsistently recorded and their perceived entry into the breeding herd was different. As pregnancy status was not recorded on the SRCs, it was confirmed only at farrowing. The season of farrowing and weaning was recorded as Hot-Wet (HW), 1st November to 31st January); Warm-Moist (WM), 1st February to 30th April); Cool-Dry (CD), 1st May to 31st July) or Hot-Dry (HD) 1st August to 31st October.

While it was originally intended that this survey be carried out soon after the farmer survey this could not be done due to the poor health of the author. Therefore direct comparisons cannot be made between the two studies as improved management occurred in farms T19 and N14 in the intervening period.

Data was analysed using Dbase IV on an IBM-AT clone personal computer. Significance of results was assessed using the Student's "t", correlation and chi-squared tests (Mead & Curnow, 1983).

4.3 RESULTS

Farm T19 was privately owned and pig breeding was the sole farm enterprise; 13% (40 sows) of the 300 sows-on-hand were sampled for a total of 93 parities. Farm U31 was a minor part of a large institution; of the total 30 sows-on-hand, data were collected from 80% (24 sows) and 51 parities. Conditions were difficult for the farm manager of U31 who was not involved in major farm decisions and the piggery was often ignored by farm management; for instance it was not unusual the farm to run out of pig feed. Data from farm N14, part of a large agricultural parastatal, was collected from 6.5% (25) of the 400 sows-on-hand and 83 parities. Table 4.1 shows information for these farms gathered during the farmer survey (see Chapter 3).

The mean parity of data collected was 4.5 for the whole study (overall) and 4.4, 2.8 and 5.6 for farms T19, U31 and N14 respectively.

The data from SRCs for all females are summarised in Table 4.2. The difference in some production traits of gilts and sows are displayed in Table 4.3 and correlations between parameters are found in Table 4.4. Table 4.5 shows the influence of season on some aspects of production. The tables are shown at the end of the results section.

4.3.1 Fecundity

The overall mean fecundity is shown in Table 4.6 as a farrowing interval of 180.4 days or a FI of 2.02. Farm N14 had a slightly higher FI than the other farms.

4.3.1.1 Gestation Length

Mean gestation length was 115.09 $\pm$3.01 days (range, 100 to 128 days, abortions not included). Farm N14 had a significantly shorter gestation length than the other two farms (Table 4.2). There was no difference between the gestation lengths of sows and gilts or any correlation between total litter size and gestation length (Tables 4.3 & 4.4). The WM season had a significantly shorter mean gestation than the other seasons (Table 4.5).

Four litters aborted between 71 and 86 days of gestation, three from N14 and one from U31. The gestation periods of 10 gilts (eight from T19, two from U31) and three sows (two from T19, one from U31) were not available.

4.3.1.2 Lactation Length

Mean lactation length was 46.24 ±12.70 days (range, 0 to 77 days). All farms had significantly different lactation lengths, farm U31 had the shortest period and the lowest variance (Table 4.2) as litters were always weaned at 35 days, if not before, while the other farms tended to adjust the planned weaning (56 days for T19, 42 days for N14) according to the state of the litter (pers. comm., farm managers, 1988). There was a significant negative correlation ($P<0.1\%$) between lactation length and WSI (Table 4.4).

4.3.1.3 Weaning to Conception Interval

Three WSIs of greater than 70 days (73, 90, 147 days) were not included in the analysis as this was considered abnormally long (females should be culled after 35 days of anoestrus (Hughes & Varley, 1980)) and greatly increased the variance. The mean WSI was 9.78 ±10.6 days (range, 1 to 55 days) for all farms. Farm U31 had a longer interval than the other two farms (Table 4.2). Sows from U31 also had a significantly longer mean WSI than those from T19 (P<0.1%) and N14 (P<1%). There was no correlation between WSI and litter size born alive or weaned but a significant negative correlation was demonstrated between WSI and parity (Table 4.4). Gilts had longer mean WSI than sows (Table 4.3).

There was a highly significant (chi-squared, P<1%) difference between the percentage of gilts (61.7%; 29/47) and sows (80.5%; 107/133) showing oestrus within 10 days of weaning; overall 24.3% (44/180) of females were anoestrous. The overall farrowing rate was 84.5% (147/174); gilts had a slightly lower rate (73.3%; 33/45) than sows (88.4%; 114/129).

Repeat mating of females was a noticeable problem, one gilt and one sow were each mated on four consecutive heats. The mean number of services/litter was 1.2 $\pm$0.54 (range 1 to 4) with more repeat matings in U31 than N14 (Table 4.2). Gilts were serviced more frequently that sows (Table 4.3) and number of services was negatively correlated to parity when parity was less than six (Table 4.4).

Of the 22 unsuccessful services, only 45.5% (10) returned during the expected period of 17 to 23 days. Another 13.6% (3) returned between 24 and 30 days, 22.9% (5) between 31 and 50 days and 18% (4) returned after 50 days.

The mean WCI was 18.03 ±26.87 days (range 1 to 176 days). Farm U31 had a longer WCI than the other farms due to longer mean WSI and more returns to service (Table 4.2). The difference was not only due to a higher percentage of gilts in this farm as multiparous sows from U31 also had longer WCI than sows from T19 ($P<5\%$) and slightly longer than sows from N14. A negative correlation was demonstrated between parity and WCI ($P<5\%$) and gilts had a longer WCI than sows ($P<0.1\%$) see Tables 4.3 & 4.4.

No sows were found to be not pregnant at term.

4.3.2 Prolificacy

Mean total litter size was 9.7 ±2.64 piglets (range, 3 to 17) and was calculated for farms U31 and N14 only as farm T19 did not record still-births (Table 4.2). Total litter size was positively correlated with parity (Table 4.4).

The mean number born alive per litter was 8.76 ±2.72 piglets (range, 0 to 17) with no difference between farms (Table 4.2). Number born alive was positively correlated with parity only when parity was less than six (Table 4.4). Gilts had smaller numbers born alive and total litter size than sows (Table 4.3). The number born alive to gilts from

N14 was significantly less than from U31 ($P<0.2\%$) and T19 ($P<1\%$). Farm U31 gilts had a slightly higher litter size born alive than sows (Table 4.3).

Still-born piglets averaged 1.03 $\pm$2.6 per litter (range, 0 to 16), the numbers were higher in U31 than N14 ($P<5\%$, Table 4.2). The variance of this parameter was high due to four litters (one from N14, three from U31) of over 12 piglets still-born. There was no difference between the numbers still-born for gilts and sows nor was there a correlation between parity and numbers still-born (Tables 4.3 & 4.4). While there was no seasonal effect on number born alive, still-births per litter were highest in the CD and lowest in the WM months ($P<5\%$, Table 4.5).

4.3.3 Piglet losses

Table 4.2 shows the overall pre-weaning loss as 21.05% $\pm$25.67% (range, 0% to 100%) of piglets born alive or 1.93 $\pm$2.31 piglets per litter (range 0 to 14). There was no significant difference between percentage loss but U31 lost more total piglets per litter than the other two farms. No seasonal effect on pre-weaning loss was seen.

Mean weaned litter size was 7.18 $\pm$2.65 piglets (range, 0 to

12) and there was no difference between farms (Table 4.2). Gilts weaned less piglets per litter than sows (Table 4.3). A positive correlation was shown between weaned litter size and parity when parity was less than six; litter size born alive and litter size weaned were highly correlated (Table 4.4).

The SRCs did not give estimates of post weaning loss but farm managers estimated it to be 5%, 16% and 6% for farms T19, U31 and N14 respectively.

Table 4.1. Data extracted from farmer survey

Item	Unit	Farm T19	Farm U31	Farm N14
Ownership		Private	Institution	Parastatal
Sow number 1984	sow	200	30	350
<u>Piggery management</u>				
Breeding stock:				
Maximum parity		10	6	15
Boar years of service	year	4	3	NA
Sow:Boar numbers	ratio	13:1	15:1	14:1
Number of services/heat		3	NA	3
Piglet management:				
Creep feed		yes	no	yes
Farrowing accomodation		rails	nil	crates
Heated creep area		yes	no	yes
Major cause of piglet death		overlie	overlie	disease
Farrowing attendance		always	often	always
<u>Productivity</u>				
Fecundity:				
Weaning age	day	49	42	56
Litters/sow/yr		2.0	1.5	1.8
Prolificacy:				
Litter size alive	pig	9.5	9.1	8.3
Litter size weaned	pig	8.0	7.1	5.7
Weaning weight	kg	13	6.5	NA

NA = Not available

Table 4.2. Summary of sow record cards

Parameter	Unit	Mean	Variance	n	S.E.
<u>Gestation length</u> - not including abortions					
Overall	days	115.09	9.09	209	3.01
(a)T19		115.79	13.41	82	3.66
(b)U31		115.36	2.74	47	1.66
(c)N14		114.21	7.07	80	2.66
signif. between farms		ab n.s., bc P<1%, ca P<0.2%			
<u>Lactation length</u>					
Overall	days	46.24	161.38	192	12.70
(a)T19		52.89	104.90	82	10.24
(b)U31		35.12	29.91	41	5.47
(c)N14		44.94	178.92	69	13.38
signif. between farms		ab P<0.1%, bc P<0.1%, ca P<0.1%			
<u>WSI</u>					
Overall	days	9.78	111.60	178	10.56
(a)T19		8.01	67.18	79	8.20
(b)U31		16.12	199.60	34	14.13
(c)N14		8.62	93.47	65	9.67
signif. between farms		ab P<0.1%, bc P<0.2%, ca n.s.			
<u>Number of services per litter</u>					
Overall	serves	1.20	0.29	175	0.54
(a)T19		1.19	0.27	70	0.52
(b)U31		1.37	0.52	41	0.72
(c)N14		1.11	0.13	64	0.36
signif. between farms		ab n.s., bc P<2%, ca n.s.			
<u>WCI</u>					
Overall	days	18.03	721.85	174	26.87
(a)T19		14.04	463.84	70	21.54
(b)U31		27.85	681.73	40	26.11
(c)N14		16.27	948.35	64	30.80
signif. between farms		ab P<1%, bc P<5%, ca n.s.			
<u>Total litter size</u>					
Overall	piglets	9.70	6.97	132	2.64
(b)U31		10.51	7.50	51	2.74
(c)N14		9.19	5.95	81	2.44
signif. between farms		bc P<1%			

Table 4.2 (Cont.) Summary of sow record cards

Parameter	Unit	Mean	Variance	n	S.E.
Born alive per litter					
Overall	piglets	8.76	7.41	224	2.72
(a)T19		8.90	5.04	92	2.24
(b)U31		8.88	13.08	51	3.62
(c)N14		8.53	6.45	81	2.54
signif. between farms		nil			
Still-born per litter					
Overall	piglets	1.03	6.77	132	2.60
(a)T19		no records			
(b)U31		1.63	11.10	51	3.33
(c)N14		0.65	3.68	81	1.92
signif. between farms		bc P<5%			
Loss per litter, birth to weaning					
Overall	piglets	1.93	5.34	192	2.31
(a)T19		2.04	2.96	82	1.72
(b)U31		2.68	10.70	41	3.27
(c)N14		1.35	4.30	69	2.07
signif. between farms		ab n.s., bc P<1%, ca P<5%			
Percentage loss per litter, birth to weaning					
Overall	%	21.05	658.71	192	25.67
(a)T19		21.77	357.00	82	18.89
(b)U31		25.71	860.52	41	29.33
(c)N14		17.41	870.45	69	29.50
signif. between farms		nil			
Weaned per litter					
Overall	piglets	7.18	7.04	192	2.65
(a)T19		6.99	3.67	82	1.92
(b)U31		7.29	11.28	41	3.36
(c)N14		7.35	8.49	69	2.91
signif. between farms		nil			

S.E. = standard error, n = number
All analysis is paired Student's t; n.s. = not significant

Table 4.3. Comparison of productivity of gilts and sows

Parameter	Farm	Unit	Mean	Variance	n	Signif.
Gestation length						
Overall	- gilts	days	114.87	6.87	45	
	- sows		115.15	9.68	164	n.s.
T19	- gilts	"	115.72	9.76	18	
	- sows		115.81	14.43	64	n.s.
U31	- gilts	"	114.94	3.00	17	
	- sows		115.60	2.44	30	n.s.
N14	- gilts	"	113.20	4.16	10	
	- sows		114.36	7.32	70	n.s.
WSI						
Overall	- gilts	days	13.72	198.20	46	
	- sows		8.41	74.17	132	P<1%
T19	- gilts	"	10.39	118.15	23	
	- sows		7.04	42.96	56	n.s.
U31	- gilts	"	19.23	270.64	13	
	- sows		14.19	145.87	21	n.s.
N14	- gilts	"	14.20	222.96	10	
	- sows		7.60	63.22	55	P<5%
Number of services per litter						
Overall	- gilts	serve	1.38	0.50	45	
	- sows		1.14	0.20	129	P<1%
T19	- gilts	"	1.26	0.51	19	
	- sows		1.16	0.17	51	n.s.
U31	- gilts	"	1.56	0.50	16	
	- sows		1.25	0.52	24	n.s.
N14	- gilts	"	1.30	0.41	10	
	- sows		1.07	0.07	54	n.s.
WCI						
Overall	- gilts	days	29.22	1146.44	45	
	- sows		14.13	514.84	129	P<0.1%
T19	- gilts	"	20.32	1161.69	19	
	- sows		11.71	184.74	51	n.s.
U31	- gilts	"	37.31	714.84	16	
	- sows		21.54	560.16	24	n.s.
N14	- gilts	"	33.20	1536.00	10	
	- sows		13.13	776.45	54	P<5%

Table 4.3 (Cont.) Comparison of productivity of gilts and sows

Parameter	Farm	Unit	Mean	Variance	n	Signif.
<u>Total litter size</u>						
	Overall - gilts	pigs	8.59	4.53	19	
	- sows		10.01	6.63	103	P<5%
	U31 - gilts	"	9.68	4.53	19	
	- sows		11.00	8.63	32	n.s.
	N14 - gilts	"	6.50	3.85	10	
	- sows		9.56	5.09	71	P<0.1%
<u>Born alive per litter</u>						
	Overall - gilts	pigs	8.11	5.95	54	
	- sows		8.97	7.70	170	P<5%
	T19 - gilts	"	8.20	2.48	25	
	- sows		9.16	5.75	67	n.s.
	U31 - gilts	"	9.21	5.75	19	
	- sows		8.69	17.34	32	n.s.
	N14 - gilts	"	5.80	7.36	10	
	- sows		8.92	5.12	71	P<0.1%
<u>Still-born per litter</u>						
	Overall - gilts	pigs	0.55	1.56	29	
	- sows		1.17	8.16	103	n.s.
	U31 - gilts	"	0.47	1.20	19	
	- sows		2.31	15.71	32	n.s.
	N14 - gilts	"	0.70	2.21	10	
	- sows		0.65	3.89	71	n.s.
<u>Number weaned per litter</u>						
	Overall - gilts	pigs	5.97	9.10	52	
	- sows		7.63	5.55	140	P<0.1%
	T19 - gilts	"	6.41	2.59	25	
	- sows		7.25	3.92	57	n.s.
	U31 - gilts	"	6.71	10.80	17	
	- sows		7.71	11.20	24	n.s.
	N14 - gilts	"	3.64	15.64	10	
	- sows		7.98	4.55	59	P<0.1%

Table 4.4. Summary of correlations

Item	Farm	D.F.	r	Signif.
Total litter size vs gestation length				
	Overall	1, 125	-0.003	n.s.
	(b)U31	1, 45	-0.11	n.s.
	(c)N14	1, 78	-0.05	n.s.
WSI vs lactation length				
	Overall	1, 171	-0.27	P<0.1%
	(a)T19	1, 77	-0.04	n.s.
	(b)U31	1, 32	-0.33	n.s.
	(c)N14	1, 63	-0.26	P<5%
WSI vs litter size born alive				
	Overall	1, 173	-0.10	n.s.
	(a)T19	1, 76	-0.09	n.s.
	(b)U31	1, 31	-0.13	n.s.
	(c)N14	1, 61	-0.17	n.s.
WSI vs litter size weaned				
	Overall	1, 171	-0.07	n.s.
	(a)T19	1, 76	0.04	n.s.
	(b)U31	1, 31	-0.02	n.s.
	(c)N14	1, 61	-0.20	n.s.
WSI vs parity				
	Overall	1, 176	-0.19	P<5%
	(a)T19	1, 77	-0.16	n.s.
	(b)U31	1, 32	-0.15	n.s.
	(c)N14	1, 63	-0.11	n.s.
Number of services per heat vs parity (parity<6)				
	Overall	1, 116	-0.27	P<1%
	(a)T19	1, 44	-0.17	n.s.
	(b)U31	1, 35	-0.33	P<5%
	(c)N14	1, 33	-0.32	n.s.
WCI vs parity				
	Overall	1, 168	-0.17	P<5%
	(a)T19	1, 67	-0.14	n.s.
	(b)U31	1, 36	-0.07	n.s.
	(c)N14	1, 61	-0.13	n.s.
Total litter size vs parity				
	Overall	1, 130	0.19	P<5%
	(b)U31	1, 49	0.16	n.s.
	(c)N14	1, 79	0.43	P<0.1%

Table 4.4. (Cont.). Summary of correlations

Item	Farm	D.F.	r	Signif.
Litter size born alive vs parity				
	Overall	1, 222	0.12	n.s.
	(a)T19	1, 90	0.07	n.s.
	(b)U31	1, 49	0.03	n.s.
	(c)N14	1, 79	0.35	P<1%
Number still-born/litter vs parity				
	Overall	1, 130	0.01	n.s.
	(b)U31	1, 49	0.17	n.s.
	(c)N14	1, 79	0.09	n.s.
Pre-weaning loss vs. parity				
	Overall	1, 190	-0.02	n.s.
	(a)T19	1, 80	0.09	n.s.
	(b)U31	1, 39	0.09	n.s.
	(c)N14	1, 67	0.04	n.s.
Litter size weaned vs parity				
	Overall	1, 190	0.16	P<5%
	(a)T19	1, 80	0.07	n.s.
	(b)U31	1, 39	0.01	n.s.
	(c)N14	1, 67	0.34	P<1%
Litter size born alive vs litter size weaned				
	Overall	1, 222	0.57	P<0.1%
	(a)T19	1, 90	0.52	P<0.1%
	(b)U31	1, 49	0.64	P<0.1%
	(c)N14	1, 79	0.56	P<0.1%

r = coefficient of correlation
D.F. = degrees of freedom

Table 4.5 Influence of season on production

Parameter	Overall	Season HW	WM	CD	HD
Gestation length and season of farrowing (days)					
Mean	115.07	115.54	114.03	115.23	115.37
Variance	10.22	14.20	4.90	10.09	10.08
Number	175	41	39	43	52
significance	WM shorter than all other seasons (P<5%)				
WSI and season of farrowing (days)					
Mean	9.44	12.35	8.50	9.41	7.79
Variance	109.73	203.76	69.69	90.83	73.65
Number	150	34	36	41	39
significance	n.s.				
WSI and season of weaning (days)					
Mean	9.41	10.66	11.03	8.00	8.07
Variance	108.41	138.57	158.97	72.88	60.86
Number	152	41	34	34	43
significance	n.s.				
WCI and season of farrowing (days)					
Mean	17.12	19.59	12.75	18.2	18.22
Variance	759.89	805.68	210.19	895.81	1132.36
Number	140	32	36	40	32
significance	n.s.				
WCI and season of weaning (days)					
Mean	17.13	19.81	19.85	17.44	11.89
Variance	751.58	1098.71	761.13	890.01	249.41
Number	142	36	34	34	38
significance	n.s.				
Litter size born alive and season of farrowing (pigs)					
Mean	8.72	8.62	9.18	8.27	8.89
Variance	6.17	6.01	5.74	8.44	4.17
Number	188	45	40	49	54
significance	n.s.				
Sill-born/litter and season of farrowing (pigs)					
Mean	0.83	1.22	0.3	1.36	0.57
Variance	4.61	10.4	0.5	6.52	2.38
Number	103	18	27	28	30
significance	CD higher than WM (P<5%)				
Litter size weaned and season of farrowing (pigs)					
Mean	7.33	7.08	7.39	7.35	7.45
Variance	6.85	5.35	6.98	9.53	5.29
Number	161	36	38	43	44
significance	n.s.				

Table 4.5 (Cont.) Influence of season on production

Parameter	Overall	HW	Season WM	CD	HD
Litter size weaned and season of weaning (pigs)					
Mean	7.36	7.13	7.30	7.54	7.50
Variance	6.97	5.16	7.00	9.98	6.20
Number	160	46	33	37	44
significance	n.s.				
Pre-weaning loss and season of farrowing (pigs)					
Mean	1.80	1.87	2.13	1.68	1.57
Variance	4.89	3.90	9.60	3.60	2.74
Number	161	36	38	43	44
significance	n.s.				
Pre-weaning loss and season of weaning (pigs)					
Mean	1.80	1.72	2.08	1.69	1.76
Variance	4.88	3.03	6.60	7.86	2.95
Number	160	46	33	37	44
significance	n.s.				

Table 4.6. Summary of fecundity

Farm	Gestation Length (days)	Lact'n Length (days)	WCI (days)	Abortion Loss (days)	Farrowing Interval (days)	FI
Overall	114.8	46.2	18.0	1.4	180.4	2.02
T19	115.8	52.9	14.0	0.0	182.7	2.00
U35	115.4	35.1	27.9	1.8	180.2	2.03
n14	114.2	44.9	16.3	2.7	178.1	2.05

Farrowing interval is calculated by adding days attributed to gestation, lactation, WCI and abortion

Table 4.7. Summary of productivity

FARM	Litter size Wean	Wean/sow /Year*	Litter size Sold	Sold/sow /Year*
Overall	7.18	14.53	6.51	13.17
T19	6.99	13.96	6.59	13.17
U35	7.29	14.77	6.12	12.40
n14	7.35	15.06	6.89	14.12

* apparent errors due to rounding

4.4 DISCUSSION

As estimates for culled sows were not taken into account, and as 30% of sows are culled for reproductive reasons (Hughes & Varley, 1980), the figures quoted here may have been overestimated. Also unfarrowed gilts were not included in this study; they are usually included in herd average figures.

