

Control of pig reproduction in a breeding programme

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Summary. Important improvements in the management of sows have been made over the past 20 years in Europe and the U.S.A. Nevertheless, annual productivity varied between 15 and 25 piglets weaned per sow per year in France for 1983. Reasons for such a difference in productivity have been analysed quantitatively.

Marked differences exist between herds in the genotype of pig used and in the age of puberty. Transportation acts as a stress stimulus and stimulates puberty attainment. However, there is variability in the occurrence of oestrus amongst different purchased batches of pigs. Recent endocrine results led to four phases in sexual maturation of gilts being distinguished (perinatal, infancy, activation and resting) and permitted a better understanding of the variation in the onset of puberty.

After a lactation of 3 weeks or more, about 25% of primiparous sows did not return to oestrus within 1 week of weaning. Fertility of these sows with a delayed oestrus was 10% lower than in sows having a normal oestrus after weaning.

The past 3 decades of research on control of ovulation have yielded positive results. However, there is no satisfactory method for the induction of puberty. One method used to regulate the oestrous cycle in gilts is treatment with a progestagen. This method is still available commercially in France. The close synchronization obtained with a progestagen treatment has led to the use of AI at fixed days (Days 6 and 7) in crossbred gilts but not for purebred gilts. Some environmental factors (e.g. male stimulation, age of gilts at treatment, diet and month of AI) have been analysed to evaluate their effects on farrowing rate and litter size.

After weaning, a short treatment with a progestagen (20 mg/day) tends to improve the synchronization of oestrus (3–9 days), especially in primiparous sows. Farrowing rate and litter size are similar in treated sows and control sows. However, this technique does not permit fixed-time AI without detection of oestrus.

Diagnosis of pregnancy was successful with ultrasound scanning. This technique can be performed 20 days after insemination if the sow is tied up during the examination and at 22 days if the sow is restrained in a retention box. From 22 days after mating, errors made for positive and negative diagnoses were < 5%.

These techniques contribute to a better control of reproduction in different management systems.

Introduction

During the past decade, changes in management of sows have increased the numbers of farrowings per year (Ridgeon, 1982; Meat Livestock Commission, 1984; Couanon & Thorel, 1984). Annual numerical productivity of sows, computed by Legault, Aumaitre, du Mesnil du Buisson (1975b) and Terqui & Legault (1984) has increased by 4 and 2 piglets in the United Kingdom and France respectively and reached a mean rate of 20.5 piglets weaned per sow per year (Fig. 1). In France, this is mainly due to a 6-day reduction in the duration of lactation and a 7-day decrease of weaning to conception interval (Couanon & Thorel, 1984). However, variability between herds remains

important and productivity ranged from 15 to 25 piglets weaned per sow in 1983. Occupancy of buildings is also variable. In herds organized for batches of matings for 3 weeks, occupancy in the farrowing building varies from 89 to 96% (Le Denmat, Dagorn & Dufour, 1984). However, the main goal of the pig industry is to have a balance between 'better' productivity and maximum efficiency. At the present time, this is not being achieved and the fault is primarily due to reproduction. This review presents the main reproductive problems and analyses the techniques available to control oestrus and to conduct pregnancy detection to maximize reproductive efficiency in pigs.

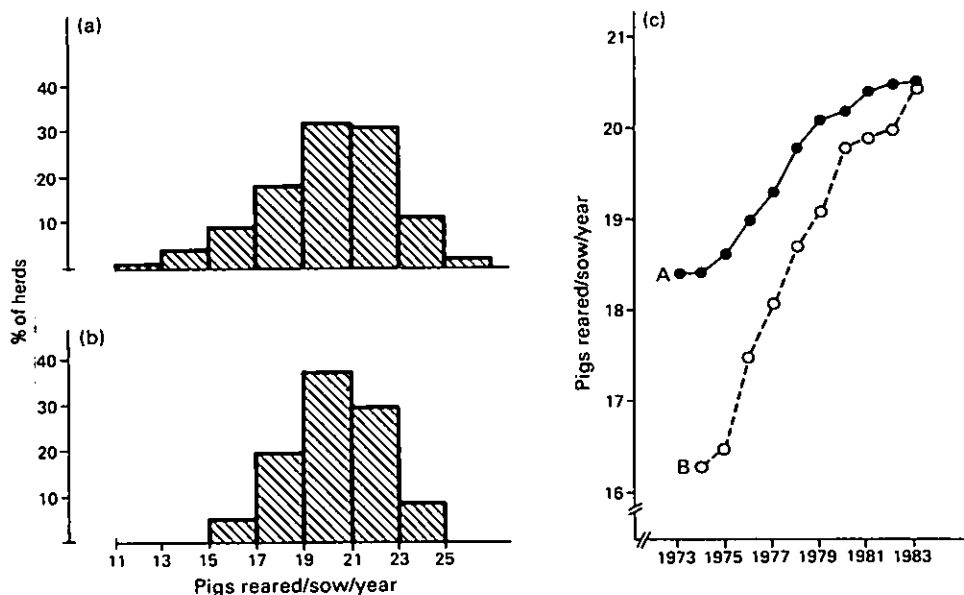


Fig. 1. Distribution of pigs reared per sow per year: (a) MLC Pig Plan Service, 735 herds (MLC, 1984); (b) French Recording Programme, 7045 herds (Dagorn, 1984a,b); (c) A = French Recording Programme (Couanon & Thorel, 1984); B = MLC Pig Plan Service (MLC, 1984).

Main reproductive problems

In France, sows in commercial herds last, on average, for 4 litters before they are culled; for every sow that is culled, a gilt must enter the herd. The annual culling rate is about 40% in the French Recording Programme (1984) (J. Dagorn, personal communication). It means that, for a unit of 100 sows, about 120 gilts must be purchased or home bred each year (2.3 farrowings per year). For every batch of matings (every 3 weeks) about 10 gilts must be ready to mate and this means that each batch is composed of about 25% primiparous sows.

Gilts

The appropriate age at which to mate a gilt depends mainly on age of puberty. Sexual precocity allows reduction of the unproductive interval between the end of the finishing period and first farrowing. An early age at first farrowing increases the numerical productivity for each year that the sow is present on the farm and decreases the cost of each weaned piglet (Legault & Dagorn, 1973; Noguera & Gueblez, 1984).

