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There are many diverse factors which can have a profound effect on the reproductive performance of the breeding herd. Not the least of these factors are: the genotype of the sow and boar, the health status of the herd and the general environment provided for the breeding females. It is intended in this paper to concentrate on those factors which are under direct management control and which are economically significant. Components of reproductive performance to be considered are: lactation length, climatic and social environment and prolificacy.

There has been progressive improvement in recent years in sow productivity and this trend seems likely to continue. Data from the Meat and Livestock Commission show that over the years 1970-1984, sow productivity in the United Kingdom for all recorded herds rose from 15.5 piglets reared per sow per year to 20.0 reared per sow per year. There is great variation between herds in this respect and in 1984 the top 10% of herds weaning piglets between 14 and 18 days of age were recorded as rearing 26.8 piglets per sow per year (2.6 litters per sow per year; 11.1 piglets born alive per litter). Not every producer can achieve performances at this level but there may be lessons to learn from these top herds which could help the average farmer.

I - Environmental effects

There is increasing concern about the effects of the environment on the general welfare of the breeding sow. Individual stalls, slatted floors and farrowing crates are but three examples where criticism is directed. Different environmental conditions in addition to the imposition of good or poor welfare to the animal, can also be associated with a different level of productive efficiency.

Light and temperature are two environmental components which may play a role in the determination of litter size although more data is needed. Sainsbury (1971) has suggested that high ambient temperature at mating is associated with poor litter size at full term, although Tomes and Neilson (1979) have presented data showing this is not always so. Obviously the effects of high ambient temperature on litter size in the female pig are confounded by effects on the male. Svajgr (1975) has demonstrated that high environmental temperatures occurring two or three weeks after mating are extremely detrimental to prolificacy. **Table 1** presents data from a recent study by Wettermann and Bazer (1985) showing that heat stress in very early pregnancy can have detrimental effects on uterine function and the development of embryos.

Table 1: Heat stress
after Wettermann & Bazer (1985) Pregnant Gilts

	Control	Heat stressed
Embryo wet weight per uterine horn (mg)	336±75	233±66
3H Leucine incorporated in uterine explants (c.p.m.)	1.18±0.24	0.55±0,21

The summer months and early autumn are the times when deficiency in the numbers of piglets born alive per litter is most likely to be seen. In practice this means that inseminations for this period are carried out in the spring, not usually the hottest part of the year. Changing photoperiod is likely to be another factor involved in seasonal effects. The experimental data which exist refute this possibility (Greenberg and Mahone, 1982; Hacker and Perera, 1981; Mabry *et al.*, 1982) In no study to date has a significant effect of photoperiod on litter size been reported. Seasonal effects therefore are still unpredictable and difficult to understand fully.

The social environment of breeding females (and boars) could be one of the most significant determinants of reproductive efficiency and prolificacy. At the present time there is much endeavour in the field of animal behaviour and the pig is an excellent model for this. Moreover, with the current awareness of the general public in matters of animal rights and welfare, there is a need to understand the relationships involved in social interaction between animals in order that we may develop systems of production and building designs which fulfill the welfare needs of the animal whilst still remaining productive.

There is evidence that alterations to the social environment of sows and gilts can be responsible for changes in reproductive function. The group working at Werribee in Australia has been very active in this area. Hemsworth, Beilharz and Brown (1978), for example, showed that sows housed in pairs between weaning and remating had a higher litter size at the next farrowing than sows housed individually.

In addition to animal social interactions, Hemsworth, Brand and Willems (1981) reported a man-animal interaction which influenced the litter size. These authors subjectively scored sows from 12 separate herds for their "withdrawal" to the human experimenters' approach. In those herds in which sows showed decreased affinity with humans, there were significantly fewer piglets born alive per litter. **Table 2** gives the correlation coefficients observed by Hemsworth *et al.* (1981) between the "aversion score" for each farm in the study and either the farrowing rate percentage or the number of piglets farrowed per litter. Those herds containing sows which showed aversion to humans for whatever reason were those herds with the lowest reproductive performance.