The summaries of mean production parameters (Tables 4.6 & 4.7) show the overall productivity to be 14.5 pigs weaned and 13.2 pigs sold/sow/year for the three Zambian farms studied. This is a very low level of productivity but not unusual in the developing world where 13.2 to 17.0 pigs weaned/sow/year have been reported (Adebambo, 1986; Rico, 1988; Kabare, 1991). However, in ideal conditions, the developing world is capable of better production and well run piggeries can produce 19 pigs weaned/sow/year (Shanmugavelu *et al.*, 1988; N. Kabare pers. comm., 1991) which is comparable with piggeries in the developed world (English *et al.*, 1982; Dijkhuizen *et al.*, 1989). The estimate of productivity found in this chapter is slightly higher than the 12.4 pigs sold/sow/year found for the same piggeries in Chapter 3. However as the management had changed in two piggeries in the intervening period and as nonfarrowed gilts and culls were not included in the SRC survey the two methods are not strictly comparable.

4.4.1 Fecundity

Table 4.6 shows that the overall mean FI was 2.02 litters/sow/year for a mean 46.2 day lactation. The FI was slightly lower than those for the developing world as shown in Table 2.1. For a lactation length of 46 days, 2.25 litters/sow/year can be achieved (Hughes & Varley, 1980) thus this study showed that fecundity was 12% less than the optimum. The FI in this estimate may be artificially high as unfarrowed gilts and culls were not included.

The mean gestation length was similar to that found by other authors but the present study showed a large variation in gestation lengths. The range was wider (100 to 128 days vs 108 to 122 days) and the percentage of values falling within two days of the mean was less (82% vs 92%) than in a larger U.K. study (English *et al.*, 1982). The reason for the significantly shorter gestation length for farm N14 is not known.

A significant seasonal effect was shown with gestation length being shorter in the WM season. This confirms the influence of season on gestation length as reported by Rico (1988).

The lack of correlation between gestation length and litter size confirms the belief of Hughes and Varley (1980) but contradicts the work of others (English *et al.*, 1982; Tomes & Nielsen, 1982). Gestation length was not recorded for 13 parities, either as result of poor record keeping or inadvertent impregnation of females by escapee boars or entire male finishers. The 10 gilts with unknown gestation periods were selected as breeders because they were suspected of being pregnant. As background of parents, feed conversion and physical conformity should be considered when selecting gilts this accidental method of selection is not recommended (English *et al.*, 1982).

Farm T19 did not record abortions which probably appeared as extended WCIs. It was noticeable that the four recorded abortions occurred between 71 and 86 days. This corresponds to a period of metabolic change for the fetus, a time when some major components of the histrotroph decline with falling progesterone levels (Bazer *et al.*, 1982; Simmen & Simmen, 1990). It may be that this period is a critical one for fetal metabolism or that pregnancies which fail prior to this are resorbed and not aborted. If the former is true, piggery managers may need to pay special attention to the sow during this period. More data on abortions would help to determine whether this is a susceptible time for the sow and her litter.

The weaning policies of the three farms were five, six and eight weeks for farms U31, N14 and T19 respectively. The shorter lactation length did not correspond to an increased FI, as expected (Hughes & Varley, 1980; English *et al.*, 1982) as it was associated with longer WSI. Several workers have reported that WSI was unaffected by lactation lengths greater than 35 days (Cole *et al.*, 1975; English *et al.*, 1982). This was partially confirmed in this study were lactation lengths of around 35 days showed an increased WSI compared with longer lactations and lactation length was negatively correlated with WSI.

The mean WSI was higher than that of the developing world (Table 2.1); the high variance in this study resulted from the retention of anoestrous sows and made correlations difficult. Oestrus does appear to be delayed in Zambia as the percentage of anoestrous females (38% of gilts, 20% of sows) was higher than reports of anoestrus in 29.4% of gilts and 7.6% of sows in Australia (Paterson *et al.*, 1980). Long anoestrous periods, some over 70 days, were recorded and may have been the result of silent oestrus, a common occurrence in seasonal infertility and exacerbated by high temperatures (Love, 1981; Christensen, 1986). If ovulation occurs during long lactations (English *et al.*, 1982), the next heat, approximately 21 days later, may appear as a delayed oestrus.

Rebreeding after weaning was more successful in sows than gilts confirming that anoestrus (Hurtgen & Leman, 1981; Tubbs *et al.*, 1990) and conception failure (Tubbs *et al.*, 1990; Tarocco, 1989) was more common in gilts than sows. The negative correlation between WSI or WCI and parity supports similar findings by Kabare (1991). The longer WCI of farm U31 was not due to the higher proportion of gilts in this farm as multiparous sows from U31 showed significantly longer WSI and WCI than sows from other farms and therefore may have been related to management on that farm.

The figure of 71% of females conceiving within 14 days of weaning agrees with estimates of Fahmy (1981) but 90% conception could be achievable with good management.

Small numbers (22) prevented meaningful analysis of returns to service such as that carried out by Glossop and Foulkes in 1988. The pattern of returns showed an abnormal distribution with 50% returning outside the expected period, possibly due to early embryonic loss (Wrathall, 1982).

The tropical climate of Zambia may be expected to influence fecundity but this was not apparent. The lack of any seasonal influence on WSI or WCI was surprising given that they are well documented to increase in warmer months (Tomes & Nielsen, 1979; Fahmy, 1981; Hurtgen & Leman, 1981; English *et al.*, 1982). Had shed temperatures been available, it may have been more useful to compare WSI or WCI with monthly mean maximum temperatures.

Improvement in FI could be achieved by using SRCs to cull sows showing abnormally long WCIs. While this study did not investigate the role of management (excluding lactation length) on WSI and WCI, attention to nutrition and management of gilts (Fahmy, 1981), feeding levels of sows (Cole, 1982), boar stimulation and manipulation of the social and physical environment (Meredith, 1979) are methods which have been shown to improve FI and could be used in Zambian piggeries.

The lower conception rate of gilts needs further investigation and it may indicate that managers are less likely to cull gilts failing to hold service than sows.

4.4.2 Prolificacy

The mean total (9.7) and born alive (8.8) litter size for the farms were lower than those of developed countries but higher than for some developing countries (see Table 2.2).

Total litter size was correlated with parity in agreement with others (Paterson *et al.*, 1980; Reyes, 1985; Singh *et al.*, 1986). The reason for the significantly lower litter size, especially of gilts, for farm N14 was not known. It was not possible to determine the ages or oestrus number at first mating of these gilts. Perhaps N14 were mating gilts at an earlier oestrus than was indicated in the farmer survey (Table 4.1) as litter size increases with oestrus number (Brooks, 1982).

It was unfortunate that farm T19 did not record numbers still-born because this implied that it was an unavoidable loss and could not be reduced. Extra data from this herd would have been helpful in assessing the influence of parity on still-born piglets numbers. Still-births comprised 10.5% of total litter size and this represented a higher percentage than in the developed and most of the developing world.

It was expected that older sows would produce higher numbers of still-births (Paterson *et al.*, 1980; English *et al.*, 1982) but this was not the case in this study. The farm with the highest percentage of still-born piglets, U31, had the lowest mean parity and no difference in still-births between gilts and sows or no correlation between still-births and parity was demonstrated. This confirms other work in the tropics where parity was not correlated to still-births (Reyes, 1985) but may have been the result of strict culling of old sows which produced large numbers of still-born piglets.

High ambient temperature has been reported to increase the number of still-births (Steinbach, 1973 & 1976) but in Zambia the highest number of still-births occurred in the CD season. It may be that many recorded still-births were actually born alive but died soon afterwards due to chilling and crushing. It is interesting that farm U31 had the highest percentage of still-born piglets and a less consistent attendance at farrowing.

4.4.3 Piglet losses

The mean piglet loss between birth and weaning was high (21%) and variable but with no significant difference between farms in percentage loss, only actual loss. Gilts have been reported to lose fewer piglets than sows (Paterson *et al.*, 1980) but in this study there was no correlation between loss and parity. Losses were higher than most recent studies in the developed world but similar to levels from the developing world. While a higher loss for farm U31 was suggested by the data, the high variance of percentage loss precluded any significance.

As farms T19 and N14 fostered excess piglets it was expected that pre-weaning mortality would be lower than U31. Perhaps the fostering policy did not go far enough and a stricter policy, which took into account piglet birth weight, as well as litter size, would improve survival. While piglet loss is often higher in the developing world, this is not always the case; in a large commercial farm in Kenya pre-weaning loss is below 7% due to provision of a good creep feed, well designed farrowing accommodation, well trained staff and a staff bonus tied to piglet survival (N. Kabare, pers. comm., 1991).

Table 4.1 shows that the lack of creep feed, a heated creep area and farrowing crates or rails all predisposed U31 to the higher total losses that were seen (Cutler *et al.*, 1989). In the farmer survey, N14 gave disease as its major cause of piglet mortality (Table 4.1), while crushing was the most common cause of mortality in U31 and T19, in common with the available literature (Hughes & Varley, 1980; English *et al.*, 1982). It may be that the superior design of N14's farrowing accommodation, i.e. the use of farrowing crates, reduced piglet mortality from crushing and was partly responsible for the slightly lower piglet loss in this farm.

There was no increase in pre-weaning loss during the CD season as reported in other parts of the developing world (Singh, 1976); tropical piggeries are usually designed to prevent overheating and are therefore unable to retain heat during the cold season. Seasonal influence on mortality was not demonstrated possibly because the farm which had no heated creep, U31, contributed less data than the other two farms to the analysis of seasonal influence. Nevertheless, a more detailed study of the influence of season on piglet mortality in the developing world would be recommended.

The area of piglet survival should be addressed by all three piggeries as losses at this stage are expensive. As the quality of piglet supervision influences survival rate (Cutler *et al.*, 1989), staff training programmes and a bonus system would be advised, but administratively may be difficult in those farms not privately owned.

Post weaning survival was not calculated from sow cards but estimated by the farm manager. The higher loss for U31 was perhaps due to poor piglet management (lack of creep feed and low weaning weight) and this farm lost pigs at the most expensive stage.

4.4.5 General

This section of the present study could have been improved if more SRCs had been sampled which may have improved the significance of some tests by reducing the variance. The computer generated SRCs for U31 lacked data on seasonality and infertile matings. Comparison between farms was made difficult by the different parity structure of the data, however these must be assumed to reflect actual parity structures of the farms. Despite these problems this section has proved invaluable in confirming information gathered in Chapter 3.

While productivity is usually lower in the tropics than the temperate zones (Steinbach, 1976; Tomes & Nielsen, 1979) the figure of 13.17 pigs sold/sow/year is very low. Efforts should be made to improve the productivity of these herds as good production is possible in the tropics (N. Kabare, pers. comm., 1991). Some recommendations can be made for management. The observation made in Chapter 3, that farm managers did not use piggery records, was confirmed in this study. By using SRCs to identify sows with abnormally long WCIs, which could be culled accordingly, the FI could be improved. Management could also be used to reduce WSI, with special attention paid to nutrition and to the social environment of weaned females.

Farrowing accommodation should be modified on farm U31 to provide a secluded and heated creep area. In addition it would be advisable for this farm to increase its lactation length to six weeks as there was a disadvantage in shorter lactations. Staff training programmes, aimed at improving piglet survival, should be instituted.

CHAPTER 5. SURVEY OF FEMALE REPRODUCTIVE TRACTS FROM ABATTOIRS.

5.1 INTRODUCTION

Abattoir studies provide a method of investigating ovulation rate, puberty, pregnant wastage, and the incidence of genital abnormalities of culled breeders or randomly collected females. Approximately one third of sows are culled due to infertility in the developed world (Hughes & Varley, 1980) and its physical causes may be apparent in a study of tracts. As there is an association between some acquired abnormalities of the reproductive tract and reproductive history (Keenan, 1980), sows culled for infertility would be expected to have a high incidence of these abnormalities.

The following study was carried out to determine whether any reasons for Zambia's low productivity could be related to abnormalities of the genital tract.

5.2 MATERIALS AND METHODS

<u>5.2.1 The sampling method</u>

The survey investigated the occurrence of reproductive abnormalities in Zambian swine herds. It was designed to be carried out over one year with 50 tracts collected each month to give a total of 600 samples. Abattoir and day of week were to be selected randomly. Reproductive histories of culled breeding females would be collected from the farm of origin. However, at the beginning of the study the author became very ill and was unable to follow the designed schedule. Visits to the abattoirs were thus determined by the health of the author and therefore the number of samples was reduced. While a large number of samples taken over one year would have been preferable, many studies have relied on small and discrete samples (Nalbandov, 1952; Pomeroy, 1960a; Einarsson *et al.*, 1974; Koh *et al.*, 1985).

The survey was carried out in four abattoirs in the Lusaka Province of Zambia. During the period from June 1987 to January 1989, 139 female porcine reproductive tracts were collected from Lusaka abattoirs. This number comprised 107 heavy-hog or baconer finishers, 8 gilts and 24 sows which were taken from an estimated annual pool of 1,700 cull females (calculated from a 33% annual culling rate of 5200 sows; see Chapter 3) and 62,000 finishers (52,000 sows selling 12 pigs/sow/year, see chapter 3). The tracts were from 15 farms and 5 abattoirs, the majority (41%) coming from one farm and one abattoir (50%) (see Table 5.1.). Twenty four tracts (16.2%) were frozen after collection by the author or abattoir foreman and examined later, the remainder were collected by the author and examined within two days of collection. Unfortunately six tracts were accidently unfrozen and were decomposing when examined; they

Table 5.1. Sources of genital tracts

Farm Code	Number	%
T19	57	41.0
T55	19	13.7
U31	15	10.8
L11	13	9.4
N14	11	7.9
K92	7	5.0
A03	6	4.3
A80	4	2.9
Other	7	5.0
Total	139	100

Abattoir Code	Number	%
Z2	70	50.4
K5	37	26.6
M3	14	10.1
U2	15	10.8
B3	3	2.2
Total	139	100

Table 5.2. Monthly Collection of Tracts

Month	1987	1988	1989
January			18
February			
March			
April		1	
May		1	
June	20	1	
July	24	6	
August	6		
September	8		
October	3		
November		28	
December		23	
Total	61	60	18

were assessed in a similar manner to other tracts but the patency of the fallopian tubes was not tested. Abattoirs Z2 and K5 were visited on a random basis; as the others did not operate every day they were visited only when groups of pigs were known to be there. The collection of tracts by month and year is shown in Table 5.2. The source of tracts was biased towards farm T19 because 40 pigs were collected from groups which had been weighed on the farm before slaughter for the calculation of dressing percentage and a further 17 were collected randomly.

The majority of tracts collected were from bacon or heavy hog finishers which were usually selected for slaughter by the farmer on the basis of body weight. All tracts, except one each from the Copperbelt and Southern Provinces, came from piggeries in the Lusaka and Central Provinces. The breed of animals collected was a Large White and Landrace mixture (see Chapter 3)

5.2.2 Collection of tracts

Only one abattoir (Z2) used an automatic slaughter line. Here pigs were electrically stunned and hung head down while their throats were cut; they were then submerged in a hot water bath, automatically dehaired and then hung by the hind legs on the butchering line. Excess hair was removed by a blow torch before the carcass was opened. In the other abattoirs pigs were either electrically stunned (one abattoir) or shot, all work then was carried out manually and each pig was hung by the hind legs and processed before the next pig was killed. Abattoirs K5 and M3 used scalding baths; the other dehaired with a blow torch only. Hot dressed weights were taken at the completion of butchering.

When stock were unnumbered at arrival at the abattoir a numbered tag was wedged into the foot of each pig as it emerged from the dehairing procedure. The reproductive tract, with the bladder attached, was removed from the carcass by the abattoir worker and placed into a numbered plastic bag. In some cases sows and gilts had numbered ear tags on arrival at the abattoir; the farm of origin was then contacted for reproductive histories of such animals. All animals from U31 were slaughtered on the farm by staff and the tracts frozen; no details of slaughtering techniques are known.

5.2.3 Post mortem examination

The tracts were transported to a laboratory in the Samora Machel Veterinary School at the University of Zambia, Lusaka, and were kept in a 4°C cold room until they were examined.

The code number, farm of origin, abattoir, hot dressed weight and examination data were recorded on a prepared work sheet. Tracts were arranged dorsal side up on a low tray and examined for any gross abnormalities; all observations were noted. The condition of the vulva was noted and the tract was opened along the dorsal surface with a scalpel and scissors, starting at the vulva and ending approximately 3 cm proximal to the utero-tubal junction. Any purulent material was noted and swabbed if possible. In 49 cases the bladder was opened and inspected; clarity of urine and the presence of sediment was noted. If the animal was pregnant the fetuses were removed, starting with the left uterus at the *corpus uteri* and working towards the utero-tubal junction; a similar process was repeated with the right uterus. The crown-rump measurement of the fetuses was taken with calipers or against a steel ruler. Fetuses were counted and examined for abnormalities. The mean crown-rump was used to estimate fetal age by the method of Marrable and Ashdown (1967). One sample of very young fetuses was not measured but the age was estimated by the known date of mating.

The uterus was examined for abnormalities. The fallopian tubes and mesosalphinx were inspected, the ampulla of the oviduct was everted and palpated. Patency of the oviduct was tested in 121 tracts by clamping off a section of the uterus 1.5 cm from the utero-tubal junction with a pair of haemostats, dye (Giemsa) was injected into the lumen and, by moderate pressure with the thumb and forefinger, was forced into the oviduct. If the oviduct was patent, the dye could be seen moving through the oviduct and issuing from the fimbriated end.

The ovary was examined for the presence or absence of follicles, *corpora lutea*, *corpora albicantia* or any abnormalities. Both abnormal and normal ovaries were preserved in 9% formalin when possible. All *corpora lutea*, *corpora haemorrhagica* and *corpora albicantia* were counted and measured with calipers. The diameters were measured of the four largest unovulated follicles.

The technique was pre-tested on 20 tracts before the start of the survey.

5.2.3.1 Ovarian function

Ovarian structures were defined after Keenan (1980) as follows:

Immature ovaries were those with no evidence of *corpora lutea* or *corpora albicantia* and with follicles less than 5.9 mm in diameter. In practice these ovaries were associated with small tracts with thin, pale uteri.

Near-pubertal ovaries had neither *corpora lutea* nor *corpora albicantia* and had at least one follicle with a diameter between 6 mm and 10 mm.

First heat ovaries, from gilts or finishers, contained either *corpora lutea* or *corpora haemorrhagica* from one cycle only with no evidence of *corpora albicantia* from previous cycles.

Normally cycling ovaries contained a combination of follicles and *corpora lutea* (or *haemorrhagica*) or *corpora albicantia*.

Non-cycling ovaries contained no evidence of *corpora lutea*, *corpora haemorrhagica* or *corpora albicantia*, all follicles were less than 2 mm in diameter and such ovaries were associated with post-pubertal tracts.

Cystic ovaries contained cystic structures. Follicular cysts were follicular structures, greater than 10.9 mm in diameter, without ovulation points and with or without luteinisation. In the case of polycystic ovaries, the condition was defined as an ovary having many partly luteinised small follicles and was confirmed histologically. Cystic corpora lutea were heavily luteinised structures, distended by a fluid filled lumen, 11mm or greater in diameter and often with obvious ovulation papillae.

Ovaries were further classified as:

follicular when the follicles were between 6mm and 10mm in diameter (late follicular ovaries had follicles >= 9mm); haemorrhagic when the follicle had ovulated and the resultant structure was either small, flat and red, conical and wine coloured or enlarged and blood filled; luteal when the structure had become predominantly pink or <u>albicantia</u> when the colour had faded to yellow or white.

5.2.3.2 Histology

When possible samples of gonads and abnormalities were fixed in 9% formalin after examination of the tract. All staining and embedding took place at the Waite Institute, Adelaide, Australia. Histology samples were imbedded in wax in an automatic processor and sections 10 microns thick were cut, affixed to slides and stained with Haemotoxylin and Eosin according to the method of Clayden, 1971 (modified by P. Hynd, pers. comm., 1990). Slides were then examined at the Waite Institute with a Zeiss binocular microscope.

5.2.3.3 Microbiology

The Department of Disease Control of the Samora Machel School of Veterinary Medicine agreed to culture 78 swabs from the pig tracts. Swabs were culture from all uteri (51) after 15th November 1989. Samples were taken from the uterus before any other examination of the tract was performed. A site half way along the left uterus was seared with a hot scalpel, an incision made and a sterile, cotton tipped swab inserted into the lumen of the uterus 10 cm on either side of the incision. Similarly bladders were opened with a hot scalpel and 17 swabs were cultured. Swabs were immediately replaced into the labelled sterile tube and the stick broken against the side of the tube to minimise contamination. An additional 10 swabs were taken of purulent material found in the tract. Due to limitations on the number of samples which could be cultured all bladders could not be swabbed. Therefore a non-random selection, biased towards the ones with cloudy urine was taken.

On arrival at the bacteriology section the swabs were plated directly onto Brucella Agar, Campylobacter Agar, 5% Sheep's Blood Agar and MacConkey Agar. Towards the end of the study four swabs were smeared onto a slide and Gram stained before culture.

After three *Brucella* cultures were identified it was decided to look for further evidence of the infection on the affected farm. Blood samples were randomly taken from the anterior vena cava of 20 weaners and prepuce swabs from three boars. The bloods were subjected to a haemagglutination test for *Brucella* in the Department of Disease control, although *Brucella bovis* was the only antigen available; prepuce swabs were cultured as above.

The dressing percentage for gilts and finishers was estimated from 40 animals by collecting both the live weight before slaughter and the hot dressed weight after slaughter.

5.2.4 General

All data was put into Dbase IV programme for analysis on a IBM compatible home computer. Statistical analysis was carried out using Student's t and chi-squared tests (Mean & Curnow, 1983) or Fisher's exact rxc test (Sokal& Rohlf, 1969) where appropriate. Photographs of tracts and histology are to be found at the end of this chapter.