Age at puberty: influence of genotype and social environment. There are marked differences in age at puberty between herds, that ranges from 5 to 10 months (Martinat, Legault, du Mesnil du Buisson, Ollivier & Signoret, 1970; Hughes, 1982). There are also large differences in breeds and genetic types that make up the various herds (Legault & Gruand, 1981; Legault & Caritez, 1982; Hughes, 1982). It appears that, under the same conditions of management, first-cross gilts attain puberty some 20 days before purebreds (Legault & Gruand, 1981). Over the past decade, French breeders have utilized crossbred sows and certainly have reduced age at first farrowing by about 3 weeks (Couanon & Thorel, 1984). The direct effect, on sexual maturity, of other environmental factors such as season of birth, and duration and intensity of light have not been identified clearly (Hughes, 1982; Aumaitre, 1983; Prunier & Etienne, 1984). It has long been known that 'stress' factors stimulate puberty. The best known 'stress' factor in pigs is that of transportation or transfer and regrouping of gilts in a new environment around the expected age at puberty.

It was found that transportation of gilts, particularly crossbred gilts, from one pig farm to another stimulated puberty of these young females (du Mesnil du Buisson & Signoret, 1962). However, a variation in occurrence of oestrus was noted among the batches of purchased pigs (Fig. 2). Of all crossbred gilts purchased only 16% had an oestrus during the week after transportation. Females that were impubertal or prepubertal on the day of transportation ovulated 9 days later (Fig. 3). A recent study could not confirm this effect in Large White pigs (Stephens & Close, 1984) and suggested that the major stimulus for induction of precocious puberty was the proximity of other pigs (Close, Stephens, Polge & Start, 1982). Besides this 'transport effect', different investigators have found a 'male effect', particularly with crossbred gilts. The greatest response was achieved when gilts have first contact at 160 days of age and with older boars (> 11 months). If boar contact was initiated at too young an age (120 or 130 days) puberty was delayed rather

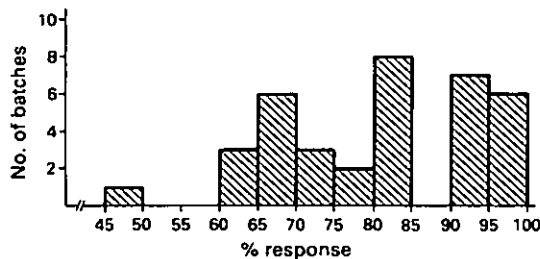


Fig. 2. Effect of 'transportation' stress on oestrus response (Days 1-10) of 521 crossbred gilts (36 batches). Day 0 was day of 'transportation' stress.

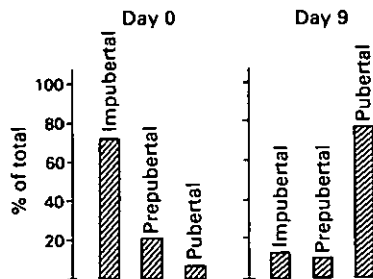


Fig. 3. Effect of 'transportation' stress on development of the genital tract of 59 crossbred gilts. Impubertal refers to gilts with follicles of < 5 mm diameter and an undeveloped uterus. (From Wodzicka-Tomaszewska *et al.*, 1985.)

than stimulated (Hughes, 1982), but this was not confirmed by Karlbom (1981/82). Similarly, Wodzicka-Tomaszewska, Martinat-Botte, Prunier & Signoret (1985) observed that boar contact alone at 190 days of age failed to induce a high occurrence of oestrus in Large White gilts, although success with such a technique has been reported by many workers.

Influence of management. Generally, gilts are mated for the first time at an age or weight which corresponds to a 2nd or 3rd oestrus. Return to oestrus may be between 18 and 25 days after the last oestrus. This variability constitutes a major problem, particularly in herds organized into batches for farrowings every 3 weeks. A recent French survey indicated that in this system only half the gilts were mated over the week of services while 80% of the overall herd was mated over this week (Le Denmat *et al.*, 1984; Fig. 4).

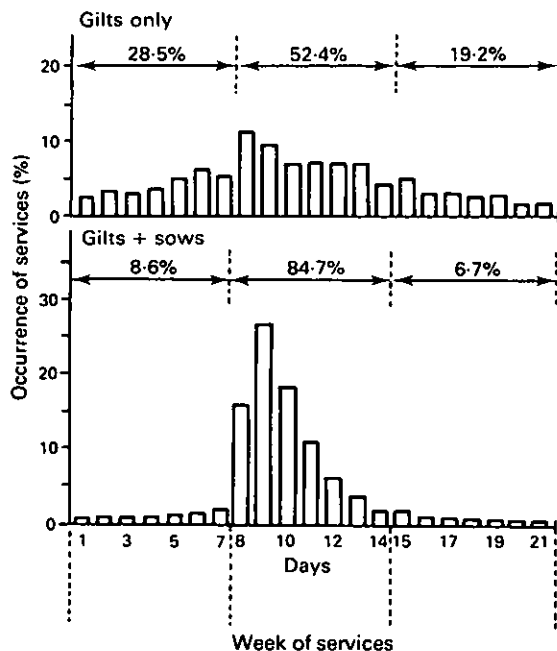


Fig. 4. Distribution of services of female pigs over 3 weeks. (From Le Denmat *et al.*, 1984.)

Sows

Parity, age at weaning, season and herd are the most important factors that affect remating. Data were collected from the French Recording Programme in 1982 and compared with those of another study of 1975. In 1982, 85% of the sows were mated during the week after weaning (Days 3–9, where Day 0 is the day of weaning), which corresponded to an increase of 6% from 1975 (Martinat-Botte, Badouard & Terqui, 1984b).

Parity. In 1982, after a lactation of 3 weeks or more, 24% of primiparous sows did not return to oestrus during the week after weaning (Days 3–9) compared with 11% of multiparous sows. This agrees with the results of many authors (Corteel, Signoret & du Mesnil du Buisson, 1964; Aumaitre, Dagorn, Legault & Le Denmat, 1976; Hurtgen, Leman & Crabo, 1980; Britt, Szarek & Levis, 1983). Such delayed exhibitions of oestrus (i.e. after Day 9) in primiparous and multiparous sows were associated with lower fertility than at those that occurred earlier (4–10%; Table 1). In this survey, the farrowing rate of primiparous sows was similar to that of multiparous sows which was not in agreement with previous results (Britt *et al.*, 1983; Martinat-Botte *et al.*, 1984a).