Table 2: Correlation coefficients between reproductive performance and the quality of stockmanship
from Hemsworth, Brand and Willems (1981)

	Farrowing %	No. of piglets born per litter
Aversion score of sows with humans	−0.77	−0.55

Many conclusions can be drawn from these simple observations, but it does seem that reproductive processes in the sow are affected by good and bad stockmanship in the same way that milk yield in dairy cattle can be influenced by the personality of the cowman (Seabrook, 1972). This relationship probably has some bearing on the fact that adrenal function, steroid hormones and stress are inextricably linked together. Some individual sows or some herds may be more stress prone or subjected to more stress via the system of buildings and management than others. This manifests itself either as complete reproductive failure or reduced profilicacy, and may account for much of the variability in litter size and hence overall sow productivity seen in practice.

II - Sow nutrition, body condition and prolificacy

There has been an abundance of published reports over the last 20 years regarding various aspects of sow nutrition, body composition and reproduction. This work has provided a database from which sound guidelines for the feeding of breeding females have been derived. It is established practice to offer sows throughout pregnancy an energy intake only a fraction above maintenance. Under average circumstances this is a cost effective means of converting feedstuffs into weaners for sale.

It has now become apparent that although average levels of energy intake suit the average sow, there are too many animals without the middle band of body condition. It may be more efficacious at low energy and protein intakes to carefully monitor individual sow body condition and adjust feed scales accordingly. At this point in time, however, the ideal body condition and body weight change have not been clearly identified for the various phases of a sow's life. As far as prolificacy is concerned, there is little doubt that the sow can experience large variations in weight change without loss of numbers born alive per litter (Varley and Cole, 1978b; Hovell and McPherson, 1977). At the extremes of body condition, the incidence of conception failure, anoestrus and ovarian dysfunction are likely to increase.

There has been an ongoing debate over the last few years as to appropriate energy allowance for sows and gilts in very early pregnancy (i.e. up to and around implantation). The question of whether overfeeding in the immediate post coitum period causes increased embryonic mortality has been open to much discussion. The evidence indicates that at least in gilts, it is advisable to restrict daily feed intake in the first three weeks after mating (Dutt and Chaney, 1968).

Evidence for multiparous sows has not been so well defined but a recent study by Toplis, Ginesi and Wrathall (1983) showed when sows were offered either 2 or 4 kg per day of a diet containing 13 MJ/kg of DE between 3 and 30 days post coitum, there were no differences in either the number of viable embryos at day 30 post coitum or in the percentage embryo survival rate. It may therefore be prudent not to increase the daily energy intake in very early pregnancy. But in multiparous sows there is often a real need to restore body condition losses resulting from the previous lactation. It should be possible to apply an increased plane of energy intake following mating without extra losses of embryos.

III - Early weaning

The application of early weaning over the last 20 years has played a major role in the increases seen in sow productivity on modern pig units. The biological effects of early weaning are now well known: for example, as lactation length is reduced there are concomitant effects on the interval from weaning to conception, conception rates and the subsequent litter size (Varley and Cole, 1978b). The problem with litter size is probably the biggest single drawback and the author has estimated from all available data that the relationship between weaning age and subsequent litter size is given by the equation:

$$Y = 6.8 + 1.1 \log_e X$$

where Y = litter size (born alive) and X = weaning age (days). In most work the conclusion is drawn that with early weaning (7-20 days) there are no benefits accruing in terms of annual sow productivity even though it is possible to produce 2.8 litters/sow/year. The general recommendation has been made that the optimisation of weaning age is over the range three to four weeks.

The question of when to wean is not so simple and there may in fact be many answers for different farmers. Not the least of the considerations are the available buildings on a particular farm and the available management skills. Most people would agree however that if sow productivity is the main goal then weaning at 21 days is the appropriate age to wean. This conclusion does not alter significantly over a period of time. What does alter is the optimum age to wean with regard to financial performance. These relationships are derived from a computer model of the sow breeding herd (Varley, 1985, unpublished) which integrates all of the known biological facts and the economic factors involved. The data depicted in **Figure 1** are for a new farm with an intensive building system and average to good management. It can be seen that physical productivity peaks at slightly less than a 20 day lactation length. Financial performance, in contrast, shows maximum expression for a weaning age of about 35 days. It is interesting to note also that return on capital at current interest rates and price structures never shows a positive value.