5.3 RESULTS

5.3.1 Characteristics of the sample

The summary of characteristics of the tracts collected are shown Table 5.3. The majority of tracts were collected in June, July, November, December and January with few samples collected in the other months, thus most tracts were collected in the CD and HW seasons (Table 5.2).

5.3.1.1 Age and body weight

Mean ages of the sampled pigs could not be estimated as few farms provided actual ages of their pigs. No age estimates were given for 33% (35) of finishers while 59% (63) were estimated to be between seven and eight months old and 8% (9) were estimated to be 9 months or older. Actual ages were given for 10 finishers (range 7 to 12.5 months), four sows (range 23 to 84 months) and for five gilts (range 11 to 22 months).

The dressing percentage for finishers and gilts was calculated to be 73% while that for sows was assumed to be 70% (Whittemore, 1980). The mean estimated live weights for all sampled animals is given in Table 5.3; mean live weights were 91.4 kg, 136.3 kg and 225 kg for finishers, gilts and sows respectively.

5.3.1.2 Ovarian function.

The state of ovaries collected is summarised in Table 5.4. Only 42.5% (59) of tracts were cycling normally. The 14 (10.1%) of animals that were classified as abnormal cycling included animals with cystic *corpora lutea* , follicular cysts and unovulated follicles associated with normal *corpora haemorrhagica*.

Two finishers were mated prior to slaughter as semen was found in the genital tract during autopsy. Both animals were peri-pubertal; one was in oestrus with follicles of 10mm diameter while the other had follicles of 6.4mm in diameter and was in pro-oestrus (Atkins & Morrissette, 1968). No cull boars were present in that consignment of finishers of mixed sex.

Table 5.3. Summary of sample

Item	Total	Finisher	Gilt	Sow
Total collected	139	107	8	24
Cold dressed weight (kg)				
number sampled	132	107	8	17
mean	81.04	67.5	99.38	157.59
range	36-209	36-117	43-132	110-209
Liveweight (kg)				
number sampled	132	107	8	17
mean	111.1	92.6	136.3	225
range	55-286	55-159	68-175	151-286
FERTILITY				
Prepubertal tracts				
number	46	46		
percentage	33%	43%		
Ovulation rate				
number	59	43	5	11
mean	12.55	11.46	11.13	16.67
range	5 - 26	5 - 22	10 - 13	9 - 26
Pregnant pigs				
number	10	7	0	3
percentage	7.2%	6.5%	0	12.5%
litter size	9.1	8.14		11.3
range	5 - 14	5 - 10		9 - 14
ovulation rate	11	9		15.7
% fetal survival	82.7%	90.5%		73%
CONGENITAL ABNORMALITIES				
Hermaphrodites				
number	3	3		
percentage	2.1%	2.8%		
Paraovarian cysts				
number	30	21	4	5
percentage	21.6%	19.6%	50%	20.8%
Hydrometra				
number	10	10		
percentage	7.2%	9.3%		
ACQUIRED ABNORMALITIES				
Ovarian cysts				
number	15	5	3	7
percentage	10.8%	4.7%	37.5%	29.2%

Table 5.3.(Cont.) Summary of sample

Item	Total	Finisher	Gilt	Sow
Oviduct complete or partial block				
number sampled	121	92	4	24
number	10	5	0	5
percentage	8.3%	5.4%		20.0%
Diverticulum				
number	1			1
percentage	0.7%			4.2%
Uterine cysts				
number	4			4
percentage	2.9%			16.7%
Endometrium abnormal &/or hydrometra				
number	4			4
percentage	2.9%			16.7%
Pus in genital tract				
number effected	11	5	0	6
percentage	10.2%	4.7%		25%
Cloudy urine				
number sampled	49	27	2	20
number affected	18	6	1	11
percentage	37%	22%	50%	55%

Table 5.4. Ovarian function

Function	Number	Percent (%)
Cycling		
Normal	59	42.5
Abnormal (a)*	11	7.9
Abnormal(b)#	4	9.5
Total!	73	52.5
Not cycling	7	5.0
Hermaphrodite	3	2.2
Pregnant	10	7.2
Immmature ovary	46	33.1
TOTAL	139	

*Abnormal(a)= ovaries with cystic *corpora lutea* or an unovulated follicle
#Abnormal(b)= ovaries with follicular cysts.
!One tract was counted as abnormal by both criteria.

5.3.2 Reproductive potential

5.3.2.1 Maturity of tracts

The 46 tracts which had not reached puberty represented 33% of the total collection and 43% of finishers. No immature tracts were found the in cull breeders. Table 5.5 shows the maturity distribution of the finisher group: 22.5% were at puberty and 24.3% were cycling normally

In Table 5.6 it can be seen that the percentage of immature animals in the various weight classes decreased with increasing live weight. For live weights between 71 and 90 kg live weight, approximately 50% of animals had reached puberty. The average live weight of pre-pubertal animals was 81.5 kg (range 55 to 119 kg) and for post-pubertal finishers was 100.4 kg (range 71 to 159); these differences were significant with Student's t test (P<5%).

A significant influence of season on the attainment of puberty was established. In the CD and HW seasons 31.4% (16/51) and 64% (27/42) respectively of finishers had not reached puberty, these differences were significant (chi-squared, P<1%). Body weights were 89 kg and 86 kg for the CD and HW seasons respectively.

Table 5.5. Maturity of finisher tracts

	Immature	Near-pubertal	First Heat	Cycling	Pregnant	Ovary Abnormal	Total
Number	28	18	24	26	7	4	107
Percent (%)	26.2	16.8	22.5	24.3	6.5	3.7	

Table 5.6. Liveweight of pigs with immature tracts

Liveweight (kg)	Number of finishers	Number immature	Percentage immature
<70	8	8	100.0
71-80	25	14	56.0
81-90	35	18	51.4
91-100	14	3	21.4
101-110	6	1	16.7
>111	19	2	10.5

5.3.2.2 Ovulation rate.

The reproductive characteristics of the sample are summarised in Table 5.3. Mean ovulation rate, as assessed from the number of *corpora lutea* in ovaries examined, was 12.6 ova overall, 11.5 for finishers, 11.1 for gilts and 16.7 for sows. The ovulation rates of finishers and gilts were significantly less that of sows (Student's t test, P<0.1%). There was no difference between mean ovulation of the left (6.7) and the right ovary (5.8).

For finishers, mean first ovulation was 10.9 ova (range 7 to 17 ova, n=23) was not significantly different from subsequent ovulations of mean 11.9 ova (range 5 to 22). The live weight of finishers, at first ovulation, had a significant influence on that ovulation. Average number of ova shed was 12.05 for pigs over 85.1 kg (n=11) and 9.93 for those under 85 kg (n=14) (chi-squared test, P<2%).

Influence of season on reproductive status was only analysed for first heat finishers to partially avoid the confounding influence of age and reproductive history on ovulation rate. There was no influence of season on pubertal ovulation rate which was 11.2 ova (range 7 to 17, n=14) in CD season and 10.71 ova (range 9 to 19, n=6) in the HW season. Live weights were 85 kg and 88 kg for the HW and CD seasons respectively.

Simple linear regression of live weight on ovulation rate was significant for the finisher group only (P<0.1%).

5.3.2.3 Pregnancy

A total of 10 pigs were pregnant at slaughter, giving an incidence of 7.1% for the whole sample. Three of the pregnant tracts were from culled breeders (9.4% of culls) and 7 were from finishers (6.5% of finishers). The average estimated fetal age was 45.7 days (range 19 to 77 days). Mean fetal survival was 82.7% (range 58.3% to 100%); the lowest survival was 58.3% in a sow which shed 24 ova. Mean litter size was 9.1; 4.6 fetuses were in the left and 4.5 in the right uterus, mean ovulation rates were 6.5 and 4.5 for the left and right ovaries respectively.

5.3.3 Congenital abnormalities of the genital tract

5.3.3.1 Hermaphrodites

Three hermaphrodites were found comprising 2.8% of finishers. All were from the same farm and could be distinguished from normal pigs by the elongated shape of their vulvas. They had incomplete secondary female organs consisting of a bifurcate uterus, corpus uterus, cervix, vagina and vulva. In all cases an epididymis developed instead of an oviduct.

Two were ambiglandular hermaphrodites with an ovotestis on both sides, the ovarian tissue of which contained normal immature and cystic follicles. In one tract there were approximately 16 cystic follicles up to 37 mm in diameter, the uteri appeared normal but the vagina and cervix were small and thin walled. The other had 9 cystic follicles up to 12 mm in diameter, the uterus was distended with sterile milky fluid and the vagina and cervix appeared normal. The macroscopic appearance of an ambiglandular hermaphrodite is shown in Figure 5.1 while testicular and ovarian tissue of the ovotestis is shown on Figures 5.2 and 5.3 respectively.

The third pig was a testicular pseudohermaphrodite with a testis on each side in the place of ovaries; the uteri were distended with yellow fluid contaminated by *E. coli* and *Staphlococcus aureus*. The clitoris was enlarged and hook shaped and protruded into the vulva, as shown in Figure 5.4.

There was no evidence of spermatogenesis in the testicular tissue in any of these animals. Figure 5.2 shows that the lumens of the seminiferous tubules were occluded. In Figure 5.5 the basement membrane could be distinguished, Sertoli cells appeared vacuolated and there was no evidence of germinal epithelium. The epididymis was apparently normal in all hermaphrodites, lined with columnar, ciliated epithelium but devoid of sperm, as shown in Figure 5.6.

5.3.3.2 Paraovarian cysts

Thirty animals (21.6%) had paraovarian cysts; 16.5% (23) were unilateral and 5.0% (7) were bilateral. Cysts occurred in the bursa (62.5%, 19), alongside the oviduct (17%, 5) and on the ovarian proper ligament (10%, 3); the position was not recorded in 10% (3) of cases. The number of cysts per affected animal averaged 1.7 (range 1-6) and the average diameter was 8.4 mm (range 2 to 20mm). Table 5.3 shows the incidence of cysts in the different classes of pigs to be 19.6% of finishers and 28% of culled breeders; these differences were not significant.

In one case a large cyst (20mm diameter) was lying close to the oviduct in the tract of a cull gilt, as shown in Figure 5.7, and may have interfered with the passage of ova, although the oviduct was patent.

5.3.3.3 Developmental abnormalities of the Müllerian ducts and *sinus urogenitalis*.

5.3.3.3.1 Aplasia and Hypoplasia

Segmental aplasia was found in one tract as shown in Figure 5.8. A section of both uterine horns and the corpus uterus was flattened to a thin ribbon; the aplasia had obliterated the uterine lumen and the blind uterus was distended with cloudy fluid.

No example of duplication of genital organs was found.

5.3.3.3.2 Hydrosalpinx and hydrometra

No example of hydrosalpinx was found.

Hydrometra was found in 10 tracts; the turgidity of the uterus and the bright yellow colour of the uterine fluid was obvious during inspection of the tracts. The endometrium appeared macroscopically normal in all cases. The condition was found only in finishers and occurred in 9.3% of that group. All animals were prepubertal except one and in all but one case the hydrometra was bilateral.

5.3.3.3.3 Other

Aplasia of the right ovary was found in one otherwise normal tract and loss of the ovary during slaughter could be excluded.

5.3.4 Acquired abnormalities of the genital tract

5.3.4.1 Disorders of the ovary

No examples of ovarian tumours, hypoplasia, hyperplasia or haemorrhage were found. Of the seven tracts with non-cycling ovaries, four were cystic and three showed no evidence of follicular activity, two of which were sclerotic.

5.3.4.1.1 Follicular ovarian cysts

The incidence of cystic ovaries in the sample is summarised in Table 5.7. Cystic follicles were identified in 7 tracts (5% of total); two were from finishers, one was from a gilt and four were from sows. Two hermaphrodite tracts with cystic follicles on the ovotestis have been discussed in a previous section.

Small multiple cysts were found in the ovaries of a cull sow, there were over 20 cysts in each ovary ranging in size from 5 to 13.2 mm diameter. The fresh polycystic ovary is shown in Figure 5.9, while histological evidence of this cystic condition, as demonstrated by degenerated granulosa, (see Figure 5.10) and by deep patches of lutein tissue with degenerated granulosa (see Figure 5.11). Not including the last mentioned tract, the average number of cystic follicles per affected animal was 7.4 (range 1 to 27) and the average cyst diameter was 13.5 mm (range 11 to 21 mm).

Figures 5.12 and 5.13 show the histology of normal granulosa in a preovulatory (9mm diameter) follicle. Luteinised thecal tissue, characteristic of luteinised cystic follicles, is shown on Figures 5.14 and 5.15. Degenerated granulosa, in a nonluteinised cyst is shown on Figure 5.16.

Single cysts were found in two animals, one on the right and one on the left ovary. The remaining four tracts had bilateral cysts; an average of 5.0 and 5.4 cysts were found on the left and right ovaries respectively. The frequency of cyst occurrence is shown in Table 5.8. Normal *corpora lutea* were found in conjunction with follicular ovarian cysts in three cases (43%).

Histological examination identified luteinisation of cysts in 4 tracts (67%); degenerated granulosa only was seen in cysts from two tracts (33%). The polycystic ovaries showed both luteinisation and degenerated granulosa. Ovaries from one tract were not examined histologically.

Four tracts were found with one unovulated follicle associated with normal *corpora haemorrhagica*. In one case the other follicles had ovulated and become flat and haemorrhagic with ovulation pores characteristic of newly ovulated follicles; this pig may have been killed during ovulation. The other three tracts had burgundy coloured, conical *corpora haemorrhagica* which indicated that ovulation had occurred approximately one day before slaughter (Atkins & Morrissette, 1968). Histologically these follicles appeared normal.

The low numbers of affected tracts precluded analysis of seasonal influence on the occurrence of cystic follicles.

Table 5.7. Incidence of cystic ovaries

Type of female	Total Number	Follicle cysts No.	%	Cystic corp. lut. No.	%	Total Cystic No.	%
Cull sow	24	4	16.7	3	12.5	7	29.2
cull gilt	8	1	12.5	2	25.0	3	37.5
finisher	104	2	1.9	5	4.8	5	4.8*
TOTAL	136	7	5.1	10	7.4	15	11.0
# post pubertal finisher	58	2	3.4	5	8.6	5	8.6*

* two finisher pigs had both follicular cysts and cystic corpora lutea
# finisher cystic ovaries expressed as a percentage of postpubertal finshers

Table 5.8. Occurrence of cyst types

Cyst Type & Number per tract	Number of tracts Follicular Cysts	Number of tracts Cystic Corpora lutea
Single or double cysts	2	8
Multiple cysts		
4 - 7	3	2
27	1	
Polycystic		
>40	1	
Total	7	10

While the clitoris was not measured, no evidence was found of the considerably enlarged clitoris as reported by Nalbandov (1952). Cystic follicles were found in conjunction with cysts on the parametrium in one sow and cystic endometrium in another.

5.3.4.1.2 Cystic *corpora lutes*

Cystic *corpora lutea* were found in 10 tracts, five were from finishers (4.7%), two from gilts (28.6%) and three from sows (12.5%). Two finishers had both a follicular cyst and cystic *corpora lutea*. The average number of cystic *corpora lutea* per tract was 2.3 (range 1 to 7) and the average diameter was 11.5 mm (11 to 18 mm). In all cases cystic *corpora lutea* were found in conjunction with normal *corpora lutea*; the average percentage of cystic relative to normal *corpora lutea* was 20.5% (range 6.3% to 77.8%). The average number of cysts per ovary was 1.0 and 1.3 for the left and right ovary respectively. There were five cases of unilateral cysts, three on the left and two on the right ovary, all others were bilateral. Figure 5.17 shows a cystic *corpus luteum* with normal luteal tissue surrounding a fluid filled centre.

A cyst on the outside of the uterus was found in one tract with cystic *corpora lutea*.

As shown in Table 5.7 some form of cystic aberration was found in 15 tracts (10.8% of sample), composed of five finishers (4.7%), three gilts (42.9%) and seven sows (29.2%). As cystic degeneration occurs only after puberty, the percentage of cystic ovaries, expressed as a function of post-pubertal (non hermaphrodite) finishers, was 8.6%.

Total cysts (follicular and cystic *corpora lutea*, Table 5.7) were significantly higher in culled breeders than in finishers (chi-squared, P<0.5%). No evidence of cystic abnormality was found in pregnant animals.

The reasons for disposal of five sows is given in Table 5.9. Sow number 12/445 was culled for anoestrus and infertility. Examination of the ovaries showed four luteinised cysts from 11 to 13 mm in diameter.

5.3.4.2 Disorders of the uterus

As mentioned above, cystic endometrium was found in two sows; in each animal only one small cyst (<5mm) was found. Two sow tracts were found with cysts in the parametrium. One had a single cyst, the other had a cyst on each horn and a large oedema in the broad ligament of the right uterus which contained sterile brownish fluid.

Table 5.9. Reasons for sow culling

Sow Code	No. of Litters	Previous litter Litter size	No weaned	Wean to Service	Abnormalities found	Cull Reason
12/472	11	12	8	4	pus in vagina (E.coli), E.coli in cloudy urine, pregnant	age
11/b22	1	10	3	3	diverticulum, hydrometra, uterine cyst & partial blockage of oviduct	aborted
11/1	6	12	NA	NA	paraovarian cysts	triple repeat
11/54	13	4	NA	NA	not cycling, pus (E.coli) in uterus	agalactica
12/445	10	6	NA	24	Follicle cysts, Staph. aureus in uterus and cloudy urine	anoestrus

NA = information not available

Three sows, N2, 38/1/89/ and 43/1/89 had a condition resembling hydrometra with flaccid uteri containing yellowish, bubbly fluid. The distension of the uterus may have been associated with the pathology of the endometrium and ovaries. Sow N2 also had cystic endometrium, no bacterial contamination of the uterus and cystic degeneration of the ovary. Sow 38/1/89 had atrophy of the endometrium and non-cycling ovaries. Sow 43/1/89 had pus in the vagina, the ovaries showed that she had cycled twice and *S. aureus* and *E. coli* were isolated from the uterus. A fourth sow, 40/1/89 had atrophied and striated endometrium; *S. aureus* was isolated from the uterus.

No uterine abnormalities were found in finishers.

5.3.4.3 Disorders of the oviduct

5.3.4.3.1 Diverticulum

Diverticulum of the oviduct was found in the left oviduct of one sow tract, approximately half way between the utero-tubal junction and the fimbriated end.

5.3.4.3.2 Blocked oviduct.

When the patency of oviducts was tested, 3.6% (5) of tracts were blocked bilaterally and 0.7% (1) was blocked unilaterally. In a further four animals the dye passed the utero-tubal junction with difficulty and only one of these was affected bilaterally. All blockages occurred at the utero-tubal junction. Some form of oviduct blockage was seen in five finishers (5.4%) and five culled breeders (15.6%); these differences were significant (chi-squared, P<5%). The ovaries of two cases of blocked or semi-blocked oviduct were in the luteal phase or early follicular phase (follicles <9mm), seven in the late follicular phase (follicles >= 9 mm) or haemorrhagic phase. One case of blocked oviduct was associated with cystic ovaries. There was a significant association between stage of the ovary and blockage of the utero-tubal junction (Fisher's exact rxc test, P<5%).

5.3.5 Bacterial infection of the urogenital tract

5.3.5.1 The genital tract

Evidence of gross infection of the genital tract was found in 7.9% of animals (five finishes and six sows) pus was found in the vagina in eight tracts and in the uterus in three tracts. There was a significantly higher proportion of cull breeders with pus in the genital tract than finishers (chi-squared, P<1%). The pus was sampled for bacteriological investigation in 10 cases and organisms were isolated in 50% of cases. *Escherishia coli* was isolated in three cases, a mixed infection of *Staphlococcus aureus* and *E. coli* in one case and *Brucella sp.* in one case.

The results of the microbiological study of the uterus are summarised in Table 5.10. Of the 51 swabs cultured 48.3% (27) were infected, comprised of 55.9% (19) of finishers and 47.1% (8) of sows. There was no difference between infection of finishers or sows nor was there any association between the stage of the cycle and presence of bacteria. Uteri of 32% (6) of prepubertal and 68% (13) of post-pubertal finishers were infected The most commonly found infections were *E. coli* and *S. aureus* which were isolated in 21.6% (11) and 13.7% (7) of swabs in either pure or mixed cultures.

No further evidence of *Brucella* was found on the farm which showed three positive *Brucella* swabs but *S. aureus* and *Proteus* sp. were cultured from all prepuce swabs.

There was no association between uterine infection and the patency of oviducts.

5.3.5.2 The bladder

Forty nine bladders (27 finishers, 2 gilts and 20 sows), were opened and examined. Cloudy urine was seen in 37% (18) of all bladders examined, comprised of 22% (6) of finishers and 55% (12) of culled breeders. The occurrence of cloudy

Table 5.10. Bacterial Infection of uteri

Infection	Total	Finisher	Sow
Uninfected	24	15	9
Infected			
E.coli	7	5	2
Staph. aureus	6	4	2
E.coli/S.aureus	4	1	3
Campylobacter	3	3	
Brucella	3	3	
Streptococcus	1	1	
Corynebacterium	1	1	
Enterobacter	1	1	
S.aureus/Enterobacter	1		1
Total Infected	27	19	8
Total sampled	51	34	17

urine was significantly higher in culled breeding stock than in finishers (chi-squared, P<2%). Sediment found in four of these bladders varied from flecks of material to soft lumps up to 10mm in diameter. The 31 normal bladders contained clear urine. Swabs were cultured from 17 bladders (5 clear, 12 cloudy). Of the 12 cultures from cloudy urine, 83% (10) showed bacterial infection while only one of the samples of clear urine was infected. Concurrent uterine infections were found in 80% (8) of infected bladders and 20% (1) of normal bladders and in all cases bacteria present in the bladder were present in the uterus but not *vice versa*. However no association was found between uterine infection and the occurrence of cloudy urine.

5.3.6 Sow disposal

Of the four sows culled for infertility (see Table 5.9) the causes for anoestrus could be linked to the presence of follicular cysts in sow 12/445. Uterine abnormalities were seen in sows 11/54 and 11/b22 while the cause of failure to hold service in sow 11/1 could not be established from the state of the genital tract.