Table 1. Oestrus and farrowing rate of sows according to parity

	Oestrus (%)†			Farrowing rate (%)		
	3-9 days	> 10 days	No. of sows	3-9 days	> 10 days	No. of sows
Primiparous sows	76**	24	9557	82*	78*	10 368
Multiparous sows	89**	11	27 369	83**	73**	30 087

†From Martinat-Botte *et al.* (1984b).

* $P < 0.05$, ** $P < 0.01$.

Age at weaning. In the main part of the same sample in 1982, age at weaning was 28 days, which represented a decrease of 6 days since 1975.

There was a negative effect on the occurrence of oestrus when piglets were weaned before 15 days of age and when lactation period exceeded 41 days. The greatest return to oestrus in the week after weaning (Days 3-9) was found after lactations of 21-30 days in primiparous and multiparous sows (Fig. 5). In the same way, farrowing rates varied little but litter size tended to increase as the length of lactation increased (Fig. 5). All of these results are in good agreement with the data recorded by Aumaitre *et al.* (1976) and Aumaitre & Dagorn (1982).

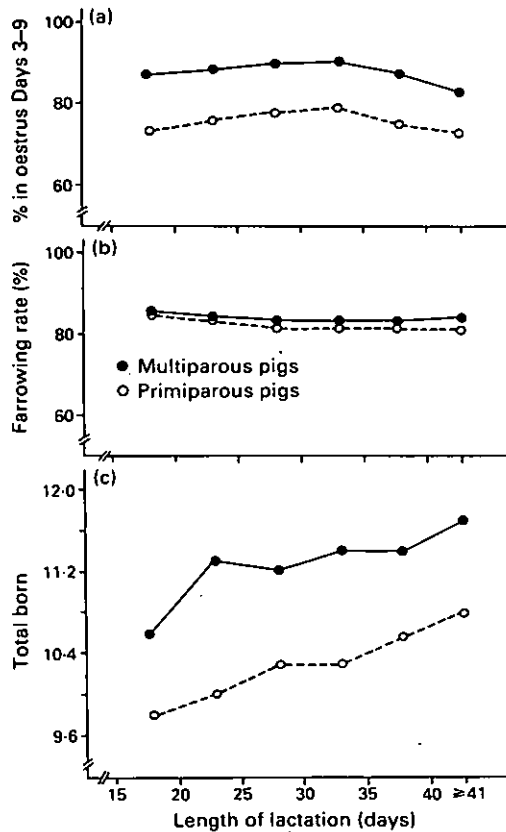


Fig. 5. Effect of length of lactation on oestrus, farrowing rate and total piglets born. (a) From Martinat-Botte *et al.* (1984b); (b) (c) calculated from oestrus 3-9 days after weaning for the same sample as in (a).

Under French farm conditions, it appeared that the best age for weaning was between 21 and 30 days of lactation.

Season. A marked seasonal increase in the incidence of primiparous sows taking more than 10 days to return to oestrus after weaning was noted in summer in France in 1982 (Martinat-Botte *et al.*, 1984b). Hurtgen *et al.* (1980) and Britt *et al.* (1983) have observed the same type of variation. Housing conditions interact with seasonal changes and, in particular, farrowing rate. For pregnancies beginning in August, September and October, there was an 8% increase in farrowing rate for confined sows (primiparous and multiparous) compared with those in open-fronted facilities (Fig. 6). The seasonal decrease was observed in large and small herds.

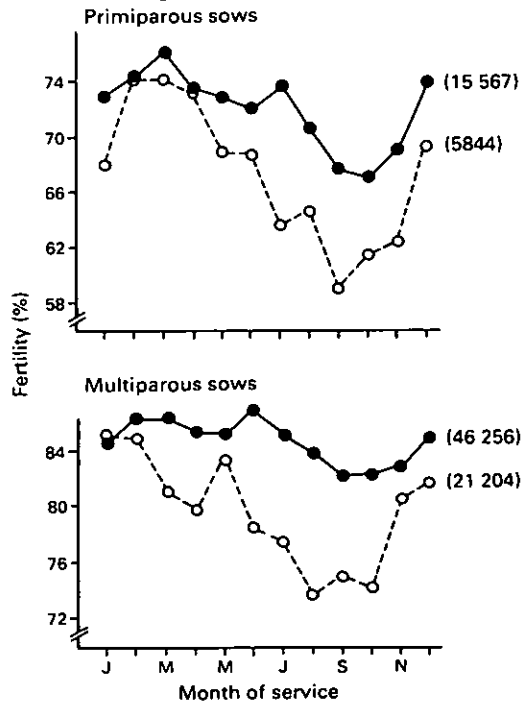


Fig. 6. Effect of parity and conditions on fertility rate (% of sows fertilized within a period of 20 days after weaning). ●, Closed building; ○, open-fronted building. No. of farrowings indicated in parentheses. (From Martinat-Botte *et al.*, 1984a.)

The seasonal fluctuation of farrowing rate after natural mating was not quite reflected in litter size. The largest litters were conceived in August and September and the lowest in February–March (Legault, Dagorn & Tastu, 1975a; Dagorn, Albar, Le Denmat & Uhlen, 1979; Martinat-Botte, Dando, Gautier & Terqui, 1981).

Herds. Data collected in the French Recording Programme indicated that 84% of the herds (313) have a problem in that the percentage of primiparous sows in oestrus during the first week after weaning was less than that of multiparous sows (Martinat-Botte *et al.*, 1984b).

Other factors, e.g. nutrition, genetics and health condition of the sow, interfere with the weaning to oestrus interval and have been reviewed by Fahmy (1981) and Aumaitre (1983).

In herds organized for batch farrowings every 3 weeks, variation in age at puberty, return to oestrus and delayed oestrus after weaning constitute the most important problems.

Control of oestrus

The past three decades of research on control of ovulation have yielded positive results and a programme for controlling oestrus is commercially available.