Figure 2 illustrates the point that financial and physical performance peaked at the same point as the pricing structure prevailing in 1975 (in the UK at least). The weaner price/feed cost ratio was much greater in the early 1970s. The optimum age to wean appears to change considerably over time and although it currently seems to be around five weeks of age, it may decrease if the economic situation changes. What is needed are inexpensive creep diets for early-weaned piglets based on soya protein and other low cost ingredients. This will not happen until our knowledge of the nutrition of the young pig is much further advanced.

Although most farmers pursue 25 piglets per sow per year from a three week weaning system, they may maximise their profits by accepting 22 piglets from a five week weaning system at today's prices with current knowledge.

IV - Endocrine status of early-weaned sows

Recent work has focused on the endocrine background of early-weaned sows (Varley, Atkinson and Ross, 1981; Varley, Peaker and Atkinson, 1984; Edwards and Foxcroft, 1983). Plasma concentrations of the steroid hormone progesterone do not differ in early pregnancy between early-weaned sows and conventionally teated sows (weaned at six weeks) but there is evidence (Edwards and Foxcroft, 1983; Kirkwood *et al.*, 1984) that the luteinising hormone (LH) surge at ovulation is significantly reduced for early-weaned sows. This could influence the timing of ovulation relative to other endocrine signals, leading ultimately to early embryonic death. Surprisingly, the reduced LH peak does not affect the ovulation rate.

Oestrogens have been given some attention by Varley *et al.*, 1984. Some sows have very high blood levels of circulating oestrogens between weaning and remating and in early pregnancy. This could be responsible for erroneous egg transport and poor implantation of blastocysts. The source of this oestrogen is open at the moment to speculation but early-weaned sows show a very high incidence of elevated oestrogens. A proportion of conventionally weaned sows show the same response but the overall incidence is much lower than for early-weaned sows.

One possibility is that the oestrogens originate from the adrenal glands. This is known to occur as a reaction to stress. It may be that some animals are predisposed to stress and will produce more oestrogens as a result. Early-weaning tends to compound together two very stressful events in the reproductive life of a breeding female. These are parturition and weaning. There is more work to be done in this field before firm conclusions are drawn but it does seem that elevated oestrogens may lead to embryonic deaths.

V - Prolificacy and neonatal management

Prolificacy, or the number of piglets born alive per litter, is usually considered by most pig farmers to be the single most important determinant of profitability. Without a high order of prolificacy it is impossible to maximise annual sow productivity. Survey data highlight the enormous variation that exists on farms and the best herds achieve 12.5 piglets/litter and at the other extreme, the poorest record 7.8 (McIntyre, 1984, personal communication MLC data).

Neonatal mortality is also of paramount importance. It is of little consequence producing 12 piglets per litter born alive if 15% of these die within 48 hours of birth, as often is the case. There are many management aids for reducing the incidence of neonatal deaths and these include high technology farrowing crates, *E. coli* vaccination and synchronised farrowing.

Supplementary rearing devices for the artificial rearing of surplus piglets are now being used widely in the UK. In other words, there are many technical options open to farmers with special problems in this area.

VI - Conclusions

From a practical viewpoint, there is a glimmer of hope that it may be possible in the future to significantly improve prolificacy and general reproductive performances. There is a vigorous effort being made by hybrid breeding companies to develop hyper-prolific female lines and Meat and Livestock Commission evaluations strongly suggest that there are significant differences between companies in breeding value of their animals for litter size. Producers now have the option to select a company's gilts on the basis of published comparative information. From the starting point of a good genotype, it is then necessary to adhere to the established recommendations of good husbandry and due consideration of some of the points listed below.

Use of an appropriate housing system with good hygiene;

Stocking density for sows not too high;

Feed sows and gilts as individuals where possible and monitor body condition;

Avoid overfeeding in early pregnancy, particularly with gilts and primiparous sows.

Consider the use of a constant light pattern in dry sow accommodation;

Avoid high environmental temperatures between weaning and mating and over the course of early pregnancy; and

Avoid the imposition of any stress on the animal, particularly at farrowing and between weaning and service and in early pregnancy.