5.4 DISCUSSION

It is difficult to make comparisons between this survey and others as there is usually considerable variation between the type of sample collected. Some workers investigated sterile sows (Warnick *et al.*, 1949; Nalbandov, 1952), others anoestrus gilts (Silveira *et al.*, 1987) while some collected female reproductive tracts in a random manner (Wiggins *et al.*, 1950; Das *et al.*, 1986).

Gilts with congenital abnormalities reducing fertility would be culled early. One would therefore expect a higher proportion of congenital abnormalities affecting fertility in gilts than in sows. In a study such as the present one the finishers had undergone no selection for fertility and the percentage of congenital abnormalities should be an accurate estimation of population levels. Acquired abnormalities would be expected to be lower in this group than in studies of culls as the finishers were not subjected to the rigours of reproduction.

5.4.1 Characteristics of the sample

The sample was unfortunately biased as one farm was over represented. Also, because of the small size of the study, only low numbers of culled breeding stock were collected. A larger sample of all types of swine would have allowed better interpretation of the data. Despite this limitation, information on the status of genital tracts of

Zambian commercial swine was collected for the first time. In addition, the slow growth of Zambian pigs meant that information on pre- peri- and post-pubertal finishers has been collected.

It was unfortunate that reproductive histories of the majority of breeding stock were not available. Although numbers of breeding stock were small some correlations may have been possible between observed abnormalities and reasons for culling.

While exact ages of the stock were difficult to collect, the fact that gilts were slaughtered after 12 months of age would indicate that these animals were being retained for too long after failing to conceive. Finishers were approximately 8 months old and weighed 91 kg, which compares favourably with the estimate of 8.4 months and 88 kg estimated in chapter 3. This represents a slow growth rate compared with that of other countries (Whittemore, 1980; Gardner *et al.*, 1990, Kabare, 1991).

The findings of the survey showed that 74% of mature tracts had normal cycling ovaries. This figure agrees with Keenan's (1980) estimate of 67.6% and would be expected to be higher in this study because of the relatively higher proportion of finishers collected.

5.4.2 Reproductive potential

5.4.2.1 Maturity of tracts

The 43% pre-pubertal finisher tracts in the study appears high when compared with surveys of culled breeding stock as these groups would be unlikely to contain immature animals. However, studies which collected random females or anoestrus gilts show a much higher proportion of pre-pubertal gilts and the figure of 43% pre-pubertal tracts is similar to such studies (see Table 2.3).

The age of puberty in gilts was reported to be around 7 months of age (Pomeroy, 1960c; Wrathall, 1973; Hughes, 1982). The estimated average age of finishers in the survey was approximately 8 months (based on farmer's estimates). If these age estimates were correct and if Zambian pigs reach puberty at the same age as those from other countries, it would be expected that over half of the animals in the survey would be post pubertal. This was the case and it was concluded that the Zambian stock reaches puberty at approximately the expected time and that they could be stimulated to reach puberty at an earlier age (Hughes, 1982).

Live weight appeared to have a strong influence on puberty in this study. Heavier finishers were more likely to have attained puberty than lighter pigs, supporting the findings of Wiggins and workers (1950) in the U.S.A. However this study could not separate the influences of age and live weight and it is likely that both influenced the attainment of puberty in Zambian pigs.

The strong seasonal influence on pubertal attainment confirmed the observations of others that spring-born gilts reached puberty earlier than those born in other seasons (Pomeroy, 1960c; Einarsson, 1974; Scanlon & Krishnamurthy, 1974). While true spring does not occur in the tropics the pigs slaughtered in the CD season in this study were born in light regimes similar to spring.

5.4.2.2 Ovulation rate

The observed ovulation rate for finishers and gilts was 11.5 and 11.2 ova respectively. The former figure represents animals which were not managed for reproduction and was higher than figures given by Van der Lende and Schoenmaker (1990) but lower than that estimated by Hughes and Varley (1980). The estimate of pubertal ovulation was 10.9 ova and was within the range quoted in the literature (Hughes & Varley, 1980) and equal to an estimate for Australia (Paterson *et al.*, 1980). The ovulation rates for sows found in this survey were higher than for non-induced sows given by Van der Lende and Schoenmaker (1990) but lower than that estimated by Hughes and Varley (1980). These figures indicate that the ovulation rates for Zambian pigs were within expected values and that Zambian swine did not appear to suffer from abnormally low ovulation rates. However an improvement of ovulation rate would increase the efficiency of pig reproduction.

No effect of season on pubertal ovulation rate could be demonstrated is this study, confirming the belief of Hughes and Varley (1980) that ovulation rate is not influenced by season but conflicting with that of Penny and co-workers (1971). In this study only pubertal oestrus was investigated, therefore limiting the data. Larger samples may have given better results.

No support was given to the theory that ovulation rate increases with ovulation number (Hughes & Varley, 1980) as the pubertal ovulation rate was not significantly less than that of cycling finishers. However factors like season, age and body weight were not isolated and may have confounded the data.

5.4.2.3 Pregnancy

The slaughter of pregnant animals may have been due to any of the following: (a) the farmer had specifically decided to slaughter a pregnant animal, (b) pregnancy was not correctly diagnosed, (c) service records were incorrect (d) boars were not properly confined to their pens or (e) entire finisher males were raised with females. The presence of pregnant animals in abattoirs for reasons other than (a) suggests poor management.

Pregnant animals comprised 7.1% of the survey sample and 9.4% of cull breeders which was higher than studies of sows and gilts in Scandinavia and Ireland (Einarsson *et al.*, 1974; Keenan, 1980) but was comparable to an Indian study (Nath *et al.*, 1982). This could be indicative of lower levels of management in the third world. Often farm managers were unaware that the culled females were pregnant.

It is likely that the pregnant finishers were impregnated by pen-mates. Boars reach puberty between 5 and 8 months (Hughes & Varley, 1980) and in Zambia are not slaughtered until they are over 7 months of age, at which stage they could be capable of fertile matings. The presence of semen in the tracts of two finishers indicated that mating occurred between finisher pigs of market weight. The raising of entire males is a reasonable management decision if they are slaughtered before puberty but in Zambia the entire male finishers may disrupt a pen of mixed sexes and may have boar taint of the carcass. Boar taint was often found in retail pork in Zambia (personal observation).

The fetal survival rate of 82.7% was high when compared with estimates from the literature 55% to 79% (Van der Lende & Schoenmaker, 1990) and 55% to 80% (Flint *et al.*, 1982). The reason for this was not clear but may have been due to the high numbers of pregnant finishers with a lower ovulation rate and higher fetal survival than sows (Legault, 1985).

5.4.3 Congenital abnormalities of the genital tract

Table 5.11 summarises the occurrence of congenital abnormalities of the genital tract and shows that 30% of animals had such abnormalities; no association was found between reproductive status and these abnormalities.

5.4.3.1 Hermaphrodites

The incidence of hermaphrodites in this study of 2.02% overall and 2.6% of finishers was higher than in other studies of randomly collected female swine, see Table 2.4a. It is of interest that all hermaphrodites originated from the same farm, especially when the history of inbreeding on that farm is taken into account (see Chapter 3). The high incidence of hermaphroditism in this study was probably due to the high contribution of animals from that farm and is an example of the dangers of inbreeding.

Aplasia of the oviduct and development of epididymis ipsolateral to testicular tissue was also observed by Teige (1957).

Table 5.11. Summary of genital abnormalities

Abnormalities	Total No.	Total %	Finishers No.	Finishers %	Gilts No.	Gilts %	Sows No.	Sows %
Infertile	12	8.6	3	2.8	1	12.5	8	33.0
Fertile	43	30.9	31	29.0	6	75.0	6	25.0
Congenital	43	30.9	34	31.8	4	50.0	5	33.0
Acquired	22	15.8	9	8.4	3	38.0	11	45.8

As ovarian tissue of ovotestes was dominated by cystic follicles and as there is no evidence in the literature of ovulation in the ovotestis (Scofield *et al.*, 1969), it was concluded that all three of the hermaphrodites were sterile. No analysis of boar taint was carried out but it was likely that the carcass quality would be reduced due to boar taint (Pfeffer & Winter, 1977).

5.4.3.2 Paraovarian cysts

The high incidence of paraovarian cysts in this survey, 22.3%, cannot be explained except to suggest that it may be a genetic characteristic of Zambian stock. The survey showed an incidence higher than that reported in the literature, with the exception of Silobad (1972), and the size and distribution of cysts was similar to that in Keenan's (1980) survey. No correlation was found between reproductive history of sows and occurrence of cysts (Keenan, 1980) therefore it was concluded that the high incidence of this abnormality in Zambia would not influence the fertility of the herd.

5.4.3.3 Developmental abnormalities of the Müllerian ducts and *sinus urogenitalis*

5.4.3.3.1 Aplasia

The incidence of aplasia at 3% of culled breeding stock was within the range of that shown for studies of culled sows and gilts in Table 2.4b. The overall incidence of 0.67% was very similar to that of random females shown in the same table. The single example of segmental aplasia and absence of tracts with duplicated parts confirmed the rarity of these abnormalities. The gilt with segmental aplasia was totally infertile yet its live weight was 175 kg (equivalent to a 19 month old gilt from another farm) indicating that she had been mated many times and should have been culled much earlier. This was an example of poor piggery management which wasted time and resources on an infertile animal.

5.4.3.3.2 Hydrosalpinx and hydrometra

The recording of several cases of hydrometra, but no hydrosalpinx, concurred with other studies (Einarsson & Gustafsson, 1970; Keenan 1985; Silveira *et al.*, 1987) but conflicted with work in the USA, India and UK (Warnick *et al.*, 1949; Nath *et al.*, 1982; Nalbandov, 1952). In the current study, the incidence of hydrometra was 7.4% overall which was much higher than other studies summarised in Table 2.4b. The reason for this is not known but, as the condition is assumed to resolve at puberty, the high incidence could be due to the high percentage of pre-pubertal females examined. It is of interest that the study from Table 2.4b with the highest incidence of hydrometra (Silveira *et al.*, 1987) also had a high incidence of pre-pubertal females.

Hydrometra in the pre-pubertal animal does not predispose an animal to infertility after puberty (Teige, 1957) and thus the high incidence in the present study would not imply a fertility problem in the Zambian herd. On the other hand, its occurrence in the post-pubertal animal would indicate a blockage at the cervix and thus infertility.

5.4.3.3.3 Other

A single missing ovary has been reported infrequently in the literature (Das *et al.*, 1986) and is considered a rare event. The one example in this study confirmed the rarity of this abnormality; the animal was considered to be subfertile as pregnancy may not establish (Bazer, 1982) or litter size would be small with the low ovulation rate.

5.4.4 Acquired abnormalities of the genital tract.

The occurrence of acquired abnormalities is summarised in Table 5.11 which indicates that a highly significant ($P<0.5\%$) association was found between acquired abnormalities and reproductive status, even when only post-pubertal finishers were considered.

5.4.4.1 Disorders of the ovary

The lack of examples of ovarian tumour, hypoplasia or hyperplasia confirmed that these abnormalities are rare.

Some form of cystic aberration was seen in 10.8% of all tracts examined; the inclusion of cystic *corpora lutea* almost doubled the percentage of cystic tracts. The higher incidence in culled breeding stock supports the contention of Keenan (1980) that the cystic condition is acquired during the rigors of reproduction.

The overall incidence of follicular cysts, at 5.4%, was similar to that found in a study of culled females (Keenan, 1985) and random females (Green & Nalbandov, 1948; Wiggins *et al.*, 1950). The incidence in cull breeders of 15.6% resembles more closely other such studies (Wilson *et al.*, 1949; Perry and Pomeroy, 1956; Pomeroy 1960b; Thain, 1965). Numbers were too small to investigate any relationship between season of collection and incidence of cystic ovaries as suggested by some authors (Wiggins *et al.*, 1950; Perry & Pomeroy, 1956; Kökelsum, 1988).

It was unfortunate that reproductive histories were not available for all culled breeders as the study would have been improved with such data for all sows. The one sow culled for anoestrus was shown to have cystic ovaries (Wrathall, 1980).

The average size of cystic follicles in this study was smaller than other studies (Keenan, 1980) but the minimum size of 11mm for cystic follicles was justified on histological evidence. A larger group of breeders may have detected a greater variation of the cystic condition similar to the large cysts found in other studies (Nalbandov, 1952; Keenan, 1980).

In contrast to the results of Keenan (1980), who found few follicular cystic ovaries with accompanying normal *corpora lutea*, this study found that 50% (4) of cystic tracts had normal *corpora lutea* but low litter size or infertility may have resulted from the lowered ovulation.

The overall incidence of cystic *corpora lutea* (6.1%) was much lower than that reported by some workers (Einarsson & Gustafsson, 1970; Einarsson and Bane, 1974 cited in Keenan 1980) but higher than that found by Keenan (1980). All tracts with cystic *corpora lutea* had normal *corpora lutea* present which agrees with other work (Keenan, 1980) but two tracts had ovaries with both follicular cysts and cystic *corpora lutea* in contrast the finding of others (Keenan, 1980).

The distribution of ovarian cysts showed a gradation of the cystic condition. The least pathological, not classed as cystic but considered potentially cystic, was the single unovulated follicle. The true cystic condition varied from follicular cysts or cystic *corpora lutea*, accompanied by normal *corpora lutea* to several cystic follicles without normal *corpora lutea*. This tends to supports the theory that the cystic condition is formed by gradual progression from a single unovulated follicle to a totally cystic condition accompanied by anoestrus and infertility (Perry & Pomeroy, 1956; Keenan, 1985). The stage of the cycle when an animal is slaughtered may influence the apparent severity of the cystic condition (Keenan, 1980) but the data suggested a threshold level of around 4 follicular cysts which prevented cyclic behaviour; however numbers were too small to make any real conclusions.

Cystic aberrations arise from the various stresses which act on the sow, i.e. hormonal disturbance caused by short lactation lengths, exogenous hormones or stress associated with piggery management of reproductive animals (Keenan, 1980). Therefore the figure of 9.1% for cystic ovaries in post-pubertal finisher females may represent the proportion of cystic ovaries which arise naturally in a reproductively unstressed population of pigs.

No pregnant tracts were found with any form of ovarian cysts supporting Perry and Pomeroy's (1956) conclusion that ovarian cysts were rare in pregnancy but contrasts with Nalbandov's (1952) estimate of 8% of pregnant sows with cystic ovaries.

5.4.4.2 Disorders of the uterus

Other studies have not given detailed descriptions or histology of abnormal endometrium. In this study the state of the endometrium was striking in 4 sows but histology was impossible as some tracts had been frozen prior to collection. That hydrometra was found in association with abnormal endometrium supported the assertion by Tiege (1957) that the two conditions were associated. It was assumed that the hydrometra resulted in infertility as it indicated a blocked cervix.

5.4.4.3 Disorders of the oviduct

A single example (2.8%) of diverticulum in the oviduct of a sows does not contradict the suggestion of Keenan (1980) that it is an abnormality of breeding stock. The condition was not mentioned by most other workers and it was therefore assumed to be rare.

It was found difficult or impossible to pass dye through the utero-tubal junction in 8.1% of tracts. This finding does not agree with Keenan (1980) or Nalbandov (1952) who found the site of blockage to be in the uterine third of the oviduct. An association was found between state of the ovary and blockage of the junction while no association was found between bacterial contamination of the uterus and blockage. Thus it was concluded that the condition was similar to the oedematous blockage of the utero-tubal junction at oestrus as described in the ewe (Edgar & Adsell, 1960). The blockage was considered not to be an abnormality of the genital tract of swine but it was surprising that it was not mentioned in Keenan's study (1980).

5.4.5 Bacterial Infection of the urogenital tract

It has been difficult to interpret the bacteriological findings of this study. All bacteriological analysis was carried out by the Disease Control Department of the Samora Machel School of Veterinary Medicine, University of Zambia. The author had no involvement with the culturing and identification of the samples. Complete reliance on the isolations is difficult for the following reasons:

1. some samples were mislaid after presentation to the Disease Control Laboratory and no identification was made,
2. half of the samples of pus produced no growth. Of the six samples of vaginal pus swabbed, bacteria were cultured from only two. It seems unlikely that the pus was sterile and, in any event, the vagina usually has a resident flora

(Bane, 1980).

3. in four samples smears were taken of the swab before culture was attempted. In three cases bacteria were provisionally identified from the smear but no organisms were cultured,
4. *Brucella* sp. was identified from three finishers from one farm. The farm manager had not seen any evidence of *Brucella* infection and subsequent attempts to find *Brucella* on that farm failed. Some time later serum from this farm and others was tested with *Brucella suis* antigen and no evidence of *Brucella suis* could be found (K. Stafford, pers. comm., 1989). It appeared that the samples were somehow contaminated in the laboratory, possibly with *Brucella bovis*,
5. There may have been some contamination during collection.

It was therefore concluded that; (a) some organisms had died before the swabs were cultured giving false negatives and (b) contamination of some samples took place both at the time of collection and during culture giving false positives.

However, the bacteriological studies did indicate that bacteria could be isolated from all groups of tracts and the isolates were representative of ubiquitous and opportunistic bacteria. This study may be the first that has demonstrated the presence of bacteria in the uteri of pre-pubertal pigs. Therefore bacteria may enter the uterus by means other than by coitus or ascending infection through the relaxed cervix during the oestrous cycle.

The observation that 83% of bladders with cloudy urine were infected indicates that the condition of the urine is a reasonable indicator of the infection status of the bladder, therefore approximately 37% of bladders were infected. The higher percentage of cloudy urine amongst culled females supports the theory of Kökelsum (1988) that bladder infection is related to parity. Evidence of ascending infection was suggested from the results. However it was not possible to draw any conclusions due to the lack of association between cloudy urine and uterine infection and the fact that uterine contamination by urine reflux after slaughter could not be discounted.

The high incidence of bladder infection could reduce farm productivity by inappetance and reduced fertility (Dial & MacLachlan, 1988). The level of cloudy urine was similar to that found by Kökelsum (1988) amongst culled breeders where urinary infections were related to parity and hygiene; the occurrence in weaners may have been due to poor farm hygiene.

5.4.6 General summary of findings

The expected infertility due to abnormalities of the genital tracts has been summarised in Table 5.11. The types of abnormality expected to cause infertility were; bilateral segmental aplasia, non-cycling ovaries, hydrometra in the post-pubertal pig and hermaphrodites. The survey showed 8.6% of the tracts were possibly infertile. Non-cycling ovaries were the most common abnormality predicting infertility. The highest percentage of infertile tracts was found in culled breeders (28%) and the lowest in the finisher group (2.8%). This agrees well with the observation that 30% of breeders are culled for infertility (Hughes & Varley, 1980) and many abnormalities increase with age and parity (Keenan, 1980).

The abnormalities which were not expected to cause infertility were paraovarian cysts, mild cystic endometrium, cystic parametrium, hydrometra in the pre-pubertal animal, abnormally cycling ovaries (including cystic *corpora lutea*, follicular cysts with more than four normal *corpora lutea*, unovulated follicle) and pus in the genital tract. Thirty one percent of tracts contained such abnormalities.

Thirty one percent of the sample had congenital abnormalities. The gilt group had the highest occurrence suggesting that they may have been the reason for gilts culling, however the small size of the gilt group makes conclusions difficult.

Acquired abnormalities occurred in 15.8% of tracts. As predicted the cull breeders had a higher incidence than the finisher group (chi-squared P<0.5%) possibly due to greater age and reproductive stress of the former group (Keenan, 1985).

These high figures of congenital abnormalities suggests that the finisher pool, from which gilts are selected, could be expected to contain many abnormal animals. Resources may be wasted on these animals before their reproductive status can be ascertained by breeding. It is possible to determine some genital abnormalities by rectal palpation with good accuracy (Silobad, 1972; Kökelsum, 1988) and this technique could be a valuable tool for Zambian pig farmers to determine the reproductive potential of breeding swine.

EXPLANATIONS FOR FIGURES 5.1 TO 5.6

Figure 5.1. Hermaphrodite No. 6/226. Ovotestis, with ovarian tissue (o), testicular tissue (t) and epididymis (e) can be seen on each side of the tract.

Figure 5.2. Hermaphrodite No. 11/259. Testicular tissue from ovotestis; slide shows that seminiferous tubules (st) are occluded and Leydig cells (l) are in the interstitial area. X 40.5, H&E.

Figure 5.3. Hermaphrodite No. 11/259. Ovarian tissue is shown with luteinised granulosa (g) and theca interna (ti). X 180, H&E.

Figure 5.4. Testicular Pseudohermaphrodite No. 1/246. Arrow points to enlarged clitoris.

Figure 5.5. Testicular Pseudohermaphrodite No. 1/246. Testis; germinal epithelium is absent, some seminiferous tubules (st) are occluded, Sertoli cells (s) appear vacuolated. X 180, H&E.

Figure 5.6. Testicular Pseudohermaphrodite No. 1/246. Epididymis; tubules are free of sperm. X40.5, H&E.