Induction of puberty

Establishment of reproductive function in young domestic females involves various events in pituitary and ovarian function. Four steps have been distinguished for prepubertal Large White gilts by Camous, Prunier & Pelletier (1985), namely, perinatal (first month of age), infancy (2nd month of age), activation (around 3rd and 4th months of age) and resting (> 4–5 months of age) (Fig. 7). During the last period, the hypothalamus, hypophysis and ovaries seemed to wait for some stimulus which induced the growth of preovulatory follicles. The age at puberty for normal or precocious puberty seemed to be related to age at the beginning of the fourth step (Prunier, 1985). However, for delayed puberty two situations have been observed; very low or very high production of oestrogen (Terqui & Legault, 1984). This perhaps explains the variability observed between hormonal treatments (PMSG, hCG, GnRH, oestradiol) in inducing a fertile ovulation in prepubertal gilts.

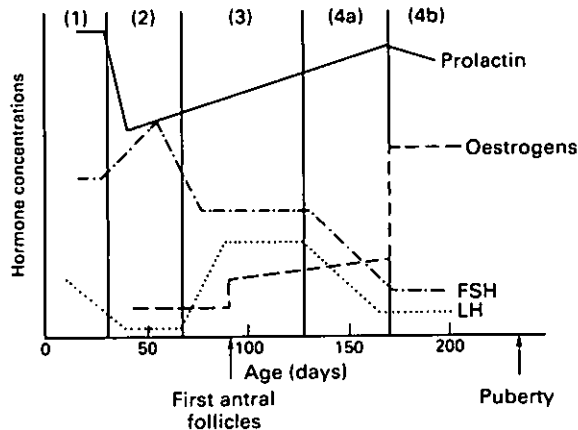


Fig. 7. Endocrine changes from birth to puberty in gilts in the four periods: (1) perinatal; (2) infancy; (3) activation; (4) resting. (From Prunier, 1984.)

Of gilts with delayed puberty (generally 8–9 months old), 60–90% of those treated with PMSG and hCG had an oestrus within 7 days, but only half of the injected gilts displayed a second oestrus within 30 days after the first oestrus (Paquignon *et al.*, 1978; Blichfeldt, 1983). Satisfactory oestrus responses were obtained with PMSG, hCG and FSH when gilts were treated near puberty, but variable fertility and litter size were observed (reviewed by Paterson, 1982). A promising treatment (oestradiol benzoate combined with PMSG and hCG) was proposed by Paterson, Pearce, Foxcroft & Reed (1984).

Control of the oestrous cycle

Historic. The oestrous cycle may be altered by inducing regression of corpora lutea or by suppressing ovarian follicular activity to delay oestrus. In the cyclic sow, prostaglandin F-2 α or its analogues did not induce luteolysis when given earlier than Day 12 or 13 of the oestrous cycle

(Guthrie & Polge, 1976) and these compounds cannot therefore be used to synchronize oestrus in cyclic gilts.

In the past, several orally active progestational agents have been examined in pigs but they often induced cysts and fertility after treatment was reduced (reviewed by Webel, 1978). One of the most promising compounds (methallibure) (Polge, Day & Groves, 1968) was withdrawn from market in 1973 because of its teratogenic effect and this has led to a resurgence of interest in progestagens. The use of progestagens in pigs has been examined and a general schedule for the use of progestagens had been described (Webel, 1976; Martinat-Botte, Locatelli & Mauleon, 1977). The orally active progestagens altrenogest (RU 2267 or allyl trembolone: Webel & Day, 1982; Day, 1984) and oxolven (SA 45249: Zerobin, 1977) have given satisfactory results.

Altrenogest (Regumate: Roussel Uclaf) is being developed in France for synchronizing oestrus in gilts and has facilitated their introduction into the breeding herd.

Use of altrenogest for reproductive management of gilts

Action. Altrenogest suppressed follicular maturation with no detectable effect on the lifespan of corpora lutea when fed at recommended levels (15 or 20 mg daily). At lower doses (2.5 or 5 mg daily) follicular growth was not inhibited and incidence of cystic follicles 10 days after treatment was higher. The hormonal patterns (progesterone, oestradiol, LH) did not differ during and after treatment (18 days) between a low (2.5 mg) and high dose (15 mg) except for oestradiol. In gilts, fed 15 mg daily, plasma oestradiol concentrations remained low during the treatment period, then began to increase the day after withdrawal of progestagen and reached a maximum 3–4 days after treatment. The opposite pattern was observed when the gilts were fed a 2.5 mg dose (Redmer & Day, 1981).

Use of altrenogest in field trials. Since 1983 in France, the efficiency of altrenogest has been tested in different environment and management systems.

Field trials were carried out at 34 different farms located in Poitou-Charentes and over 2 years (1983, 1984 since October). All gilts (1223) were orally treated with altrenogest for a period of 18 days. The treatment began on any day of the cycle after the breeder had controlled puberty. The compound, an oily solution, was packed in a 360 ml pressurized container which had been calibrated to release 5 ml (the daily dose was 15–20 mg/gilt). It was recommended that farmers start feeding the animals and then administer altrenogest on the feed remaining in front of each gilt. Both individual and group feeding was investigated. A comparison of daily dose (15 or 20 mg) has been made. At the end of the progestagen treatment the gilts were allowed boar contact for 4 days or kept away from the boar. Each batch had been allocated randomly to two groups before treatment. Most of the crossbred gilts were inseminated twice (whether in oestrus or not) at Day 6 and Day 7 after the end of progestagen feeding. A previous study has shown that AI on fixed days could be done for crossbred gilts (Martinat-Botte, Bariteau, Bussière, Jobard & Terqui, 1984c). The purebred gilts (Large White and Landrace) were inseminated (twice) at oestrus and 24 h later. Each insemination was performed with 4×10^9 or 6×10^9 spermatozoa by a technician or by farmer (fresh semen, Guelph extender) (Paquignon, Bariteau, Bussière, Dacheux & Courot, 1982; Bariteau, Bussière, Courot & Paquignon, 1984).

For each gilt, genotype, age at start of treatment, the absence or presence of the boar during the progestagen feeding, management and month of AI was recorded. Multivariate analyses of the data were performed (Bachacou, Masson & Millier, 1981).