This last point relates to the quality of stockmanship as well as to management techniques. In recent years there has been an increase in the ratio of pigs to stockman as herds have increased in size. It is of paramount importance to ensure that those still working in the industry are fully trained and of the highest calibre. However good the genotype, the housing, the feeding and the style of management, the primary constraint may always be the person actually tending to the animal's needs.

In the future, with the introduction to Europe of Chinese breeds capable of producing 16 to 20 liveborn piglets per litter, and with our increasing understanding of the basic mechanisms controlling embryonic mortality, it might yet be possible to sell 3,000 bacon pigs a year from 100 sows.

References

Dutt, R.H. and C.H. Chaney, 1968. Feed intake and embryo survival in gilts. Prog. Rep. Ky. Agric. Exp. Stu. No. 176:33-35.

Edwards, S. and G.R. Foxcroft, 1983. Endocrine changes in sows weaned at two stages of lactation. J. Reprod. Fert. 67:161-172.

Greenberg, L.G. and J.P. Mahone, 1982. Failure of a 16 h L = 8hD or a 8hL = 16hD photoperiod to influence lactation or reproductive efficiency in sows. Can. J. Anim. Sci. 62:141-145.

Hacker, R.R. and M. Perera, 1981. Effect of light changes on swine reproduction. University of Guelph. Annual Report. 1981. pp. 21-23.

Hemsworth, P.H., R.G. Beilharz, and W.J. Brown, 1978. The importance of the courting behaviour of the boar on the success of natural and artificial matings. Appl. Anim. Ethol. 4:341-347.

Hemsworth, P.H., A. Brand, and P. Willems, 1981. The behavioural response of sows to the presence of human beings and its relation to productivity. Livest. Sci. 8, 67-74.

Hovell, F.D. De B. and R.M. MacPherson, 1977. Thin sows. 1. Observations on the fecundity of sows when underfed for several parities. J. Agric. Sci., Camb. 89:513-522.

Kirkwood, P.N., K.R. Lapwood, W.C. Smith, and I.L. Anderson, 1944. Plasma concentrations of LH, protein, oestradiol-17 and progesterone in sows weaned after lactation for 10 or 35 days. J. Reprod. Fert. 70:95-102.

Mabry, J.W., F.L. Cunningham, R.R. Kraeling and G.B. Rampacek, 1982. The effect of artificially extended photoperiod during lactation on maternal performance of the sow. J.Anim. Sci. 54:918-921.

Sainsbury, D.W.B, 1971. Climatic environment and pig performance. IN: Pig Production, ed. D.J.A. Cole, pp. 91-106. Buttersworth, London.

Seabrook, M.F, 1972. A study to determine the influence of the herdman's personality on milk yield. J. Agric. Labour. Sci. 1:1-45.

Svajgr, A.G., 1975. Stretching the feed dollar. Feedstuffs. March 17, p.14.

Tomes, G.J. and H.E. Nielsen, 1979. Seasonal variations in the reproductive performance of sows under different climatic conditions. Wld. Rev. Anim. Prod. 15:(1) 9-19.

Toplis, P., M.F.J. Ginesi, and A.E. Wrathall, 1983. The influence of high food levels in early pregnancy on embryo survival in multiparous sows. Anim. Prod. 37:45-48.

Varley, M.A. and D.J.A. Cole, 1978a. The relationship between the weight change of the sow and her reproductive output. Proc. Brit. Soc. Anim. Prod. 1978. Page 368 (abstr.).

Varley, M.A. and D.J.A. Cole, 1978b. Studies in sow reproduction. 6. The effect of lactation length on pre-implantation losses. Anim. Prod. 27:209-214.

Varley, M.A., R.E. Peaker, and T. Atkinson, 1984. Effect of lactation length of the sow on plasma progesterone, oestadiol-17 and embryonic survival. Anim. Prod. 38:113-119.

Varley, M.A., T. Atkinson, and L.N. Ross, 1981. The effect of lactation length on the circulating concentrations of progesterone and oestradiol in the early-weaned sows. Theriogenology 16:179-183.