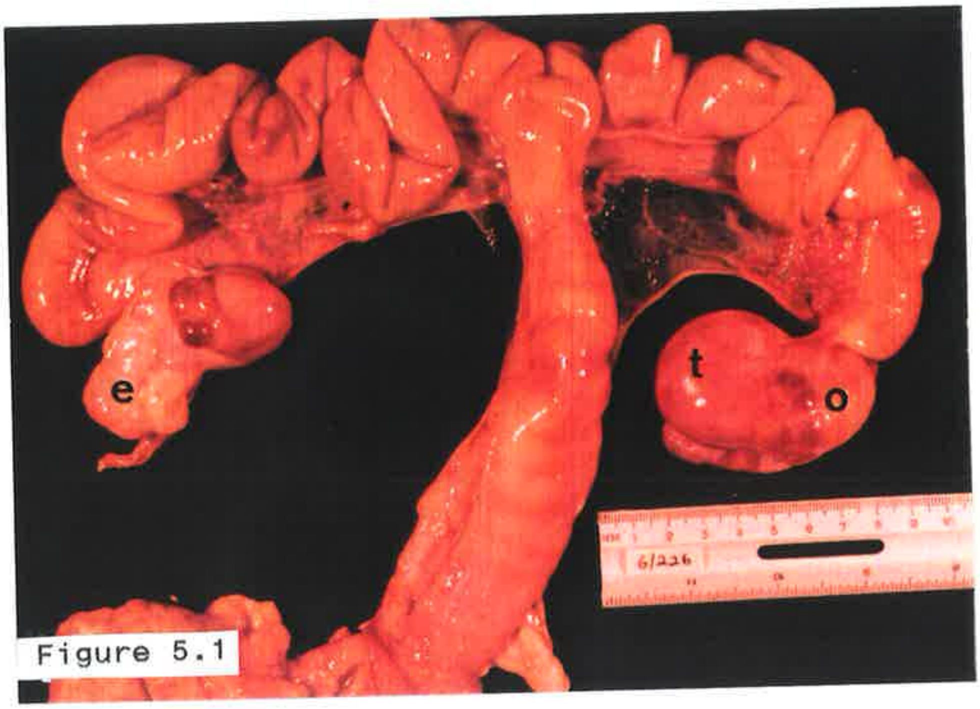


Figure 5.1

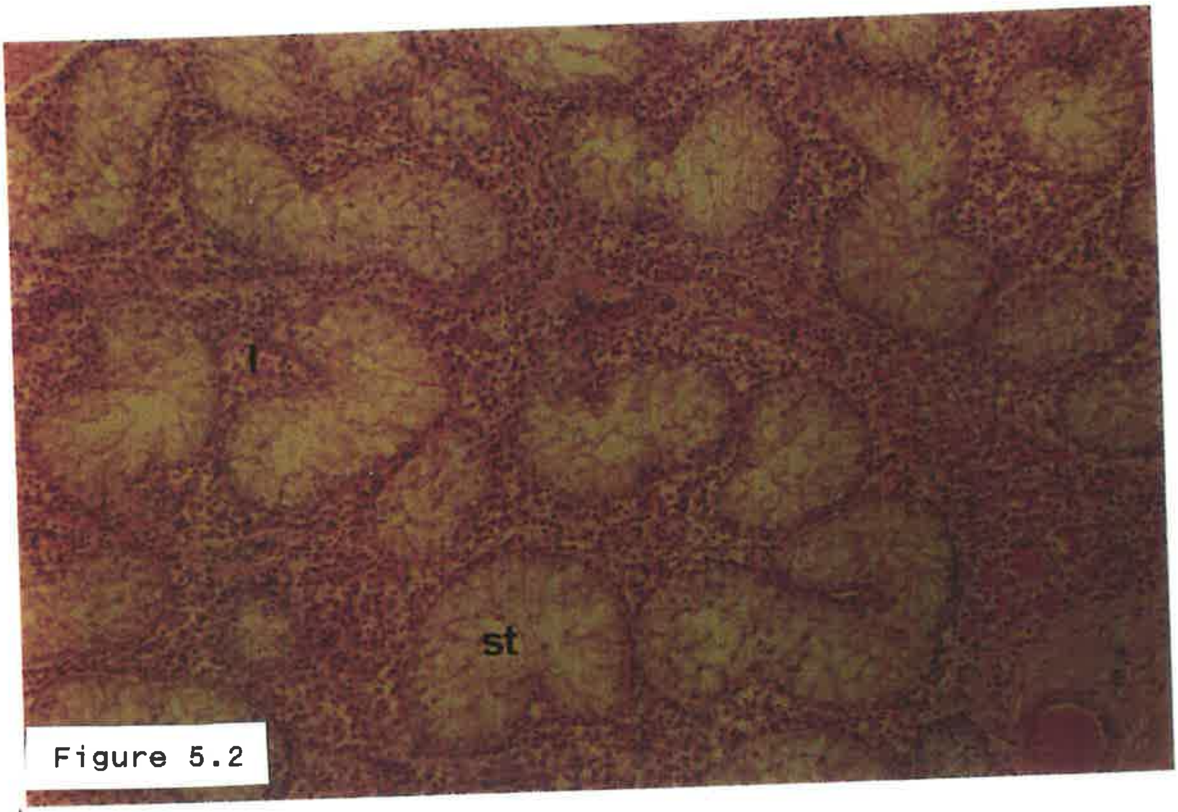
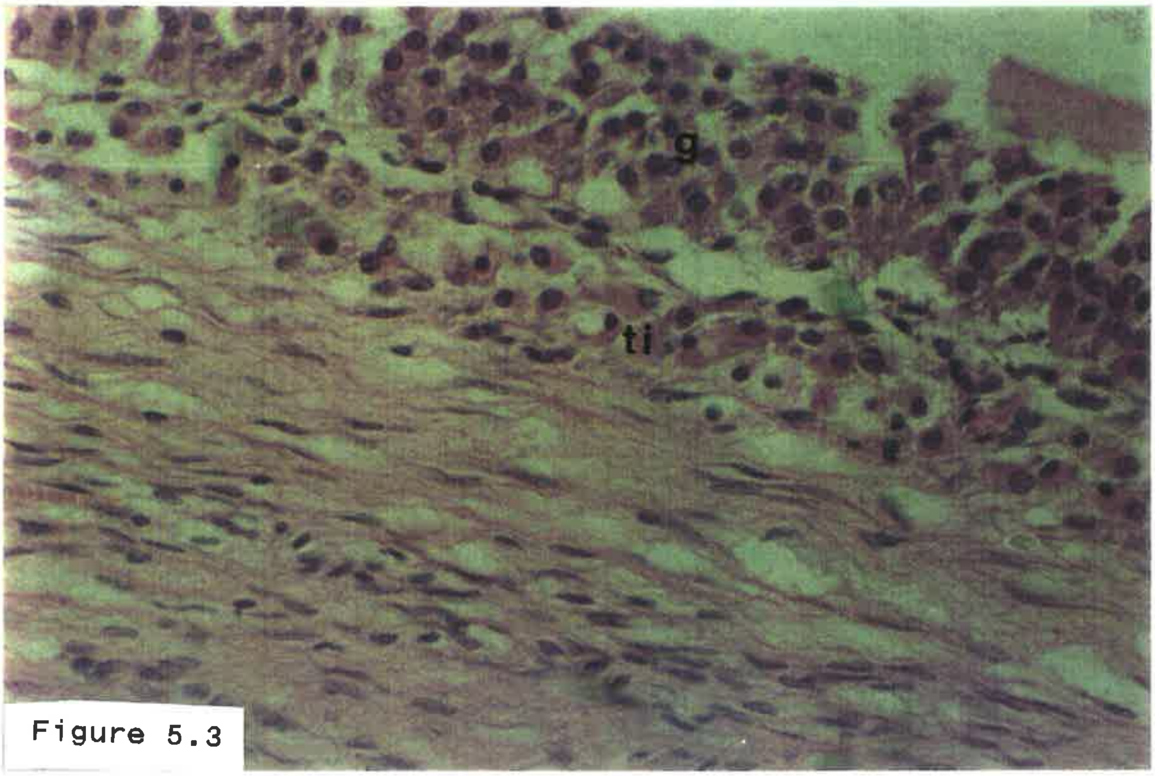


Figure 5.2



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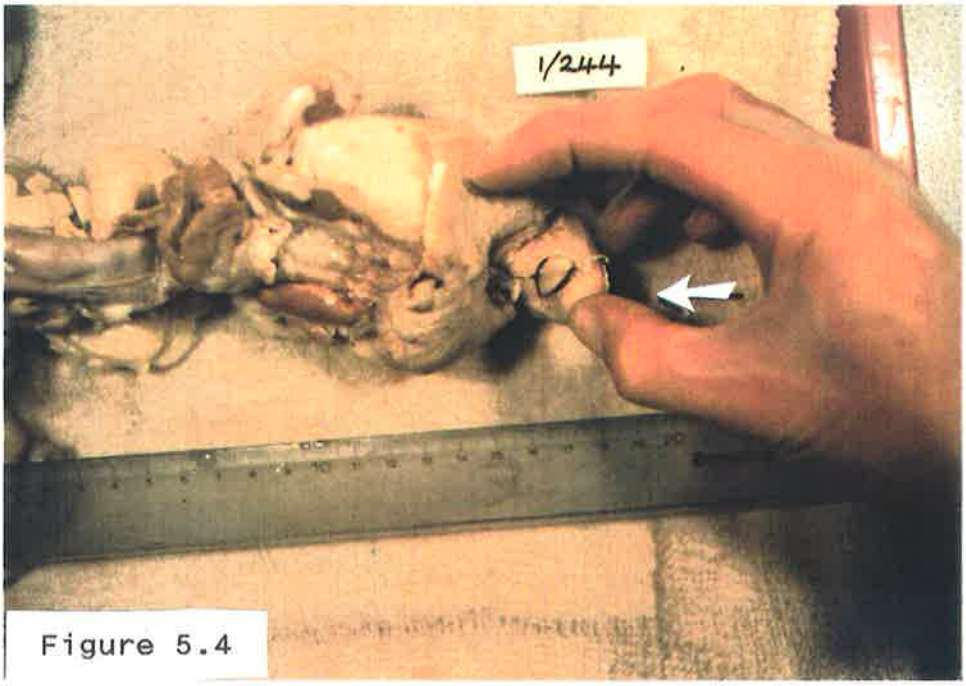

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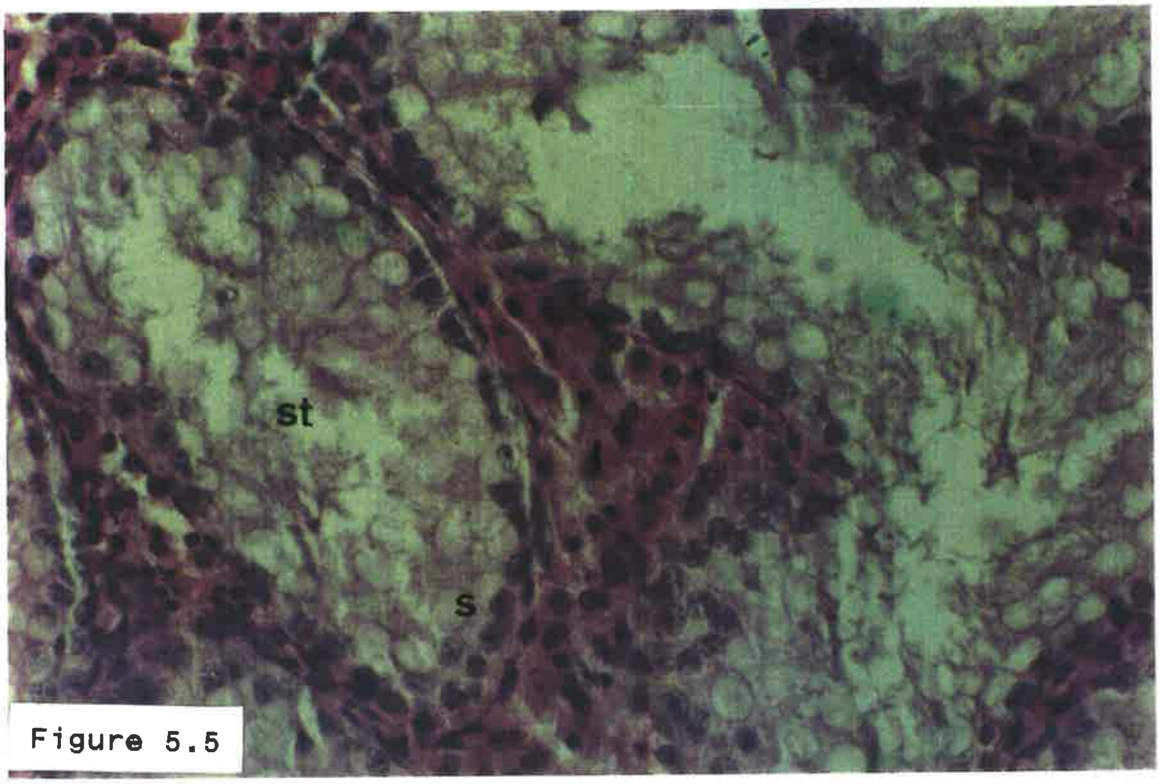


Figure 5.5

Figure 5.6

EXPLANATIONS FOR FIGURES 5.7 TO 5.13

Figure 5.7. Finisher No. 6/223. Arrows show paraovarian cysts in mesosalpinx.

Figure 5.8. Gilt No. 24/1/89. Segmental aplasia (a) of uterus corpus and both uteri; the uteri (u) distal to the aplasias are distended.

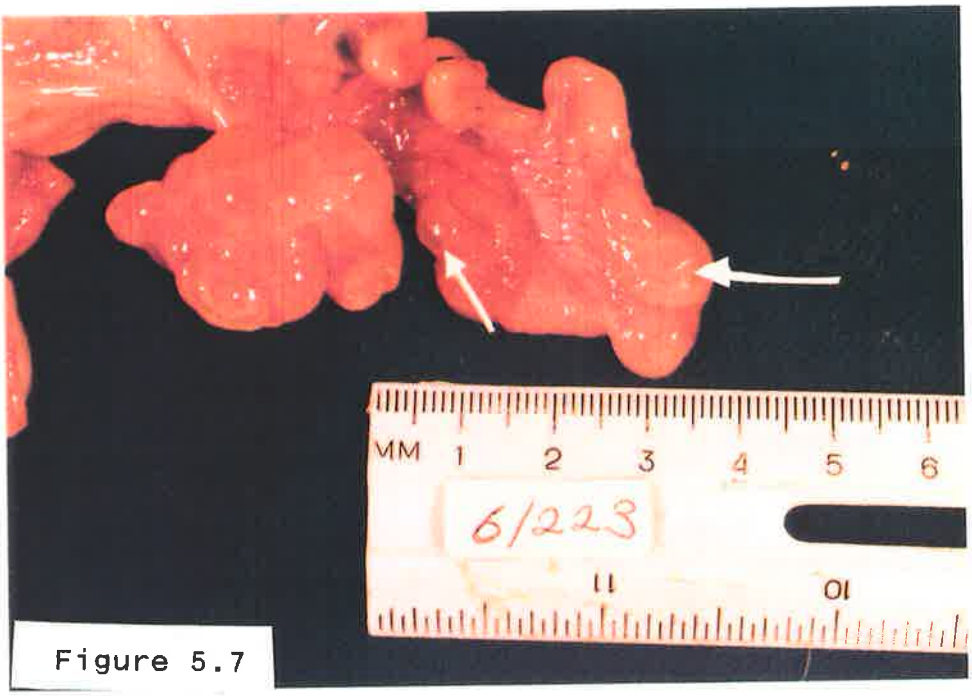
Figure 5.9. Sow No. 41/1/89. Fresh poly cystic ovary.

Figure 5.10. Sow No. 41/1/89. Poly cystic ovary; cyst lumen (c) is lined with degenerated granulosa (g). X 40.5, H&E.

Figure 5.11. Sow No. 41/1/89. Poly cystic ovary; slide shows deep lutenised theca (l) with degenerated granulosa (g). X 180, H&E.

Figure 5.12. Finisher No. 1/291. Normal preovulatory follicle. X 40.5, H&E.

Figure 5.13. Finisher No. 1/291. Normal preovulatory follicle; granulosa (g) and theca interna (ti) are shown. X 180, H&E.



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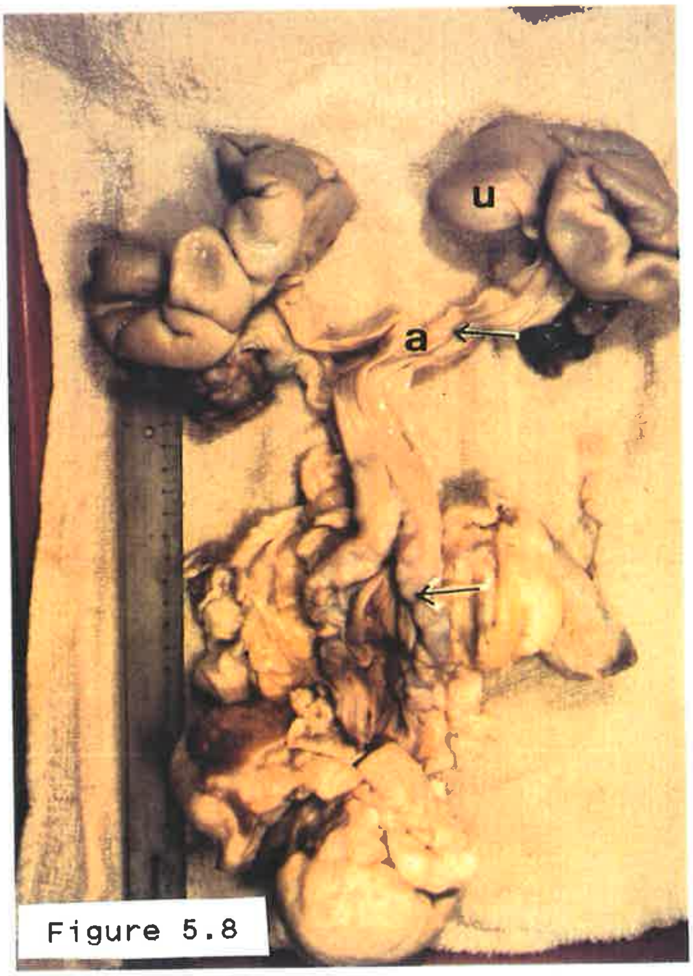

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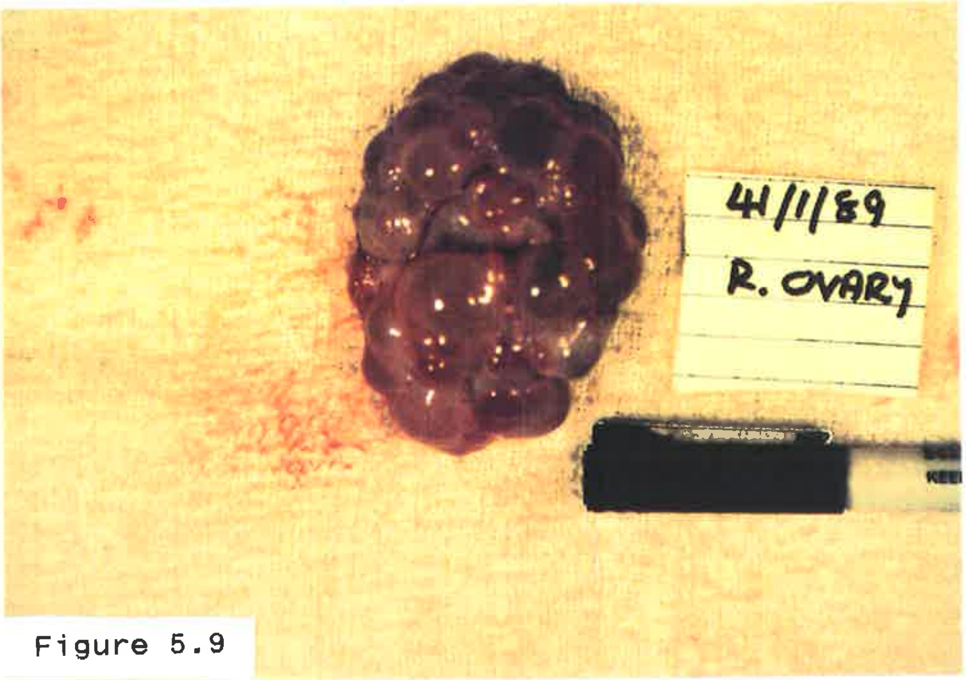

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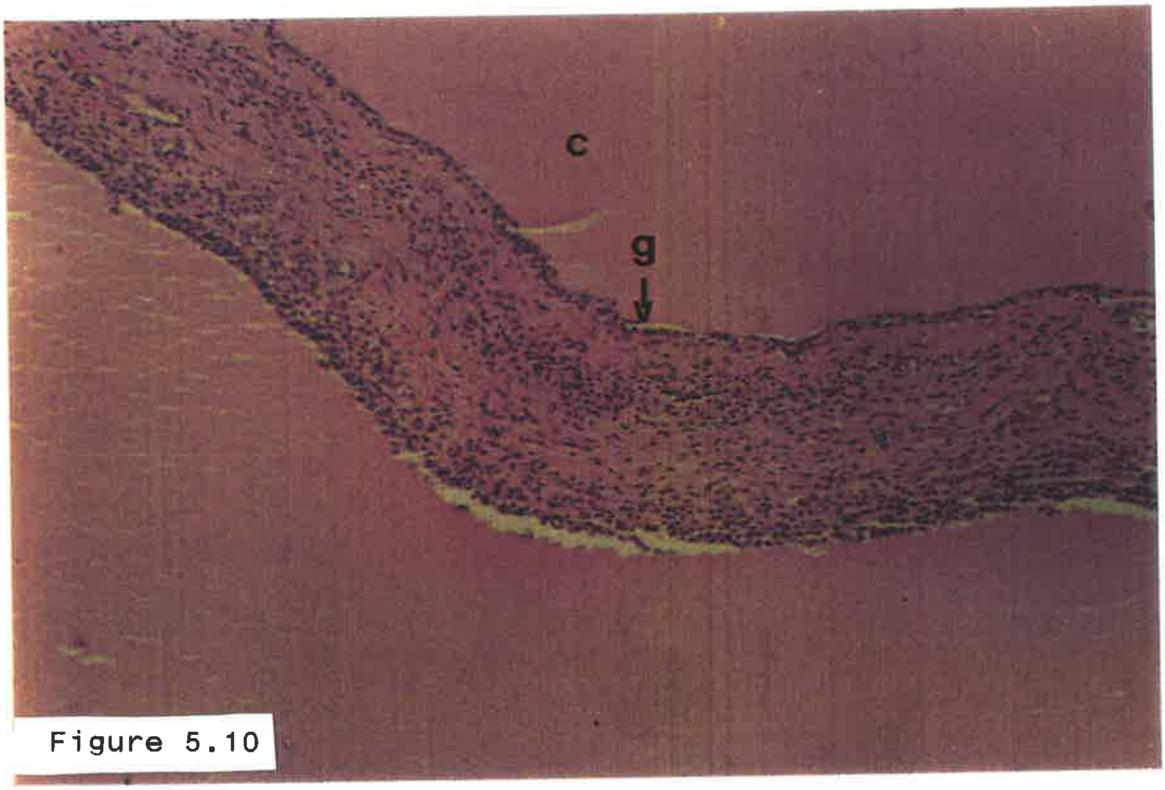

