Experimental and prospective aspects of the utilization of prolific Chineses breeds in Europe

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EXPERIMENTAL AND PROSPECTIVE ASPECTS OF THE UTILIZATION OF PROLIFIC CHINESE PIG BREEDS IN EUROPE.

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I - INTRODUCTION

In november 1979, France imported for experimental purposes 3 breeding pigs (one boar and two gilts) from each of 3 Chinese local breeds Meishan (MS), Jiaxing (JX), Jinhua (JH). These populations had a good reputation in their native land based on exceptional reproductive abilities (PHILIPS & HSU, 1944 ; EPSTEIN, 1969). On the other hand, they were known to have very poor production performances (LEGAULT, 1978).

Because litter size at birth has remained almost constant for the past 20 years (SKJERVOLD, 1979 ; NOGUERA & LEGAULT, 1984 ; OLLIVIER & al., 1986), the main objective of the project was to estimate the interest of these Chinese breeds capacities under intensive western production systems and find the best way for exploiting them.

This review intends to summarize experimental and field results available nowadays and analyze from a theoretical viewpoint different possibilities of utilizing these "new breeds".

II - REPRODUCTION

A - Teat number and age at puberty.

Results first published by LEGAULT and CARITEZ (1983) are presented in table 1. The JX breed exhibits the highest teat number (18,8 ± 1,9) while JH and MS reach 16,1 ± 1,4 and 15,9 ± 0,9 teats respectively. The 3 breeds rank the same way in first generation crosses with Large White (LW) and French Landrace (LF) ; mean values are intermediate and varies from 14,7 in "1/2 MS" to 16,2 in "1/2 JX".

TABLE 1 : Statistics of teat number and age at puberty in females. Number (N), mean (X), standard deviation (sd)

Genotype	Teat number			Age at puberty (d)		
	N	X	sd	N	X	sd
MS	1293	16,1a	1,4	36	81ab	9
JX	472	18,8b	1,9	22	91b	10
JH	214	15,9c	0,9	17	109b	15
MSxLW	1743	14,7e	1,4	38	87a	11
JXxLW	492	16,2a	1,4	40	93ab	13
JHxLW	127	15,1d	1,4	36	96b	14

a,...e : different letters indicate significant differences (P <0,05) between means.

The onset of puberty in purebred gilts occurs as exceptionally early as in China (LEGAULT, 1978 ; ZHANG & al., 1983 ; CHENG, 1983 ; XU, 1985). (mean age at first oestrus varies from 81 ± 9 days for MS to 109 ± 15 j. for JH). Particularly interesting results are those of F1 females, which attain puberty before 100 days of age indicating that age at first oestrus is affected to a large extent (30-40%) by heterosis in Chinese x European crosses. However, biological and economic consequences of an earlier breeding age have not yet been objectively tested.

B - Sow prolificacy and productivity.

Experimental and field results concerning these traits will be presented separately. Results obtained in INRA's experimental herd "Le Magneraud" concern both purebred and different types of "1/2" and "1/4 Chinese" sows and have already led to several publications (LEGAULT & CARITEZ, 1982 ; 1983 ; LEGAULT, 1983). Up to date results for main genetic types of sows are shown in table 2. Under intensive management system (28 days weaning and continuous breeding), MS and JX prolificacy is quite similar to results obtained in China (ZHANG & al., 1983 ; CHENG, 1983) with seasonal breeding rythm and 8 weeks weaning. As quoted by LEGAULT & CARITEZ (1983), two main groups of sows may be distingui - shed according to level of prolificacy ; the "prolific" group includes : purebred MS, JXxMS, and F1 crosses of MS and JX with LW and LF. Poorer performance of JX pure breed is mainly due to low litter size in first parities ; as shown in figure 1, JX sows reach high levels of prolificacy when they become adult.

First results of F1 crosses between so-called "hyperprolific" LW boars (LEGAULT & GRUAND, 1976) and MS sows are in good agreement with theoretical expectations based on results of LEROY & al. (1986) for total number born and number born alive, but not for number weaned which is below these expectations. These results need however to be confirmed on a larger sample of data. As indicated in table 2, using F1 MS or JX instead of European sows allows an increase of litter size of about 4 piglets born and more than 3 piglets weaned, which leads to an improvement of numerical productivity (number of piglets weaned/sow/year) of 7 to 9 units.