Wetterman R.P. and F.W. Bazer, 1985. Influence of environmental temperature on profilicacy of pigs. IN: Control of Pig Reproduction II. Ed. Foxcroft G.R., D.J.A. Cole, and B.J. Weir, J. Reprod. Fert.:Supplement 33.

Figure 1 : Effect of weaning age on economic aspects of pig production

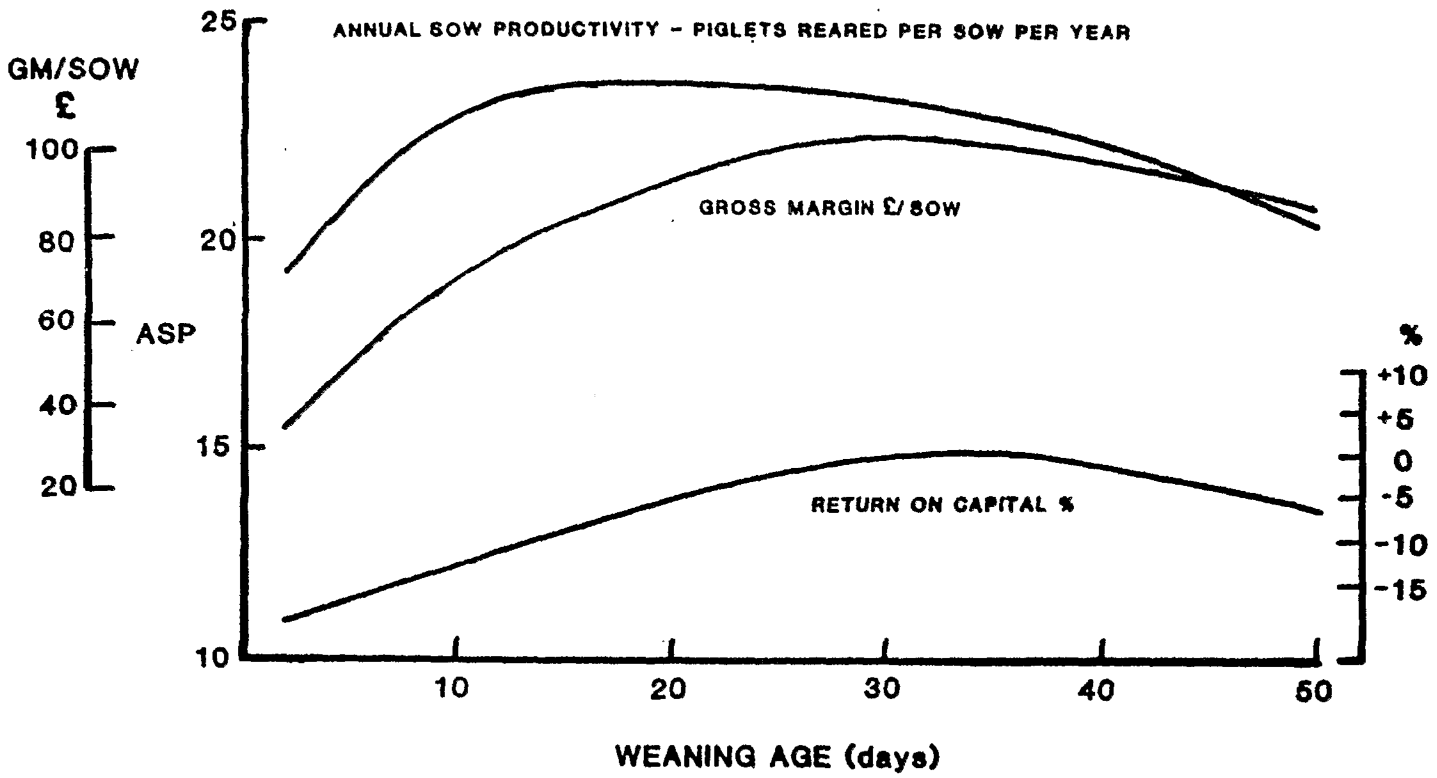

Figure 2 : The effect of weaning age on profitability in Great Britain