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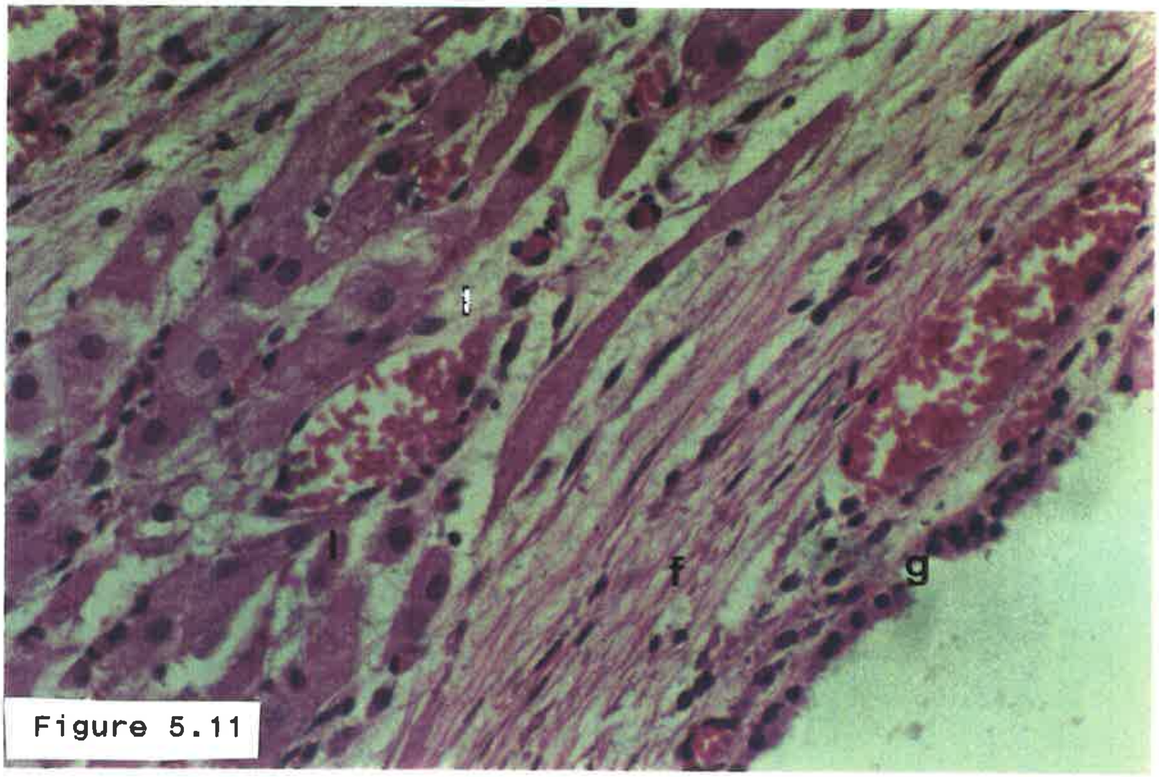
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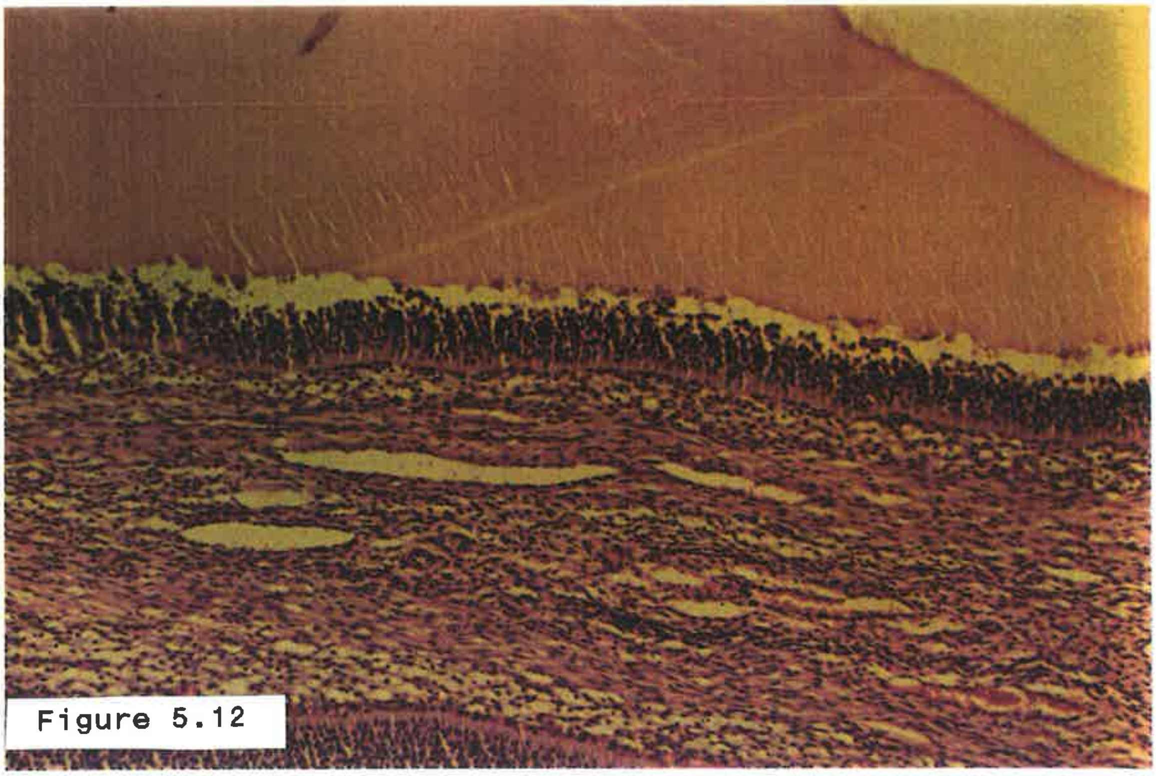
Figure 5.11



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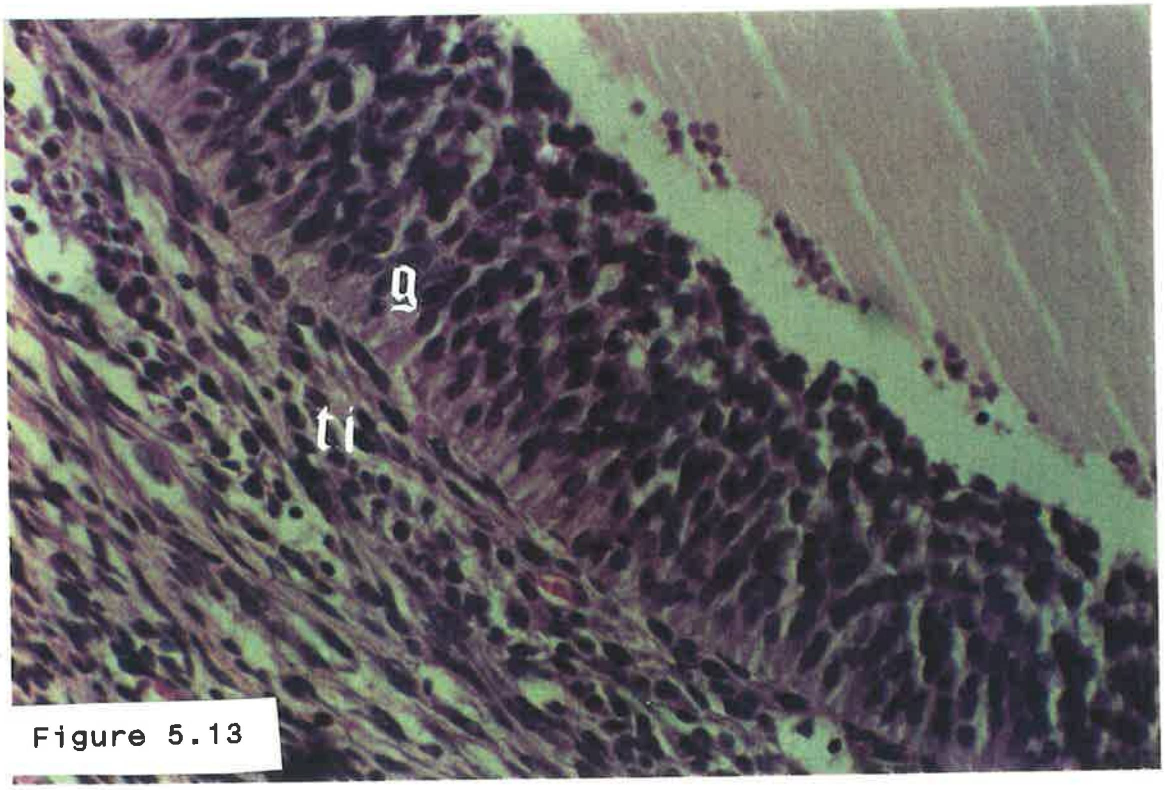

Figure 5.13

EXPLANATIONS FOR FIGURES 5.14 TO 5.17

Figure 5.14. Sow No. M16. Cystic follicle; luteinised patch of cells (l) lie against the cyst lumen (c). X40.5, H&E.

Figure 5.15. Sow No. M16. Cystic follicle; higher magnification of the patch of lutein cells (l) above. X 180, H&E.

Figure 5.16. Finisher No. 8/418. Non luteinised cyst; degenerated granulosa (g) lies against the cyst lumen (c). X 180, H&E.

Figure 5.17. Finisher No. 12/229. Cystic corpora lutea; normal lutein cells (l) surround cyst lumen (c). X 9, H&E.

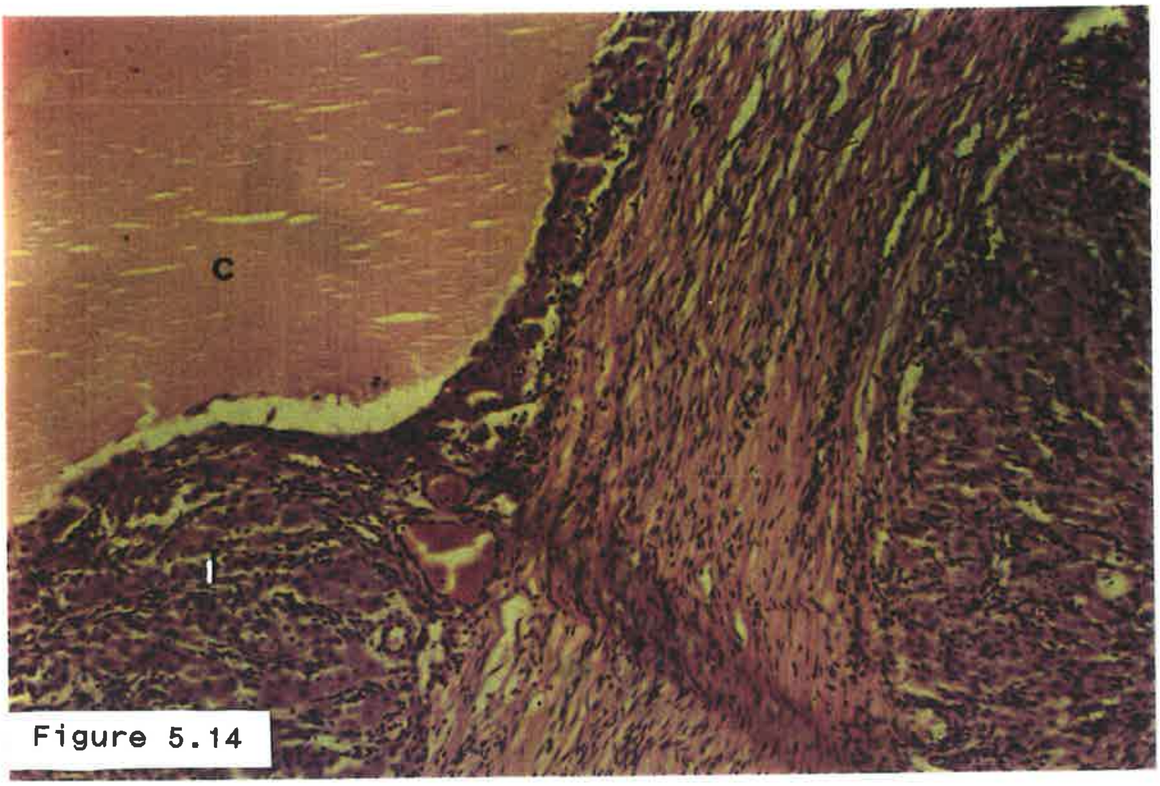

Figure 5.14

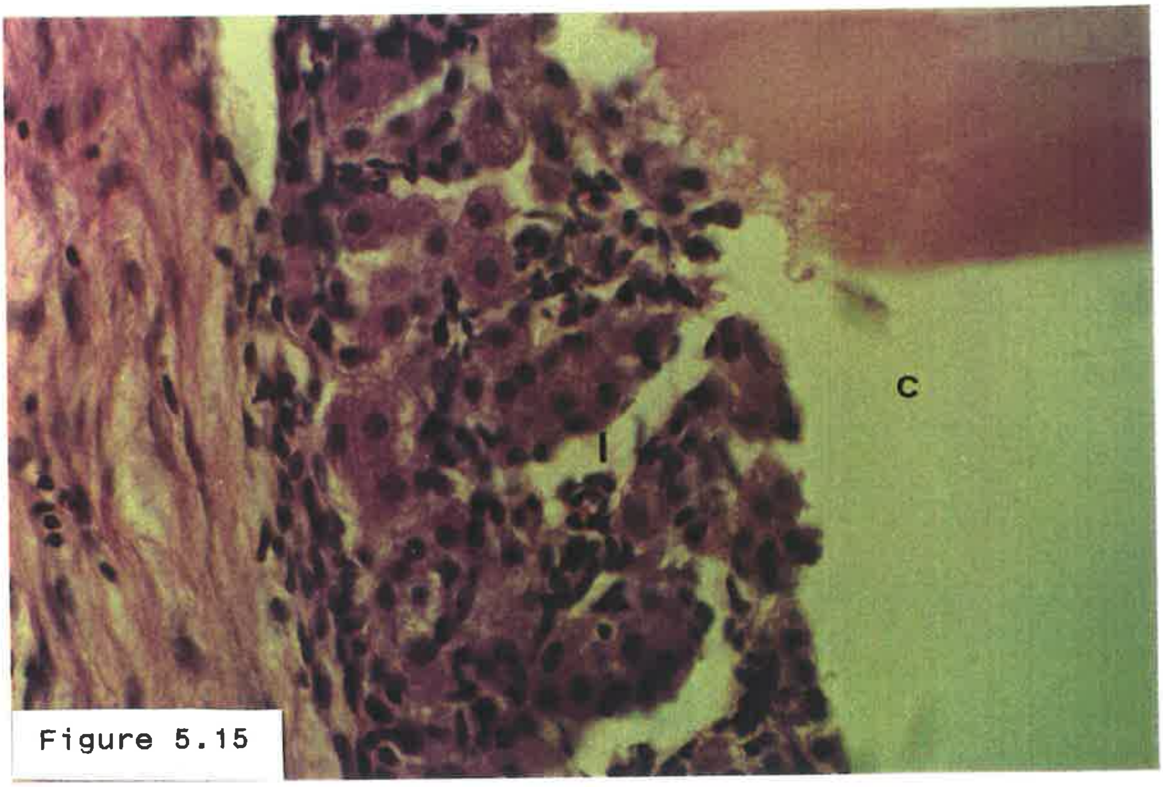

Figure 5.15

Figure 5.16

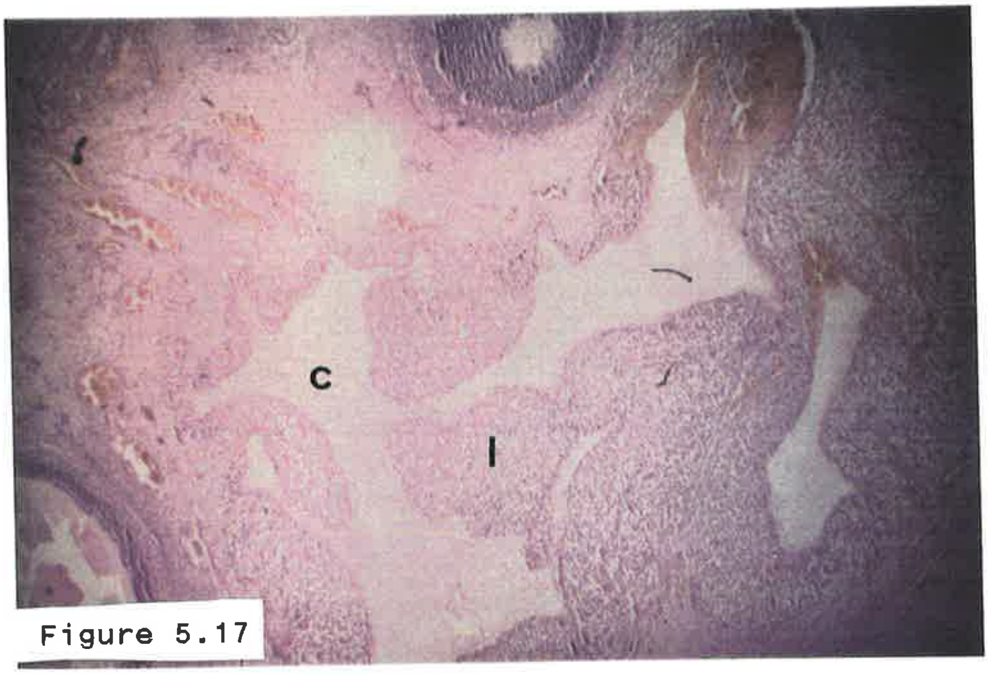

Figure 5.17

CHAPTER 6. EFFECT OF TRANSLOCATION AND BOAR CONTACT ON THE ATTAINMENT OF PUBERTY

6.1 INTRODUCTION

Several areas of further research were suggested by the farmer, SRC and abattoir surveys, amongst them was the late age of first mating of gilts. Chapter 5 indicated that Zambian gilts spontaneously reached puberty between seven and eight months of age, in common with observations by other workers (Hughes & Varley, 1980). The vast majority of Zambian farmers used no specific management for their gilts, they were often selected from the weaner pool after puberty or when pregnant; often they did not appear on SRCs until the first farrowing. The period between gilt selection and mating is considered unproductive and a reduction in this period would improve overall productivity and reduce feed costs (Brooks & Smith , 1980). If simple management techniques could be shown to stimulate puberty in gilts then perhaps Zambian pig farmers could use these techniques to improve piggery efficiency.

6.2 MATERIALS AND METHODS

Due to logistical and financial constraints it was necessary to carry out the following experiment as an on-farm trial on farm T19.

The study was originally designed so that 20 female weaners would be randomly selected, from a pool of known age weaners, at 120 days of age. These would be raised in an isolated pen three metres from the rest of the piggery. At 165 days half of these gilts would be randomly allocated to the treatment group which would be moved into the breeding house and be exposed to a mature boar for 30 minutes per day for 40 days. Control animals would remain in the isolation pen. Body weight and backfat of all stock would be measured fortnightly from 165 days until the end of the experiment when all animals would be slaughtered at 200 days of age and the genital tracts examined.

The inability of the author to properly control the experiment, due to her poor health, resulted in the farm manager disrupting the experimental procedures. Thus the experiment was carried out as follows.

Thirteen gilts were selected by the farm manager at approximately 134 days of age and placed in an isolated pen three metres from other pigs. Soon after the experiment commenced two gilts were removed, due to illness, by the farm manager. It was unfortunate that the gilts were selected without the supervision of the author to ensure random selection but by the time that the author discovered this it was not possible to select another group. Nine days after selection the gilts were given numbered ear tags and weighed. Every fortnight thereafter they were weighed on the farm's mobile scales and backfat measurements were taken. Ultrasonic estimates of backfat were made at 45 mm (USP1) and 80 mm (USP3) from the midline on the last rib using a Sonalyser, an ultrasound instrument from Werner Electronics of South Australia. USP2 was calculated by averaging USP1 and USP3 (King *et al.*, 1986).

It was intended that half of the pigs would be randomly selected for relocation at 175 days of age and then be exposed to a mature boar on a daily basis; the control gilts meanwhile would remain in isolation. Unfortunately the farm manager moved all of the experimental pigs into the breeding house at 173 days of age. Again the author was presented with a *fait accompli*. It was decided to continue with the experiment and use the other collections from this farm during the same season as controls. These controls were of unknown ages but assumed to be similar to the treatment group and while, theoretically, they were kept isolated from boars it was found in the abattoir study (see Chapter 5) that some finishers from this farm were pregnant at slaughter.

Throughout the experiment the gilts were managed by the piggery staff as normal finishers.

From three days after relocation, the gilts were introduced to a mature boar for 30 minutes each day. This was continued for two weeks until it became obvious that it was a strain on the management. Daily contact was then discontinued in favour of housing a mature boar in the adjacent pen until the end of the experiment. Fence-line contact between the boar and the gilts was maintained. The gilts were slaughtered at 222 days of age (49 days after relocation) and their reproductive tracts collected and examined in the usual manner (see Chapter 5). Not all of the experimental animals could be slaughtered as the manager kept two animals for breeding (despite assurances to the contrary at the beginning of the experiment).

Differences between the treatment and control pigs in puberty attainment and genital abnormalities were analysed using Fisher's exact rxc test (Sokal & Rohlf, 1969). The significance of differences in mean live weight and backfat between the pubertal and post-pubertal pigs were assessed by using Student's t test (Mead & Curnow, 1982).

6.3 RESULTS

A summary of the results is presented in Table 6.1 which compares the experimental pigs with all other finishers (excluding pregnant or hermaphrodite pigs) collected from the same farm. Both experimental and control pigs were slaughtered at similar mean and range of live weight and hot dressed weight. The age at slaughter of the experimental pigs was 7.5 months. The age of the control pigs was not known but estimated to average 7.5 months; as these pigs were slaughtered when they reached a certain weight, or on demand, there could have been a wide variation in the actual slaughter age.