Oestrus response. By Days 4–8 after treatment, 94% of the gilts exhibited oestrus. Genotype modified this response significantly. For the Large White gilts, the distribution of oestrus was skewed slightly to the right compared with the other genotypes, i.e. Landrace and crossbred gilts (Fig. 8). Treatment at a dose of 20 mg daily gave a synchronization similar to that with 15 mg but oestrus tended to be delayed by about 1 day (Day 6) (Fig. 8), as found by Polge (1982).

Better results were obtained with Landrace and crossbred gilts when a boar was close to the gilts

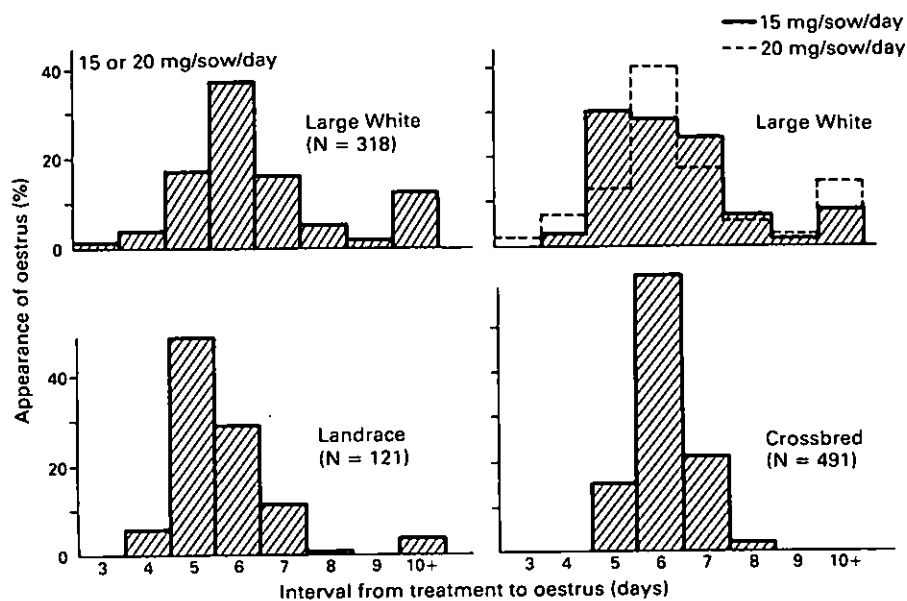


Fig. 8. Appearance of oestrus in gilts treated orally with altrenogest for 18 days. Day 0 = last day of treatment.

Table 2. The effect on gilts (no. in parentheses) treated with altrenogest (18 days orally) on the oestrus response in the presence or absence of a boar during and after progestagen treatment (Day 0 = last day of progestagen treatment)

Boar		% in oestrus Days 4-8		
During treatment	After treatment	Large White	Landrace	Crossbred
Close to gilts	Put with gilts*	78 (46)	100 (10)	94 (175)
Close to gilts	Close to gilts	79 (34)	100 (21)	100 (125)
In same building	Close to gilts	94 (111)	98 (43)	85 (41)
Outside	Outside	—	—	95 (67)

* In the same pen and left from Days 0 to 4.

during and after progestagen treatment; no effect of male stimulation after treatment was observed whatever the genotype (Table 2). Age of gilts on the first day of progestagen feeding did not affect the oestrus response. Synchronization of oestrus was more affected by genotype than by management.

Farrowing rate and litter size at first oestrus after treatment. The close synchronization obtained with altrenogest treatment has led to the use of fixed-time artificial insemination on Days 6 and 7 after the last progestagen feeding and without detection of oestrus. The time for AI has to be modulated according to genotype (Martinat-Botte *et al.*, 1984c).

Fixed-time AI on Days 6 and 7 in crossbred gilts gave normal fertility and litter size only when 6×10^9 spermatozoa were inseminated (Table 3). With this technique, better pregnancy rates were obtained when crossbred gilts were fed individually (Table 4). For Large White gilts inseminated at a detected oestrus, 4×10^9 spermatozoa per insemination can be used but this is not a satisfactory number for Landrace gilts (Table 3).

Whatever the genotype, a seasonal variation in farrowing rate was noted but the decrease was

Table 3. Fertility in gilts (no. in parentheses) after synchronization of oestrus with altrenogest according to their genotype and the number of spermatozoa per insemination

Fertilization	Genotype	4 × 10 ⁹ spermatozoa/AI		6 × 10 ⁹ spermatozoa/AI	
		Farrowing rate(%)	Litter size†	Farrowing rate (%)	Litter size†
Fixed-time AI†	Crossbred	64** (223)	9.8 ± 2.9	73** (221)	9.5 ± 2.8
AI at detected oestrus	Large White	81 (67)	9.7 ± 2.9	83 (77)	9.5 ± 3.2
	Landrace	81* (47)	8.6 ± 3.0	62* (48)	9.7 ± 3.1
	Crossbred	79 (61)	10.0 ± 2.7	75 (24)	10.5 ± 3.8
	Overall total	80 (175)	9.5 ± 2.9	76 (149)	9.9 ± 3.2

† Days 6 and 7 after treatment.

‡ Mean ± s.d. no. of live born piglets.

* $P < 0.05$; ** $P < 0.01$.**Table 4.** Fertility in gilts (no. in parentheses) after synchronization of oestrus with altrenogest by different methods

		Farrowing rate (%)	
		Fixed-time AI†	AI at detected oestrus
Dosage (mg/female/day)	15	70 (198)	74 (165)
	20	69 (264)	79 (193)
Feeding	Individual	73** (336)	76 (239)
	Group	60** (126)	77 (119)
Gilts bred by farmer	Large White	—	79 (73)
	Landrace	—	72 (91)
	Crossbred	76 (33)	86 (43)
Gilts purchased	Large White	—	80 (86)
	Landrace	—	70 (10)
	Crossbred	69 (429)	64 (55)

† Days 6 and 7 after treatment.

** $P < 0.01$.

less important for home-bred gilts than for purchased gilts (Table 5). The age of gilts at treatment had some effect in that, while an earlier treatment had no negative effect, a higher fertility was obtained when gilts were treated between 211 and 240 days of age (Table 6).