Litter weights at birth and 21 days present important bot not surprising interactive effects between litter sire and dam breeds (see figure 2). "1/2 MS" and "1/2 JX" exhibit the heaviest litter weights at birth, but also at weaning, which is a sign of their excellent milking abilities.

Crossbreeding genetic parameters (DICKERSON, 1969, 1973) between MS and LW have been estimated for litter traits according to standard methods (ALENDA & al., 1981 ; QUINTANA & ROBISON, 1983 ; BRUN & ROUVIER, 1984) using all available data. Results are presented in table 3. These are only rough estimates because all genetic types were not true contemporaries. However, as first noted by LEGAULT (1985), LW x MS crossbred sows exhibit exceptionally high levels of maternal heterosis (from 17% for total number born to 21% for number weaned), while direct heterosis is rather consistent with standard values (SELLIER, 1976, 1982 ; JOHNSON, 1981). In other respects, the most important part of the difference between the two breeds is due to direct additive genetic effects, thus indicating large favourable additive effects of MS embryo and piglet viability.

TABLE 2 : Least squares estimates of litter traits in different types of crosses between European and Chinese breeds.

Genetic type of the dam	N	litter size (L.S. means ± s.d.) Total number born	Number born alive	Number weaned
JX	173	11,88 ± 0,4	11,30 ± 0,32	10,18 ± 0,30
JH	44	12,06 ± 0,62	11,56 ± 0,58	9,69 ± 0,55
MS	305	15,55 ± 0,27	14,52 ± 0,26	13,04 ± 0,24
LW	132	12,41 ± 0,44	11,53 ± 0,41	10,13 ± 0,39
LF	23	10,01 ± 1,03	9,81 ± 0,97	9,14 ± 0,91
JXxMS	37	17,62 ± 0,64	15,80 ± 0,61	13,04 ± 0,57
LWxMS	71	16,81 ± 0,51	15,76 ± 0,48	14,81 ± 0,46
LW(hyper)xMS	72	17,40 ± 0,55	16,36 ± 0,52	14,27 ± 0,49
LWxJX	11	18,59 ± 1,20	15,74 ± 1,13	14,55 ± 1,06
MSxLW	70	15,96 ± 0,51	15,23 ± 0,49	13,56 ± 0,46
JXxLW	19	16,11 ± 0,96	15,44 ± 0,91	13,92 ± 0,85
JHxLW	11	12,54 ± 1,24	11,59 ± 1,16	10,38 ± 1,10
MSxLF	19	15,59 ± 0,95	14,02 ± 0,89	13,09 ± 0,84
JXxLF	21	17,22 ± 0,94	16,27 ± 0,88	14,39 ± 0,83
JHxLF	11	13,65 ± 0,65	13,02 ± 1,14	11,32 ± 1,07
1/4 CH	64	13,60 ± 0,65	12,34 ± 0,61	11,02 ± 0,58
overall	1083	13,89	13,02	11,68

LW (hyper) : LW boar from the "hyperprolific" line.
The model includes the effects of batch, parity (1, ..., 5), dam and sire genotypes.

TABLE 3 : Crossbreeding experiment between Large White and Meishan breeds. Estimated Dickerson's crossbreeding genetic parameters for litter traits.

Parameter (or contrast between parameters)	Litter size		
	Total number born	Number born alive	Number weaned
$x^o_{MS} - x^o_{LW}$	2,15 ± 0,86	2,42 ± 0,80	2,49 ± 0,76
$x^m_{MS} - x^m_{LW}$	1,47 ± 0,88	1,34 ± 0,82	0,31 ± 0,78
$x^n_{MS} - x^n_{LW}$	0,70 ± 0,61	0,65 ± 0,57	1,38 ± 0,54
h^o	0,84 ± 0,49	0,97 ± 0,46	0,98 ± 0,44
h^m	2,60 ± 0,38	2,68 ± 0,5	2,60 ± 0,34

x^o_{MS} , x^o_{LW} : direct additive genetic effects for MS and LW breeds, respectively.

x^m_{MS} , x^m_{LW} : maternal additive genetic effects for MS and LW breeds, respectively.

g^n , g^n : grand-maternal additive genetic effects for MS and LW breeds, respectively.

h^o : direct heterosis effect.

h^m : maternal heterosis effect.