There were no significant differences between the treatment or control groups for ovulation rate or incidences of congenital or acquired abnormalities, however the incidence of paraovarian cysts approached significance (Fisher's exact rxc P<7.1%).

At slaughter, five gilts of the treatment gilts were post-pubertal and four were pre-pubertal; one of the post-pubertal gilts had severely cystic ovaries. The proportion of treatment and control pigs attaining puberty was slightly

Table 6.1. Comparison of experimental and control pigs

Item	Treatment	Control	Signific.
Number of samples	9	29 *	
LIVEWEIGHT (kg)			
Mean	83.1	82.4	n.s.
Range	75 - 92	77 - 92	
HOT DRESSED WEIGHT (kg)			
Mean	63.1	60.2	n.s.
Range	55 - 72	55 - 70	
OVULATION RATE			
Mean	10.3	9.9	n.s.
Range	10 - 11	9 - 12	
number cycling	4	7	
CONGENITAL ABNORMALITIES			
Paraovarian cysts			
number affected	4	4	n.s.
percentage	44.4%	13.8%	P<7.1%
ACQUIRED ABNORMALITIES			
<u>Bacteria in uterus</u>			
number swabbed	9	23	
number affected	2	13	n.s.
percentage	22.2%	56.5%	
<u>Ovarian cysts</u>			
number affected	1	0	n.s.
percentage	11%	0%	
MATURITY OF TRACTS			
<u>Post-pubertal</u>			
number postpubertal	5	7	n.s.
percentage	55%	24%	
number at first heat	1	6	P<3.3%
percentage at first heat	**25%	"100%	
<u>Not reached puberty</u>			
number	4	22	
number immature	0	13	
number near-pubertal#	4	9	n.s.
percentage	100%	40.9%	P<0.6%

* (excludes pregnant or hermaphrodite animals)
** Total cycling =4 as cystic gilt not included
\# ovaries with follicles over 6mm diam.
" total cycling = 6, one pregnant tract not included

higher than the controls (P<8.7%). Compared with the controls a lower percentage of the pubertal treatment pigs were experiencing their first heat. This difference was significant (Fisher's exact rxc, P<3%) suggesting that the pubertal treatment gilts had cycled more often than those in the control group.

Tables 6.2 and 6.3 show the changes in live weight and backfat respectively for those gilts which had reached puberty or were pre-pubertal at slaughter. While live weight showed a gradual increase with time, backfat was much more dynamic and both increased and decreased over the experimental period. The differences between the means of both groups were not significant but the Student's t values have been included to show the changes with time. Significance was approached at 185 days of age for live weight and 171 days of age for backfat.

The influence of season may have been overcome in this experiment. From Chapter 5 it was found that 26% of finishers collected in the HW season had attained puberty; in this study 55% had attained puberty.

Table 6.2. Mean live weight changes with time

AGE(days)	143	157	171	185	198	214
Average liveweight (kg)						
Pubertal gilts	42.00	55.20	59.80	68.60	74.80	85.80
Immature gilts	43.00	51.25	55.50	63.00	68.75	79.75
variance						
Pubertal gilts	10.16	5.36	8.56	13.04	12.56	18.16
Immature gilts	10.00	27.19	24.69	20.50	29.19	32.69
Pooled variance	10.07	17.83	17.78	17.3	22.06	26.46
Student's t	1.03	1.41	1.44	2.01	1.93	1.76
df	7	7	7	7	7	7
P	<0.40	<0.20	<0.20	<0.10	<0.10	<0.10

Table 6.3. Mean backfat change with time

AGE(days)	157	171	185	198	214
Average liveweight (kg)					
Pubertal gilts	11.30	12.80	13.50	14.30	16.10
Immature gilts	11.00	11.13	12.25	13.00	15.25
variance					
Pubertal gilts	1.66	2.56	0.70	3.16	1.04
Immature gilts	0.67	0.80	2.19	2.63	3.19
Pooled variance	1.09	1.55	1.55	2.85	2.27
Student's t	0.42	1.99	1.51	1.15	0.85
df	7	7	7	7	7
P	<0.90	<0.10	<0.20	<0.40	<0.50

n = 5 for prepubertal gilts, n = 4 for prepubertal gilts
df = degrees of freedom
P = probability

6.4 DISCUSSION

The results showed that translocation and minimum boar contact did not significantly increase the proportion of pubertal gilts at 7.4 months of age compared with controls. However all the indicators of puberty suggested that the treatment pigs were generally more mature than the controls. The percentage of pubertal pigs was slightly higher, the percentage of pre-pubertal pigs approaching puberty was slightly higher and pubertal gilts had cycled more often in the treatment group than controls. Of these parameters only the latter was significant but the fact that significance was approached in the others suggests that the treatment may have had some low-level response.

Selection of the planned numbers of animals and the retention of controls could have improved the analysis of the experiment. The treatment could have been improved by starting the boar contact earlier and maintaining it for the entirety of the experiment. In addition the stimulatory effect of cycling gilts on pre-pubertal pen-mates was not isolated (den Hartog & Noordewier, 1984).

Effective comparison of backfat and live weight between pubertal and pre-pubertal gilts at slaughter was marred by low gilt numbers. Tables 6.2 and 6.3 show that those animals which had attained puberty began the experiment with slightly higher live weight and backfat than their pre-pubertal counterparts. These differences were not significant for any part of the growth curve but were maintained over the course of the experiment. Tables 6.2 and 6.3 show that significance approached the 5% level at 185 days for live weight and 171 days for backfat. This indicates an area for further research and may suggest that both backfat and live weight may have different influences at different gilt ages.

King (1989b), suggested that live weight at 170 days had an influence on pubertal age. The present study partly confirms this and suggests that body composition at around this age requires further study.

It appears that these Zambian pigs were growing much more slowly than those animals reported from other places. Table 6.4 compares backfat, live weight and age reported in studies from different parts of the world and shows that, at similar ages, pigs in this study were less than 70% of the live weights reported from the developed and temperate world. The measurements at day 170 of the experiment corresponds to the live weight and backfat of the most nutritionally restricted of King's (1989b) groups. In this group the maximum pubertal age was reported (202 days).

Table 6.4.
Comparison of gilt growth in different regions of the world

Author	Country		Backfat (mm)	Liveweight (kg)	Age (day)
DEVELOPED & TEMPERATE COUNTRIES					
Burnett et al., 1988	Ireland		13.2	75.4	130
(Breed not stated)			15.4	88.5	150
			16.1	99.4	170
			19.2	114.9	190
King, 1989a	Australia		13.9	65.4	134
King, 1989b		Group 1	11.6	59.6	170
(Breed LW x LR)		Group 2	14.2	73.3	"
		Group 3	15.5	84.3	"
		Group 4	18.8	95.9	"
		Group 5	22.1	107.6	"
		Group 6	24.6	118.0	"
Paterson 1989	Australia	Target		100.0	200
Signoret et al., 1990 (Breed Oest hybrid)	France			94.0	169
DEVELOPING AND TROPICAL COUNTRIES					
Steinbach, 1977	Nigeria	cool season		81	224
(Breed not stated)		hot season		70	225
N. Kabare, pers.comm, 1991 (Breed LW x LR)	Kenya			95	225

The low weight of Zambian pigs may be due to nutritional restriction, resulting in a lower growth rate or Zambian pigs may have a naturally lower growth rate due to inbreeding or environmental influences. Growth rates of animals in the tropics are often lower than in the temperate zone. Heat stress will reduce food consumption (Steinbach, 1977) and can delay puberty (Flowers & Day, 1990). Adequate growth rates are necessary for maximum gilt response to boar stimulation (Dyck, 1989).

Before conclusions can be drawn on methods to improve the pubertal age of Zambian pigs, the slow growth rates need to be investigated and remedied. This experiment indicated that much more detailed gilt management than that employed in this experiment is required to stimulate puberty in Zambian gilts.

The progress of, and problems encountered with, this experiment highlights the difficulties of on-farm experiments. In his initial zeal to assist, the farm manager compromised the experiment in ways which reduced its scientific value. At the end of the experiment, now having lost interest, he removed two animals for his own use. The author was powerless to prevent these intrusions as she depended on the manager's goodwill for the use of his facilities.

The most significant factor reducing the usefulness of the conclusions was the lack of rigourous controls. While the other collections from the same farm were used as controls this was most unsatisfactory. The exact ages of these animals were not known and were likely to vary.

CHAPTER 7. OVERALL CONCLUSION

The farmer survey showed the Zambian commercial swine industry to be lacking in proper infrastructural, nutritional and management requirements for efficient production. The average production of approximately 13.6 pigs weaned and 12 pigs sold/sow/year was very low, unprofitable and resulted in a lack of confidence in the industry. Specific problems found in the survey were poor record keeping, unsuitable farrowing accommodation, expensive and poor quality feed, unfair marketing strategies, lack of adequate genetic diversity and an extension service which did not meet the needs of the farming community. The general lack of knowledge of pig farms about many issues of pig breeding was striking.

Area of poor production was low number of piglets weaned per litter, due to high piglet mortality of 20%, and a FI of 1.7 litters/sow/year, due to extended WCI. While total litter size could have been improved it did not appear to be a major problem. The study showed wide variation in levels of productivity so that a few farms had quite good results. Zambian pigs grew more slowly than and less efficiently than those in other parts of the world and had a high grower FCR of 4.7.

The results of the farmer survey were confirmed by the analysis of SRC data. Overall productivity of these farms was 14.5 pigs weaned and 13.2 sold/sow/year. These results were in good agreement with the estimates of Chapter 3 and as these farms had reasonably good management they were expected to have better that average production. Thus, despite original misgivings, the farmer survey provided a reasonable estimate of production. The SRC analysis identified low litter size to be a major constraint while FI appeared to be more satisfactory than in the farmer survey.

By comparison with Table 2.1 and 2.2, the Zambian figures found in Chapter 4 had a 12% lower litter size born alive, an 8% lower FI and a 30% higher pre-weaning mortality than in the developed world but the figures were similar to those in the developing world. Ovulation rates were found to be comparable with that of other countries and therefore may not have been a limiting factor in litter size.

The SRC survey confirmed the findings of the farmer survey that poor record utilisation was a problem especially in culling for reproductive failure. It also confirmed the work of others identifying the rebreeding of gilts as a major problem (Hurtgen & Leman, 1981; Hughes, 1982; Tarocco, 1989; Tubbs *et al.*, 1990) and suggested that early embryonic death may be one cause of extended WCI.

It was surprising that no seasonal influence on fertility was established but the high variance of many parameters in this study prevented significant conclusions. The affect of season on gestation length was of interest as it had only been reported from Cuba (Rico, 1988). The high incidence of still-births should be investigated as it was possible that some deaths attributed to still-birth may have died shortly after birth and thus may have been preventable.

A 10% improvement in litter size born alive, FI or number weaned per litter would result in an extra 1.1, 0.9 and 1.4 piglets weaned/sow/year. These parameters could be improved through management changes and an efficient extension service could transfer the necessary information to pig farmers.

Genital abnormalities were generally higher in this study that in others, especially the occurrence of hermaphrodites, hydrometra and paraovarian cysts. This may have been due to the genetic make-up of the Zambian herd but, with the exception of hermaphroditism, was not likely to cause infertility.

Overall 12.9% of tracts were considered to be infertile; this percentage was highest in culled breeders but lowest in finishers. Abnormalities not affecting fertility were similar in both groups. The study showed a higher proportion of acquired abnormalities in the cull breeder group than in finishers, suggesting that they were influenced by age or reproduction (Keenan, 1985).

While the results of the bacteriological study must be viewed with some reservations, this study showed bacterial contamination of the uterus of the pre-pubertal pig for the first time and confirmed the work of others that the porcine uterus is not sterile (Keenan, 1980). The bacteria cultured were of the opportunistic and ubiquitous types found in other studies (Keenan, 1980; Muirhead, 1986; MacLachlan & Dial, 1987). Bladders showed a contamination rate similar to that of Kökelsum (1988) and the high incidence may have been related to poor hygiene.

It was concluded that the low productivity of Zambian herds was not due to physical abnormalities present in the Zambian herd but to management constraints.

Chapters 3, 4 and 5 showed that the growth rate of Zambian stock was slow compared with that from other parts of the world. Reasons for this were not isolated but poor feed quality, incorrect feeding regimes and inbreeding could have been involved. The study also indicated that, despite slow growth rate, gilts spontaneously reached puberty at approximately the expected age; the strong seasonal influence on puberty attainment supported the findings of others (Pomeroy, 1960c; Einarsson *et al*., 1974; Scanlon &

Krishnamurthy, 1974). Thus piggery efficiency could be improved by reducing pubertal age of gilts, thereby reducing herd unproductive days. Although an experiment to induce puberty by translocation and boar exposure was not successful, the data suggested that some stimulation had occurred. Further work in this area is recommended.

The Zambian commercial swine industry does not have the ability to deal with sophisticated management techniques requiring the importation of goods or equipment, therefore relatively simple techniques have been recommended to improve productivity. Pre-weaning mortality may be reduced by improved piglet management including staff training, nutrition and improvement in farrowing accomodation. Farrowing index may be reduced by strict culling of sub-fertile sows and appropriate management of females to encourage early cycling after weaning. Specific gilt management is needed to stimulate puberty at appropriate live weights.

The Government of Zambia should improve the extension services so that the industry is able to implement such changes, assist in the importation of new stock and feed ingredients and improve the marketing of pig meat to stimulate interest in the industry. Although the industry is small there is no reason why it should remain inefficient and currently the industry is so inefficient that it is wasting valuable resources.

The feed situation is out of the hands of the small farmer and the Government should improve availability of good quality stock feed to all intensive animal industries. The monopoly on stock-feed milling is likely to disappear following the change from a One-Party State to a multi-party democracy in 1991 and a concomitant reduction in government control.

Increased investment in the country, as a result of political changes, may stimulate improvements in Zambia's agriculture. Government or private investment in commercial swine could bring efficiency to the industry. In Taiwan, a modernisation programme was installed in 1970 with financial and technical assistance of the United Nations. The industry retained small holders as well as developing large piggeries, imported breeding stock and introduced heated creep areas; by 1981 she had an efficient swine industry (Fuller & Chung, 1981). Zambia may well be able to follow this path with appropriate input of funds and technical advice.

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SURVEY INTO THE COMMERCIAL PIG INDUSTRY OF ZAMBIA COVERING THE 1983-1984 FINANCIAL YEAR

1. FARM CODE

2. DATE

3. PROVINCE OF PIGGERY? LUSAKA (1), CENTRAL (2), COPPERBELT (3), SOUTHERN (4)

4. POSITION OF RESPONDENT IN THE PIGGERY

5. OWNERSHIP OF PIGGERY? PRIVATE (1), COMPANY (2), INSTITUTION (3)

6. PIGGERY CAPACITY (sow number)?

7. AVERAGE SOWS-ON-HAND 1983-1984?

8. EXPECTED SOWS-ON-HAND 1984 ONWARDS?

9. AVERAGE BOARS-ON-HAND?

10. IN TERMS OF ECONOMIC INPUTS IS THE PIGGERY A MAJOR (1), MINOR (2) OR SOLE (3) FARM ENTERPRISE? (OTHER = 4)

11. WHAT IS THE MAJOR TYPE OF STOCK SOLD? PORK (1), BACONER (2), HEAVY HOG (3), WEANER (4)

12. WHAT WAS THE AVERAGE LIVEWEIGHT (kg) OF GROWING STOCK WHEN SLAUGHTERED OR SOLD?

13. HOW OLD (months) WAS THE STOCK AT SALE OR SLAUGHTER ?

14. HOW MANY FINISHERS WERE SOLD IN 1983/84?

15. HOW MANY WEANER PIGS WERE SOLD IN 1983/84?

16. HOW MANY CULL SOWS AND GILTS WERE SOLD IN 1983/84?

17. HOW MANY CULL BOARS WERE SOLD IN 1983/84?

18. HOW MANY GILTS WERE PURCHASED DURING 1983/84?

19. HOW MANY BOARS WERE PURCHASED DURING 1983/84?

20. HOW MANY GILTS WERE SELECTED AS REPLACEMENT SOWS ?

21. PLEASE INDICATE WHETHER BOARS CAME FROM ANY OF THE FOLLOWING SOURCES? ALWAYS (1), OCCASIONALLY (2), NEVER (4)

(a) FROM WITHIN THE HERD
(b) FROM ANOTHER PIGGERY

(c) FROM A ZAMBIAN STUD BREEDER
(d) IMPORTED INTO ZAMBIA

22. WHICH OF THE FOLLOWING METHOD OF PIG HOUSING BEST DESCRIBES THIS PIGGERY?
(a) FULLY INTENSIVE
(b) SEMI INTENSIVE
(c) FULLY EXTENSIVE

23. PLEASE INDICATE THE BREED OF PIG SOLD ON THIS PIGGERY?
(a) PURE LANDRACE
(b) PURE LARGE WHITE
(c) OTHER PURE BREED
(d) LANDRACE X LARGE WHITE
(e) OTHER CROSS

24. WHAT WAS THE AVERAGE LITTER SIZE BORN ALIVE FOR THE PIGGERY?

25. WHAT WAS THE AVERAGE LITTER SIZE WEANED?

26. WHAT WAS THE AVERAGE LITTER SIZE SOLD?

27. HOW MANY PIGLETS WERE BORN DEAD PER LITTER?

28. WHAT WAS THE AVERAGE LITTERS/SOW/YEAR?

29. AT WHAT AGE (days) ARE PIGLETS USUALLY WEANED?

30. WHAT WAS THE AVERAGE BIRTHWEIGHT (kg) PER PIGLET?

31. WHAT WAS THE AVERAGE WEANING WEIGHT (kg) PER PIGLET?

32. WHAT WAS THE AVERAGE OF WEANING TO SERVICE INTERVAL FOR SOWS?

33. WHAT WAS THE RANGE OF WEANING TO SERVICE INTERVAL FOR SOWS?

34. WHAT WAS THE AVERAGE OF WEANING TO SERVICE INTERVAL FOR GILTS?

35. ON AVERAGE HOW MANY LITTERS DOES A FEMALE PRODUCE BEFORE SHE IS CULLED?

36. WHAT AGE (months) DOES A GILT REACH PUBERTY?

37. WHAT AGE (months) AND WEIGHT (kg) IS A GILT AT FIRST MATING?

38. AT WHICH HEAT IS A GILT USUALLY MATED FOR THE FIRST TIME?

39. WHAT IS THE AVERAGE LITTER SIZE BORN ALIVE FOR GILTS?

40. HOW OFTEN DID THE FOLLOWING DISEASES OCCUR IN THE PIGGERY?
OFTEN (1), RARELY (3), NEVER (4)
(a) SCOURS
(b) MANGE
(c) WORMS
(d) MMA
(e) TSS

41. WHAT WAS THE SOURCE OF PIG FEED CONCENTRATE USED HERE?
(1) ALL PURCHASED, (2) BOTH PURCHASED AND FARM MIXED, (3) ALL FARM MIXED

42. WHERE ANY OTHER FEEDS USED? (1) GREEN PASTURE, (2) KITCHEN WASTE, (3) BREWERY WASTE, (4) OTHER................, (0) NONE

FOR THOSE PIGGERIES USING PURCHASED FEED.

43. WERE YOU COMPLETELY SATISFIED (1), REASONABLY SATISFIED (2) OR NOT SATISFIED (3) WITH THE QUALITY OF FEED?

44. WAS THE FEED SUPPLEMENTED OR IMPROVED IN ANY WAY? IF SO PLEASE SPECIFY.......................................

FOR THOSE PIGGERIES MIXING FEED

45. WHICH OF THE FOLLOWING FEEDS WERE MIXED ON THE FARM?
(a) BREEDER, (b) GROWER/FINISHER , (c) WEANER, (d) CREEP
(e) ALL PURPOSE, (f) COMBINATION

46. DID YOU GROW ANY FEED INGREDIENTS YOURSELF? YES (1) NO (2)

47. HOW WOULD YOU DESCRIBE THE AVAILABILITY OF FEED INGREDIENTS? EXCELLENT (1), SATISFACTORY (2), NOT SATISFACTORY (3)

48. HOW MANY TONNES OF PIG FEED WERE CONSUMED IN 1983-84?

49. WHAT WAS THE OVERALL (FARM) FEED CONVERSION FOR THE PIGGERY?

50. WHAT WAS THE FEED CONVERSION FROM WEANING TO SLAUGHTER?

51. DID YOU USE CREEP FEED? FREQUENTLY (1), OCCASIONALLY (2), NEVER (4)

FOR THOSE FARMS WHICH USE CREEP FEED

52. WAS THE CREEP FEED SPECIALLY FORMULATED FOR PIGLETS?

53. HOW MUCH CREEP FEED WAS CONSUMED PER PIGLET?

54. DURING THE 1983-84 YEAR DID THIS PIGGERY MAKE A GOOD PROFIT (1), SMALL PROFIT (2), BREAK-EVEN (3) OR LOSS (4)?

55. DURING 1984 ONWARDS DO YOU EXPECT TO DO BETTER (1), THE SAME (2) OR WORSE (3) THAN IN 1983-84? (NOT APPLICABLE (4)).

56. IN YOUR OPINION, WHAT ARE THE MAJOR PROBLEMS FACING THE PIG INDUSTRY OF ZAMBIA?....................................

57. WHO PURCHASED THE MAJORITY OF YOUR FINISHER PIGS? ZAPP (1), PRIVATE BUTCHER OR PROCESSOR (2), COMBINATION OF PURCHASERS (4)

58. DO YOU HAVE A FIRM CONTRACT FOR THE PURCHASE OF YOUR STOCK FOR 1984 ONWARDS?

59. PLEASE INDICATE HOW OFTEN A GOVERNMENT VETERINARIAN OR ADVISER VISITED THIS FARM IN 1983-84? >4 TIMES (1), 1-3 TIMES (2), NEVER (4)

60. PLEASE INDICATE HOW OFTEN A PRIVATE VETERINARIAN OR ADVISER VISITED THIS FARM IN 1983-84? >4 TIMES (1), 1-3 TIMES (2), NEVER (4)

61. IN WHAT FORM ARE PERMANENT PIGGERY RECORDS STORED? (1) BOOK, (2) SOW CARDS, (3) NOTES, (4), COMPUTER, (5) NO RECORDING SYSTEM.