Pregnancy rate differed between herds, about 44% of farmers obtaining fertility up to 80%. Nevertheless, this variability was less important than that in previous studies (Martinat-Botte *et al.*, 1984c) in which it seemed that pig breeders had submitted fewer pubertal gilts. Altrenogest was ineffective in impubertal gilts but effective in prepubertal and pubertal gilts (Martinat-Botte, Bariteau, Mauleon, Scheid & Signoret, 1982).

Control of oestrus after weaning

No satisfactory results have yet been obtained in France with an hormonal treatment (PMSG, hCG) due to variability in farrowing rate for the same dose of PMSG and hCG (Martinat-Botte, du Mesnil du Buisson & Mauleon, 1975). Consequently, the effects of a progestagen treatment, in

Table 5. Fertility in gilts (no. in parentheses) after synchronization of oestrus with altrenogest according to month of AI (1-12 = January-December respectively)

Gilts	Fertilization	Farrowing rate (%)			
		Months 1+2+3	Months 4+5+6	Months 7+8+9	Months 10+11+12
Home bred	AI at detected oestrus	82 ^a (72)	75 ^a (57)	78 ^a (50)	85 ^a (28)
Purchased	AI at detected oestrus	79 ^a (47)	73 ^a (45)	65 ^a (49)	90 ^a (10)
	Fixed-time AI†	74 ^a (151)	69 ^b (102)	65 ^b (68)	64 ^c (108)

† Days 6 and 7 after treatment.

Within rows, a vs b, $P < 0.05$; a vs c, $P < 0.001$.

Table 6. Fertility of gilts (no. in parentheses) after synchronization of oestrus with altrenogest according to age of gilts at the beginning of the treatment

Age of gilts (days)	Farrowing rate (%)	
	Fixed-time AI†	AI at detected oestrus
150-180	76 (46)	68 (28)
181-210	65* (247)	79* (87)
211-240	73 (118)	82 (159)
> 241	74* (51)	68* (84)

† Days 6 and 7 after treatment.

* $P < 0.05$.

particular altrenogest at weaning, have been studied to control oestrus in primiparous and multiparous sows.

Previous studies showed that when the progestagen was given orally during the last 7 days of lactation, the synchronization of oestrus after weaning was the same as in controls. When altrenogest treatment started 3 days before weaning, treatment improved synchronization of oestrus but the percentage of sows with delayed oestrus (> 10 days after weaning) was not different between control and treatment groups. A short progestagen feeding period beginning on the day of weaning permitted a reduction in the percentage of delayed oestrus (Fig. 9) and was studied more closely.

Use of altrenogest at weaning in field trials. The trials took place on 32 farms ($n = 2215$, 1982-1984) at which weaning occurred on a fixed date but with a period of lactation ranging from 3 to 7 weeks. The batch of farrowings was divided at random into two groups, controls and treatment, for which sows were fed from the day of weaning for 3 days with 20 mg altrenogest daily. At the end of the progestagen feeding, sows were kept with or without a boar for 4 days. All the sows were inseminated twice at the detected oestrus with 3×10^9 or 6×10^9 spermatozoa per insemination (fresh semen, Guelph extender). For each sow, the number of piglets suckled, age at weaning, genotype, absence or presence of a boar during progestagen feeding and month of AI were recorded. Multivariate analysis of the data was performed with the Amance Software (Bachacou *et al.*, 1981).

Oestrus response. Whatever the parity, a short treatment with altrenogest allowed some improvement in the percentage of oestrus by Days 4-8. Presence of the boar tended to increase the

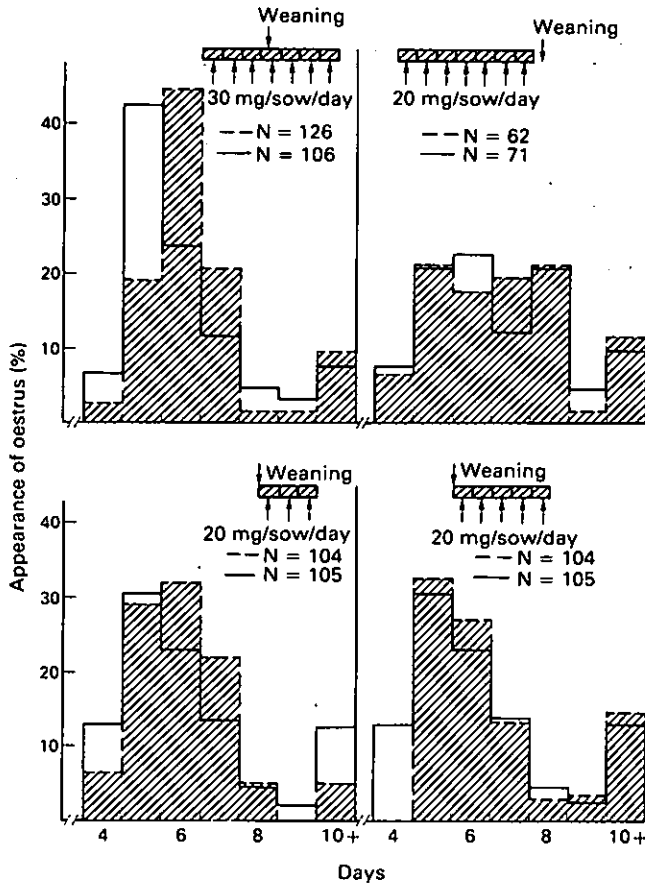


Fig. 9. The effect of altrenogest (Regumate) given during lactation or after weaning on appearance of oestrus in sows. Day 0 = last day of altrenogest feeding in experimental sows (---) and day of weaning in control sows (—).

Table 7. The effect of altrenogest at weaning on the % oestrus response (Days 4–8) of sows (no. in parentheses)

Age at weaning (days)	Primiparous sows			Multiparous sows		
	Controls	Altrenogest + ♂ contact†	Altrenogest‡	Controls	Altrenogest + ♂ contact†	Altrenogest‡
< 20	85 (13)	100 (6)	100 (10)	98 (44)	100 (11)	95 (22)
21–30	90 (138)	100 (67)	90 (77)	96 (342)	97 (162)	95 (173)
> 31	91 (64)	80 (30)	89 (35)	94 (201)	100 (81)	95 (99)
Total	90 (215)	92 (103)	90 (122)	96 (587)	98 (254)	95 (294)

Day 0 was the day of weaning for controls and the last day of progestagen treatment for the experimental sows.