Studies on prolificacy have been completed by two field evaluation programs. In a first one "half Chinese" sows ("1/2 MS" and "1/2 JX") have been compared to European contemporaries (80% of which were Large White x Landrace) in 18 production farms (BRUEL & al., 1986). Results shown in table 4 confirm the experimental ones with an advantage of 3 piglets born/litter for "half chinese" : but the corresponding advantage at weaning is less than in table 2, with an average superiority of "1/2 Chinese" sows of 2 piglets or 5,4 weaned piglets/sow/year.

In the second program, comparaisons are based on "1/4 Chinese" ("1/2 Chinese" sows x LW boar) and European contemporaries (GUEBLEZ & al., 1986). Differences in prolificacy between the two genetic types are inferior to results obtained in "Le Magneraud" (see table 2) ; from 0,4 to 0,9 weaned piglets/litter, corresponding to an advantage in numerical productivity varying from 1 to 2,3 weaned piglets/sow/year.

C - Ovulation rate and embryo survival.

The origin of MS high prolificacy has been investigated through analysis of its physiological components, ovulation rate and embryo survival. ROMBAUTS & al. (1982) have shown that MS gilts were characterized by moderate ovulation rate, quite similar to LW gilts at the same age, suggesting that MS important litter sizes was mainly due to low embryo mortality.

This hypothesis has been confirmed by BOLET & al. (1986) who compared MS, control LW and so-called "hyperprolific" LW sows (LEGAULT & GRUAND, 1976). As shown in figure 3, MS females have the same ovulation rate as control LW, but a lower embryonic mortality (16% against 26%). On the contrary, the "hyperprolific" sows advantage over control LW stems from an increase in ovulation rate.

III - PRODUCTION TRAITS

As for prolificacy, two sources of data are available for production traits : some originate from INRA's experimental herds, others from central testing stations.

A - Growth and carcass traits

First results on growth and carcass performances of pigs from 2 -and 3- way crosses involving the three Chinese breeds have been presented and discussed by LEGAULT & al. (1985). MS breed appeared as the most interesting one : reduction of gross margin from fattening "1/4 MS" is 27% and 42% lower than from "1/4 JX" and "1/4 JH" respectively when compared to European control pigs. That is the reason why records from central testing stations mainly concern MS breed (BRUEL & al., 1986 ; GUEBLEZ & al., 1986) and the results summarized in table 5 are limited to MS. Comparisons have been conducted within sire ; observed differences correspond to half of the genetic difference between dam sows, i.e., European control and "1/2 MS" in the first two studies, European control and "1/4 MS" in the third one. Decrease in average daily gain of "1/4" and "1/8 MS" pigs ranges from 22 to 28 g/day and goes along with an increase in food conversion ratio of 0,07- 0,23 kg/kg feed for "1/4 MS" and 0,06 kg/kg feed for "1/8 MS". Reduction in killing out percentage varies 0,4 to 0,7%. At last, Chinese crossbred pigs carcasses are characterized by lower muscle and higher fat contents which is expressed by a decrease in estimated carcass lean percentage of 3,5 -4,2% in "1/4 Chinese" and 2,5% in "1/8 chinese" pigs.

Table 4 : Field comparison of "1/2" and "1/4 Chinese" sows to European contemporaries

	genotype	number of litters	total born	born alive	weaned	weaning fertilisation interval(j.)	numerical productivity
a	"1/2 chinese"	322	14,0	13,3	11,0	7,5	26,5
	control		11,1	10,4	9,0	12,9	21,1
	"1/2 chinese"	319	14,2	13,4	10,9	9,2	26,1
b	control		11,1	10,4	9,0	13,4	21,0
	"1/4 chinese	215	11,8	11,3	9,4	9,5	22,5
c	control		11,0	10,4	9,0	14,1	20,9
	"1/2 chinese"	127	14,7	13,9	11,0	10,3	26,2
d	"1/4 chinese"	69	12,2	11,7	10,1	9,5	24,2
	control		11,3	10,6	9,2	12,6	21,7

a : BRUEL & al. (1986).
b, c, d : GUEBLEZ & al. (1986).
b : records from 18 production farms with "1/2 chinese" sows only.
c : records from 12 production farms with "1/4 chinese" sows only.
d : records from 8 production farms with "1/2 and 1/4 chinese" sows.