62. HOW OFTEN ARE THESE RECORDS UPDATED? ONE/WEEK (1), ONCE/MONTH (2), LESS OFTEN THAN ONCE A MONTH (3), NOT APPLICABLE (0)

63. ARE ANY OF THE FOLLOWING HYGIENE TECHNIQUES USED? YES (1), NO (2) (a) CAR DIP?
(b) FOOT BATHS FOR PERSONNEL ENTERING OR LEAVING SHEDS?
(c) CHEMICAL DISINFECTION OF PENS BETWEEN GROUPS OF PIGS?
(d) WHITE WASHING OF PENS BETWEEN GROUPS OF PIGS?

64. WOULD YOU SAY THAT DISEASE WAS A SIGNIFICANT PROBLEM ON THIS PIGGERY?

65. HOW LONG IS A BOAR KEPT IN FULL SERVICE? ONE YEAR (1), TWO YEARS (2), THREE YEARS (3), FOUR OR MORE YEARS (4)

66. COULD YOU INDICATE HOW OFTEN THE FOLLOWING CRITERIA WERE USED IN THE DECISION TO CULL A BOAR FROM THE HERD?
(a) AGE/ BODY WEIGHT?
(b) POOR REPRODUCTIVE PERFORMANCE?
(c) PHYSICAL DISABILITIES?
(d) BEHAVIOURAL PROBLEMS?
(e) GENETIC DEFECTS?
(f) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4).

67. AT WHAT AGE (months) ARE BOARS CONSIDERED FULLY WORKING?

68. ARE SOWS AND BOARS MATED INDIVIDUALLY OR IN GROUPS? INDIVIDUAL (1), GROUP (2).

FOR THOSE PIGGERIES USING INDIVIDUAL MATING

69. HOW MANY SERVICES DOES A BOAR PERFORM/WEEK? 1-2 (1), 3-4 (2), 5-6 (3), >6 (4)

70. DURING A PARTICULAR HEAT PERIOD HOW MANY TIMES IS A SOW MATED? ONCE (1), TWICE (2), THREE OR MORE (3), SOW AND BOAR LEFT TOGETHER FOR +- 12 HOURS (4).

71. WHEN MATING IS TAKING PLACE IS SOMEONE ON HAND TO OBSERVE? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

72. WHAT PERCENTAGE OF GILTS WERE CULLED FOR INFERTILITY?

73. WHEN GILTS ARE SELECTED FROM THE HERD AS SOW REPLACEMENTS, HOW OFTEN ARE THE FOLLOWING CHARACTERISTICS USED?
(a) PEDIGREE OF PARENTS
(b) PHYSICAL CONFORMATION (LEGS, TEATS ETC.)
(c) GROWTH RATE OF GILT
(d) OTHER
FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

74. HOW OFTEN ARE THE FOLLOWING CRITERIA USED IN THE DECISION TO CULL A PARTICULAR SOW FROM THE HERD?
(a) FAILURE TO SHOW HEAT, MATE OR CONCEIVE
(b) PHYSICAL DISABILITIES, HEALTH
(c) POOR MILK SUPPLY, UDDER PROBLEMS
(d) AGE, PARITY
(e) LOW LITTER SIZE
(f) BEHAVIOURAL PROBLEMS
(g) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

75. IS BEDDING PROVIDED FO THE SOW AND LITTER AT FARROWING? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

76. IS SOMEONE IN ATTENDANCE DURING FARROWING? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

77 DO FARROWING PENS HAVE FARROWING CRATES OR RAILS? CRATES (1), RAILS (2), A MIXTURE OF CRATES AND RAILS (3), NEITHER (4).

78. IS THERE A SEPARATE CREEP AREA FOR YOUNG PIGLETS ? YES (1), NO (2)

79. IF YES TO Q72; IS THE CREEP AREA KEPT WARM BY HEATING OR INSULATION? YES (1), NO (2)

80. COULD YOU PLEASE INDICATE HOW OFTEN THE FOLLOWING CAUSE PIGLET MORTALITY?
(a) CRUSHING BY THE SOW
(b) SAVAGING BY THE SOW
(c) INADEQUATE MILK SUPPLY
(d) LOW PIGLET BIRTH WEIGHT
(e) DISEASE
(f) CHILLING
(g) WEANING STRESS
(h) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

END OF SURVEY

SOW CARD SURVEY

SOW NUMBER FARM CODE
BIRTH DATE

GILT FIRST SERVICE DATE
" SECOND SERVICE
" THIRD SERVICE

LITTER NUMBER				
FARROW DATE				
GESTATION LENGTH				
NO. BORN ALIVE				
NO. BORN DEAD				
AVE BIRTH WEIGHT				
WEANING DATE				
LACTATION LENGTH				
NO. WEANED				
AVE WEAN WEIGHT				
SERVICE DATE 1				
SERVICE DATE 2				
SERVICE DATE 3				
SERVICE DATE 4				
WEAN TO IST SERV.				
WEAN TO 2ND SERV.				
WEAN TO 3RD SERV.				
WEAN TO 4TH SERV.				
WEAN TO CONCEPT.				

ABBATOIR SURVEY FORM

1. CODE.........   2. DATE COLLECTED ../../..
                                3. DATE EXAMINED ../../..
4. FARM CODE........   5. ABATTOIR CODE.........

6. LIVEWEIGHT..........7. HOT DR. WEIGHT.....................

8. TYPE: finisher sow gilt

REPRODUCTIVE TRACT

9. VULVA...............   10. VAGINA................
11. CERVIX.............   12. COMMENTS.....................

	LEFT	RIGHT
UTERUS	13........................	14.................... ....
IF PREGNANT		
no concepta	15...............	16...............
no abnormal	17...............	18...............
no dead	19...............	20...............
no resorbed	21...............	22...............
crown-rump length (mm)	23.......24.........	36.......37.........
	25.......26.........	38.......39.........
	27.......28.........	40.......41.........
	29.......30.........	42.......43.........
	31.......32.........	44.......45.........
	33.......34.........	46.......47.........
	35........	48........

49. mean length...........   50. est age ....

FALLOPIAN TUBES	51.................	52..................... ....

53. REPRODUCTIVE STAGE: pre-pubertal pregnant cycling non-cycling

OVARY	54.................	55.................. ....

56. CYCLE PHASE: luteal haemorrhagic follicular NA

COPRPORA LUTEA\HAEM

57. NUMBER.........   58. NUMBER..........

diam (mm)
59.......60.........   73.......74.........
61.......62.........   75.......76.........
63.......64.........   77.......78.........
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67.......68.........   81.......82.........
69.......70.........   83.......84.........
71.......72........   85.......86.........

87. mean diam.........   88. colour..........

FOLLICLES

diam (mm)
89.......90.........   93.......94.........
91.......92........   95.......96.........

C. ALBICANTIA
97. number.....   100. number.....
98. diam......   101. diam......
99. colour ......   102. colour ......

FALLOPIAN TUBE DYE TEST

103...........   104..........

CYSTIC FOLLICLES

105...............   106.................
....

106. BLADDER...

107. URINE......................

108. SAMPLES TAKEN...

109. COMMENTS..
....

110. FIRST HEAT: yes no

SURVEY INTO THE COMMERCIAL PIG INDUSTRY OF ZAMBIA COVERING THE 1983-1984 FINANCIAL YEAR

1. FARM CODE

2. DATE

3. PROVINCE OF PIGGERY? LUSAKA (1), CENTRAL (2), COPPERBELT (3), SOUTHERN (4)

4. POSITION OF RESPONDENT IN THE PIGGERY

5. OWNERSHIP OF PIGGERY? PRIVATE (1), COMPANY (2), INSTITUTION (3)

6. PIGGERY CAPACITY (sow number)?

7. AVERAGE SOWS-ON-HAND 1983-1984?

8. EXPECTED SOWS-ON-HAND 1984 ONWARDS?

9. AVERAGE BOARS-ON-HAND?

10. IN TERMS OF ECONOMIC INPUTS IS THE PIGGERY A MAJOR (1), MINOR (2) OR SOLE (3) FARM ENTERPRISE? (OTHER = 4)

11. WHAT IS THE MAJOR TYPE OF STOCK SOLD? PORK (1), BACONER (2), HEAVY HOG (3), WEANER (4)

12. WHAT WAS THE AVERAGE LIVEWEIGHT (kg) OF GROWING STOCK WHEN SLAUGHTERED OR SOLD?

13. HOW OLD (months) WAS THE STOCK AT SALE OR SLAUGHTER ?

14. HOW MANY FINISHERS WERE SOLD IN 1983/84?

15. HOW MANY WEANER PIGS WERE SOLD IN 1983/84?

16. HOW MANY CULL SOWS AND GILTS WERE SOLD IN 1983/84?

17. HOW MANY CULL BOARS WERE SOLD IN 1983/84?

18. HOW MANY GILTS WERE PURCHASED DURING 1983/84?

19. HOW MANY BOARS WERE PURCHASED DURING 1983/84?

20. HOW MANY GILTS WERE SELECTED AS REPLACEMENT SOWS ?

21. PLEASE INDICATE WHETHER BOARS CAME FROM ANY OF THE FOLLOWING SOURCES? ALWAYS (1), OCCASIONALLY (2), NEVER (4)

(a) FROM WITHIN THE HERD
(b) FROM ANOTHER PIGGERY

(c) FROM A ZAMBIAN STUD BREEDER
(d) IMPORTED INTO ZAMBIA

22. WHICH OF THE FOLLOWING METHOD OF PIG HOUSING BEST DESCRIBES THIS PIGGERY?
(a) FULLY INTENSIVE
(b) SEMI INTENSIVE
(c) FULLY EXTENSIVE

23. PLEASE INDICATE THE BREED OF PIG SOLD ON THIS PIGGERY?
(a) PURE LANDRACE
(b) PURE LARGE WHITE
(c) OTHER PURE BREED
(d) LANDRACE X LARGE WHITE
(e) OTHER CROSS

24. WHAT WAS THE AVERAGE LITTER SIZE BORN ALIVE FOR THE PIGGERY?

25. WHAT WAS THE AVERAGE LITTER SIZE WEANED?

26. WHAT WAS THE AVERAGE LITTER SIZE SOLD?

27. HOW MANY PIGLETS WERE BORN DEAD PER LITTER?

28. WHAT WAS THE AVERAGE LITTERS/SOW/YEAR?

29. AT WHAT AGE (days) ARE PIGLETS USUALLY WEANED?

30. WHAT WAS THE AVERAGE BIRTHWEIGHT (kg) PER PIGLET?

31. WHAT WAS THE AVERAGE WEANING WEIGHT (kg) PER PIGLET?

32. WHAT WAS THE AVERAGE OF WEANING TO SERVICE INTERVAL FOR SOWS?

33. WHAT WAS THE RANGE OF WEANING TO SERVICE INTERVAL FOR SOWS?

34. WHAT WAS THE AVERAGE OF WEANING TO SERVICE INTERVAL FOR GILTS?

35. ON AVERAGE HOW MANY LITTERS DOES A FEMALE PRODUCE BEFORE SHE IS CULLED?

36. WHAT AGE (months) DOES A GILT REACH PUBERTY?

37. WHAT AGE (months) AND WEIGHT (kg) IS A GILT AT FIRST MATING?

38. AT WHICH HEAT IS A GILT USUALLY MATED FOR THE FIRST TIME?

39. WHAT IS THE AVERAGE LITTER SIZE BORN ALIVE FOR GILTS?

40. HOW OFTEN DID THE FOLLOWING DISEASES OCCUR IN THE PIGGERY?
OFTEN (1), RARELY (3), NEVER (4)
(a) SCOURS
(b) MANGE
(c) WORMS
(d) MMA
(e) TSS

41. WHAT WAS THE SOURCE OF PIG FEED CONCENTRATE USED HERE?
(1) ALL PURCHASED, (2) BOTH PURCHASED AND FARM MIXED, (3) ALL FARM MIXED

42. WHERE ANY OTHER FEEDS USED? (1) GREEN PASTURE, (2) KITCHEN WASTE, (3) BREWERY WASTE, (4) OTHER................, (0) NONE

FOR THOSE PIGGERIES USING PURCHASED FEED.

43. WERE YOU COMPLETELY SATISFIED (1), REASONABLY SATISFIED (2) OR NOT SATISFIED (3) WITH THE QUALITY OF FEED?

44. WAS THE FEED SUPPLEMENTED OR IMPROVED IN ANY WAY? IF SO PLEASE SPECIFY...

FOR THOSE PIGGERIES MIXING FEED

45. WHICH OF THE FOLLOWING FEEDS WERE MIXED ON THE FARM?
(a) BREEDER, (b) GROWER/FINISHER , (c) WEANER, (d) CREEP
(e) ALL PURPOSE, (f) COMBINATION

46. DID YOU GROW ANY FEED INGREDIENTS YOURSELF? YES (1) NO (2)

47. HOW WOULD YOU DESCRIBE THE AVAILABILITY OF FEED INGREDIENTS? EXCELLENT (1), SATISFACTORY (2), NOT SATISFACTORY (3)

48. HOW MANY TONNES OF PIG FEED WERE CONSUMED IN 1983-84?

49. WHAT WAS THE OVERALL (FARM) FEED CONVERSION FOR THE PIGGERY?

50. WHAT WAS THE FEED CONVERSION FROM WEANING TO SLAUGHTER?

51. DID YOU USE CREEP FEED? FREQUENTLY (1), OCCASIONALLY (2), NEVER (4)

FOR THOSE FARMS WHICH USE CREEP FEED

52. WAS THE CREEP FEED SPECIALLY FORMULATED FOR PIGLETS?

53. HOW MUCH CREEP FEED WAS CONSUMED PER PIGLET?

54. DURING THE 1983-84 YEAR DID THIS PIGGERY MAKE A GOOD PROFIT (1), SMALL PROFIT (2), BREAK-EVEN (3) OR LOSS (4)?

55. DURING 1984 ONWARDS DO YOU EXPECT TO DO BETTER (1), THE SAME (2) OR WORSE (3) THAN IN 1983-84? (NOT APPLICABLE (4)).

56. IN YOUR OPINION, WHAT ARE THE MAJOR PROBLEMS FACING THE PIG INDUSTRY OF ZAMBIA?..

57. WHO PURCHASED THE MAJORITY OF YOUR FINISHER PIGS? ZAPP (1), PRIVATE BUTCHER OR PROCESSOR (2), COMBINATION OF PURCHASERS (4)

58. DO YOU HAVE A FIRM CONTRACT FOR THE PURCHASE OF YOUR STOCK FOR 1984 ONWARDS?

59. PLEASE INDICATE HOW OFTEN A GOVERNMENT VETERINARIAN OR ADVISER VISITED THIS FARM IN 1983-84? >4 TIMES (1), 1-3 TIMES (2), NEVER (4)

60. PLEASE INDICATE HOW OFTEN A PRIVATE VETERINARIAN OR ADVISER VISITED THIS FARM IN 1983-84? >4 TIMES (1), 1-3 TIMES (2), NEVER (4)

61. IN WHAT FORM ARE PERMANENT PIGGERY RECORDS STORED? (1) BOOK, (2) SOW CARDS, (3) NOTES, (4), COMPUTER, (5) NO RECORDING SYSTEM.

62. HOW OFTEN ARE THESE RECORDS UPDATED? ONE/WEEK (1), ONCE/MONTH (2), LESS OFTEN THAN ONCE A MONTH (3), NOT APPLICABLE (0)

63. ARE ANY OF THE FOLLOWING HYGIENE TECHNIQUES USED? YES (1), NO (2) (a) CAR DIP?
(b) FOOT BATHS FOR PERSONNEL ENTERING OR LEAVING SHEDS?
(c) CHEMICAL DISINFECTION OF PENS BETWEEN GROUPS OF PIGS?
(d) WHITE WASHING OF PENS BETWEEN GROUPS OF PIGS?

64. WOULD YOU SAY THAT DISEASE WAS A SIGNIFICANT PROBLEM ON THIS PIGGERY?

65. HOW LONG IS A BOAR KEPT IN FULL SERVICE? ONE YEAR (1), TWO YEARS (2), THREE YEARS (3), FOUR OR MORE YEARS (4)

66. COULD YOU INDICATE HOW OFTEN THE FOLLOWING CRITERIA WERE USED IN THE DECISION TO CULL A BOAR FROM THE HERD?
(a) AGE/ BODY WEIGHT?
(b) POOR REPRODUCTIVE PERFORMANCE?
(c) PHYSICAL DISABILITIES?
(d) BEHAVIOURAL PROBLEMS?
(e) GENETIC DEFECTS?
(f) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4).

67. AT WHAT AGE (months) ARE BOARS CONSIDERED FULLY WORKING?

68. ARE SOWS AND BOARS MATED INDIVIDUALLY OR IN GROUPS? INDIVIDUAL (1), GROUP (2).

FOR THOSE PIGGERIES USING INDIVIDUAL MATING

69. HOW MANY SERVICES DOES A BOAR PERFORM/WEEK? 1-2 (1), 3-4 (2), 5-6 (3), >6 (4)

70. DURING A PARTICULAR HEAT PERIOD HOW MANY TIMES IS A SOW MATED? ONCE (1), TWICE (2), THREE OR MORE (3), SOW AND BOAR LEFT TOGETHER FOR +- 12 HOURS (4).

71. WHEN MATING IS TAKING PLACE IS SOMEONE ON HAND TO OBSERVE? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

72. WHAT PERCENTAGE OF GILTS WERE CULLED FOR INFERTILITY?

73. WHEN GILTS ARE SELECTED FROM THE HERD AS SOW REPLACEMENTS, HOW OFTEN ARE THE FOLLOWING CHARACTERISTICS USED?
(a) PEDIGREE OF PARENTS
(b) PHYSICAL CONFORMATION (LEGS, TEATS ETC.)
(c) GROWTH RATE OF GILT
(d) OTHER
FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

74. HOW OFTEN ARE THE FOLLOWING CRITERIA USED IN THE DECISION TO CULL A PARTICULAR SOW FROM THE HERD?
(a) FAILURE TO SHOW HEAT, MATE OR CONCEIVE
(b) PHYSICAL DISABILITIES, HEALTH
(c) POOR MILK SUPPLY, UDDER PROBLEMS
(d) AGE, PARITY
(e) LOW LITTER SIZE
(f) BEHAVIOURAL PROBLEMS
(g) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

75. IS BEDDING PROVIDED FO THE SOW AND LITTER AT FARROWING? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

76. IS SOMEONE IN ATTENDANCE DURING FARROWING? ALWAYS (1), OFTEN (2), RARELY (3), NEVER (4).

77 DO FARROWING PENS HAVE FARROWING CRATES OR RAILS? CRATES (1), RAILS (2), A MIXTURE OF CRATES AND RAILS (3), NEITHER (4).

78. IS THERE A SEPARATE CREEP AREA FOR YOUNG PIGLETS ? YES (1), NO (2)

79. IF YES TO Q72; IS THE CREEP AREA KEPT WARM BY HEATING OR INSULATION? YES (1), NO (2)

80. COULD YOU PLEASE INDICATE HOW OFTEN THE FOLLOWING CAUSE PIGLET MORTALITY?
(a) CRUSHING BY THE SOW
(b) SAVAGING BY THE SOW
(c) INADEQUATE MILK SUPPLY
(d) LOW PIGLET BIRTH WEIGHT
(e) DISEASE
(f) CHILLING
(g) WEANING STRESS
(h) OTHER

FREQUENTLY (1), OFTEN (2), RARELY (3), NEVER (4)

<u>END OF SURVEY</u>

SOW CARD SURVEY

SOW NUMBER   FARM CODE
BIRTH DATE

GILT FIRST SERVICE DATE
" SECOND SERVICE
" THIRD SERVICE

	LITTER NUMBER			
FARROW DATE				
GESTATION LENGTH				
NO. BORN ALIVE				
NO. BORN DEAD				
AVE BIRTH WEIGHT				
WEANING DATE				
LACTATION LENGTH				
NO. WEANED				
AVE WEAN WEIGHT				
SERVICE DATE 1				
SERVICE DATE 2				
SERVICE DATE 3				
SERVICE DATE 4				
WEAN TO IST SERV.				
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6. LIVEWEIGHT..........
7. HOT DR. WEIGHT.....................

8. TYPE: finisher sow gilt

REPRODUCTIVE TRACT

9. VULVA...............
10. VAGINA...............
11. CERVIX.............
12. COMMENTS.....................

	LEFT		RIGHT	
UTERUS	13......................		14....................	
	....		....	
IF PREGNANT				
no concepta	15................		16...............	
no abnormal	17................		18...............	
no dead	19................		20...............	
no resorbed	21................		22...............	
crown-rump length (mm)	23.......	24.........	36.......	37.........
	25.......	26.........	38.......	39.........
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	33.......	34.........	46.......	47.........
	35........		48........	

49. mean length...........
50. est age ....

FALLOPIAN TUBES	51..................	52....................
	....	....

53. REPRODUCTIVE STAGE: pre-pubertal pregnant cycling non-cycling

OVARY	54..................	55....................
	....	....

56. CYCLE PHASE: luteal haemorrhagic follicular NA

COPRPORA LUTEA\HAEM

	57. NUMBER.........	58. NUMBER..........
diam (mm)	59.......60.........	73.......74.........
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87. mean diam......... 88. colour..........

FOLLICLES		
diam (mm)	89.......90.........	93.......94.........
	91.......92........	95.......96.........
C. ALBICANTIA	97. number.....	100. number.....
	98. diam......	101. diam......
	99. colour	102. colour ......
FALLOPIAN TUBE DYE TEST		
	103...........	104..........
CYSTIC FOLLICLES		
	105................	106.................
	....	....

106. BLADDER..

107. URINE.......................

108. SAMPLES TAKEN..

109. COMMENTS...
....

110. FIRST HEAT: yes no