† Treatment with altrenogest (Regumate) for 3 days, beginning on the day of weaning and the boar introduced into the sows' pen and left from Days 0 to 4.

‡ Treatment was given for 3 days, beginning on the day of weaning.

synchronization of oestrus and this was particularly evident for primiparous sows weaned early (< 30 days; Table 7).

Farrowing rate and litter size at first oestrus after treatment. Multivariate analysis indicated an interaction of treatment with the type of insemination (AI by technician or farmer): when AI was performed by the farmer, farrowing rate was significantly lower (69.5% vs 77.9%). These results do not agree with those in a previous report (Bariteau *et al.*, 1984). The data in Table 8 were calculated only when AI was performed by a technician. Whatever the length of lactation, the farrowing rate was similar in treated sows to control sows. There was a slightly larger litter size in primiparous than multiparous treated sows but it was not statistically significant (Table 8). No seasonal variation in fertility was observed and herd variability was small in this sample.

Table 8. Fertility after AI (at oestrus and 24 h later, 3×10^9 or 6×10^9 spermatozoa/insemination) in sows (no. in parentheses) after use of altrenogest at weaning

Parity	Age at weaning (days)	Farrowing rate (%)			Litter size§		
		Controls	Altrenogest + ♂ contact†	Altrenogest‡	Controls	Altrenogest + ♂ contact†	Altrenogest‡
Primiparous	< 20	82 (11)	100 (6)	90 (10)	9.4 ± 3.0	6.3	9.4 ± 2.0
	21–30	75 (105)	67 (49)	76 (68)	9.8 ± 3.1	9.7 ± 2.5	10.4 ± 3.1
	> 31	70 (44)	79 (30)	84 (25)	9.4 ± 2.3	9.4 ± 3.5	10.2 ± 3.2
	Total	74 (160)	74 (85)	79 (103)	9.6 ± 2.9	9.3 ± 2.9	10.2 ± 3.0
Multiparous	< 20	74 (43)	50 (10)	73 (22)	10.0 ± 2.2	9.7 ± 3.4	9.5 ± 2.3
	21–30	79 (333)	79 (152)	76 (167)	9.9 ± 2.8	9.8 ± 2.8	10.0 ± 3.0
	> 31	82 (151)	83 (62)	80 (64)	10.3 ± 3.3	9.4 ± 2.9	10.9 ± 2.9
	Total	79 (527)	79 (224)	77 (253)	10.1 ± 2.9	9.7 ± 2.9	10.3 ± 2.9

† Treatment with altrenogest (Regumate) for 3 days, beginning on the day of weaning and the boar introduced into the sows' pen and left from Days 0 to 4.

‡ Treatment was given for 3 days beginning on the day of weaning.

§ Mean ± s.d. no. of live born piglets.

Pregnancy detection

The increase in our knowledge of reproduction of the sow and the development of technology during the past 2 decades (reviewed by Dyck, 1982) have permitted us to propose several techniques for pregnancy diagnosis.

Detection of oestrus with a boar, the most widely used diagnosis of pregnancy, appeared the best method although variable responses between herds have been recorded (Bosc, Martinat-Botte & Nicolle, 1977). A promising and early pregnancy diagnosis (13–15 days after insemination) by determination of blood concentration of prostaglandins has been proposed (Martinat-Botte, Gautier, Despres & Terqui, 1980). However, the difficulty of blood collection is a limiting factor for development of this technique.

Recently, ultrasound scanning, largely used in human medicine, has been extended to farm animals. (Chevalier & Palmer, 1982; White, Russel & Fowler, 1984; Fowler & Wilkins, 1984). In the sow, Botero, Martinat-Botte & Chevalier (1984) and Inaba, Nakajima, Matsui & Imori (1983) indicated that echography B-mode is reliable for early pregnancy detection. This technique has been tested on farms to check its efficiency (Martinat-Botte, Botero & Bariteau, 1985).

Use of ultrasound scanning. Examinations were carried out by the same operator who had prior experience in interpreting echographic pictures in pregnant and non-pregnant sows (Botero *et al.*, 1984). The apparatus was equipped with a 3.5 MHz transducer. The probe was inserted in a plastic obstetrical sleeve with an aqueous scanning gel. The transducer was then placed against the skin in the area of the abdominal flank of the standing sow or gilt, directed towards the urogenital tract and moved between the first and the third posterior teats. Sows (N = 2257), all presumed to be pregnant, underwent a single echographic examination between 18 and 90 days after insemination. These diagnoses were compared with the real physiological state of the animals at farrowing or at return of oestrus.

The overall accuracy rate averaged 93.2%. For pregnant sows, the accuracy appeared greater after 21 days of gestation than before (99.6% vs 96.6%). The majority of errors occurred between 18 and 21 days of pregnancy in sows that subsequently gave birth to less than 5 piglets. For a litter size of 6 or more piglets, the accuracy was 98.7%. This technique allowed the detection of 54% of non-pregnant sows but the accuracy changed according to the time of examination. At the present time, a high accuracy is obtained when the examination is performed within 7 days of the return to oestrus (80%). Conditions at the time of examination are extremely important.

Table 9. The accuracy rate (%) according to the system of restraint for pregnancy diagnosis of pigs by ultrasound scanning (from Martinat-Botte *et al.*, 1985)

	Day of echography after insemination					Total
	18-19	20-21	22-23	24-25	> 26	
Closed building						
Tethered	90 ^b (113)	93 ^b (239)	96 ^a (265)	95 ^a (134)	96 ^a (633)	95 ^a (1384)
Retention-box	80 ^c (90)	87 ^c (158)	94 ^a (113)	92 ^c (91)	93 ^c (294)	90 ^c (746)
Semi-outdoor building						
Retention-box	67 ^c (9)	80 ^c (40)	94 ^a (18)	100 ^a (13)	96 ^a (47)	89 ^c (127)

Values are % with the no. of examinations in parentheses.

a vs b, $P < 0.05$; a vs c, $P < 0.001$.

Diagnosis can be performed from 20 days after insemination if the sow is tied up during examination and 2 days later if the sow is restrained in a retention box (Table 9). From 22 days after mating, errors are < 5% for positive and negative diagnosis. This technique allows the possibility of other uses such as observation of cystic ovaries and metritis (Martinat-Botte & Botero, 1985).

Nevertheless, ultrasound scanning necessitates a period of learning and adaptation for each operator before it can become a useful tool for breeders.

Practical applications

In pigs, reproductive inefficiency exists due to variation in age at puberty as well as variation in the proportion of animals returning to oestrus and delays in the time taken to return to oestrus after weaning.

For herds organized into batches for farrowings in the French Recording Programme, introduction of gilts is a limiting factor. Under most conditions, 50% of the breeding herd are gilts and only 50% of them become primiparous sows.

A system of reproductive management is being developed in France that involves a sequence of

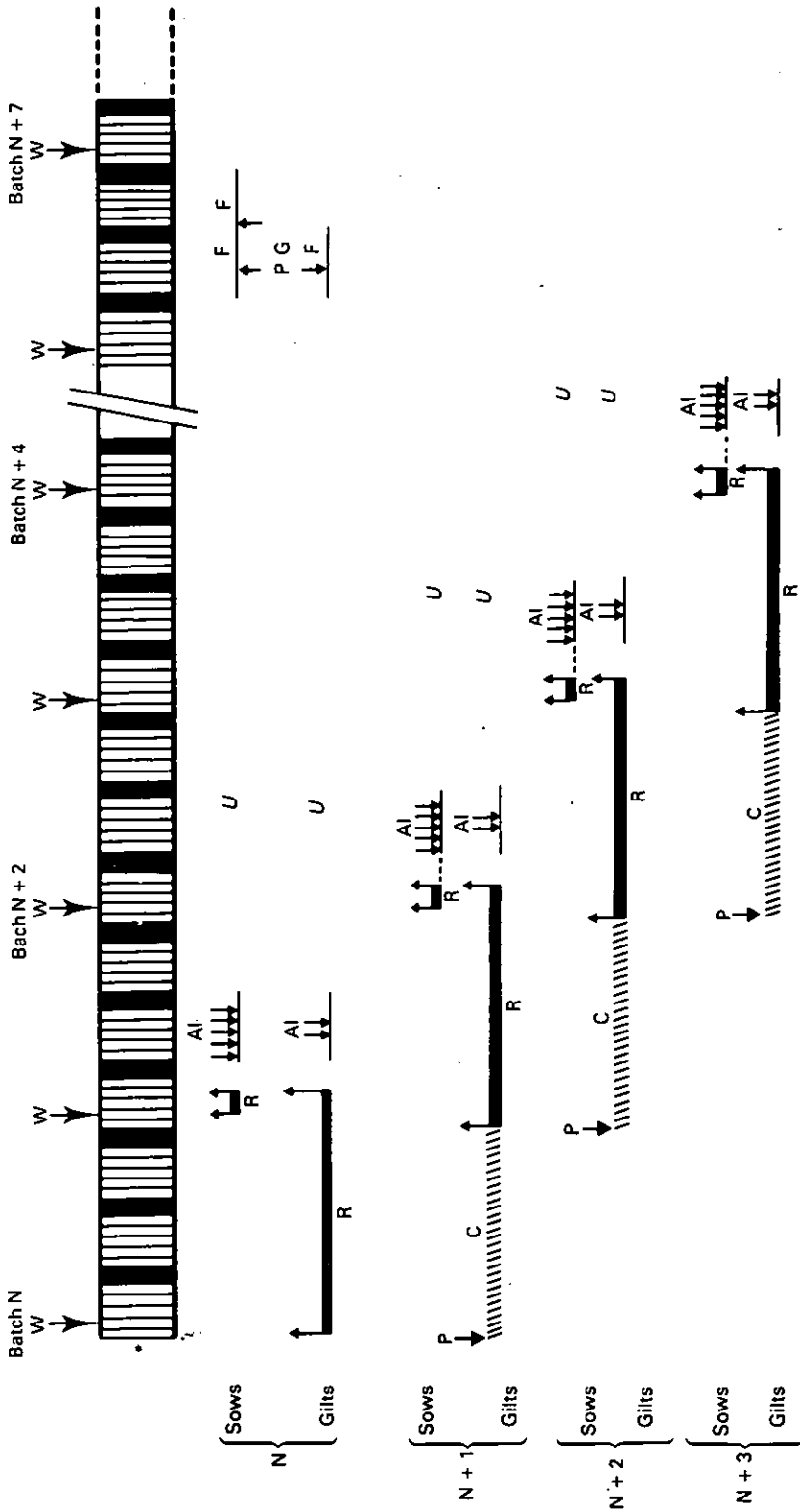


Fig. 10. A proposed management system for sows. R = altrenogest (Regumate); *days of week, solid bars = Saturday and Sunday; AI = artificial insemination; C = control of puberty; U = ultrasound scanning; PG = analogue of PGF-2α; F = farrowing; N = batch identification; W = weaning.

events associated with synchronization of oestrus (using altrenogest), pregnancy diagnosis (with ultrasound scanning) and synchronization of parturition with prostaglandins (Fig. 10). Such a system still needs further investigation to evaluate its real economic impact. However, a main advantage which has been identified is the better organization of labour. In fact, the use of altrenogest for pubertal gilts allows a closer synchronization of oestrus and permits insemination of gilts (crossbred and Landrace gilts have been used and these constitute about 85% of the pig population in France; Dagorn, 1984b) during 2 days (fixed-time AI, Wednesday, Thursday: Fig. 10). High fertility and satisfactory litter size (73% and 9.8 respectively) have been obtained after such treatment.

After weaning, a short treatment with altrenogest associated with the presence of the boar is usually successful in improving synchronization of oestrus and it improves the possibility of using AI on limited days during the week after weaning. Fertility and litter size are similar to those of controls.

Ultrasound scanning is also a useful technique for detecting pregnancy. In this scheme, examinations can be conducted on Friday morning (Fig. 10), 3 weeks after the week of service, and this permits the farmer to place gilts and sows in their pregnancy quarters earlier. PGF-2 α and its analogues are useful to induce farrowing and this use could be incorporated into the scheme. Plans for their use have been proposed to synchronize farrowings on limited days during the week (Bosc, Martinat-Botte, Grouzelle & Hurault, 1977).

With the system proposed for reproductive management in Fig. 10, labour is avoided or reduced during weekends and this permits precise control over the whole pig production process.

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