TABLE 5 : Central testing results ; within sire comparison of "1/4" and "1/8 Meishan" slaughter pigs.

Reference	LEGAULT et al., 1985		BRUEL et al., 1986		GUEBLEZ et al., 1986	
Genetic type	control	"1/4MS"	control	"1/4MS"	control	"1/8MS"
variables						
Number of animals	85	93	77	76	100	101
Average daily gain (g)	818a	790b	858a	836a	852a	825b
Food conversion ratio (kg)	3,40a	3,63b	3,00a	3,07a	2,92a	2,98a
Dressing out %	78,3a	77,9a	77,8a	77,1b	78,9a	78,3b
Carcass length (mm)	970a	958b	998a	988a	995a	992a
Ham (kg)	8,86a	8,39b	8,83a	8,27b	8,97a	8,55b
Loin (kg)	11,20a	10,47b	11,94a	11,02b	12,17a	11,59b
Backfat (kg)	4,72a	5,21b	4,15a	4,80b	4,09a	4,42b
Lean %	49,1a	45,6b	53,6a	49,4b	54,2a	51,7b
Reflectance	390a	369b	635a	587b	613a	614a
Imbibition time	9,9a	10,9a	8,9a	9,9a	11,1a	11,2a
Ultimate pH	5,61a	5,66a	6,01a	6,04a	6,04a	5,99a

a, b : Least square means with different letters significantly differ ($P < 0,05$).

Killing out and estimated lean carcass percentages of pure - breeds have been extrapolated from experimental records assuming additivity of genetic effects (LEGAULT & al., 1985 ; figure 4). Estimated lean carcass percentage of MS and JX are 22-24% lower than Piétrain (P) and Belgian Landrace (LB) breeds and 16-18% lower than LW and LF. JH breed is fatter than JX and MS, but with a higher killing out percentage.

Another characteristic of Chinese breeds is the profile of their backfat layer (figure 5): rump fat thickness is significantly higher than backfat thickness contrary to P breed and unlike LW breed which exhibits no difference between the two sites of measurement.

B - Technological and eating qualities of meat.

The 3 standards estimators of meat technological yield : ultimate pH, reflectance and wetting time show a trend in favour of "1/4 chinese" (table 5), but the only significant difference concerns reflectance. The meat quality index of JACQUET & al., 1984) that predicts the technological yield of Paris cooked ham processing is improved by about 1 percentage point in "1/4 Chinese" compared to control European pigs. Differences between "1/8 Chinese" and control are small and non significant.

Two comparisons of meat eating qualities of "1/2" and "1/4 Chinese" with European control have been conducted (TOURAILLE & al., 1983, 1985) using the following criteria : tenderness, juiciness flavor.

As indicated in table 6, results are clearly in favour of "1/2 Chinese" for the 3 criteria but differences are no more significant for "1/4 Chinese".

Table 6 : Eating qualities of meat

reference	genotype	criteria		
		tenderness	juiciness	flavor
TOURAILLE et al. 1983	Px (MS or JX)	5,7a	4,6a	5,2a
	P x P	4,1b	3,3b	4,5b
TOURAILLE et al., 1985	LW x MS	6,0a	4,3a	4,9a
	LWx (MSxLW)	5,2b	3,5b	4,4b
	LW x LW	5,2b	3,3b	4,3b

P : Piétrain - LW : Large White - MS : Meishan - JX : Jiaxing
a, b.- Different letters indicate significant differences (P< 0,05) between estimates.

IV - Some possible ways for exploiting Chinese breeds.

Because discontinous crossing plans are an easy way for taking advantage of Chinese breeds high prolificacy over a short term period, experimental evaluation of their interest in French pig industry has focused since 1980 on this aspect. Other routes can yet be planned for exploiting their potentialities. SELLIER & LEGAULT (1986) have briefly presented and discussed some of these :

- creation and selection of a composite line including Chinese genes.
- search and utilization of a putative "major gene".

In the light of the above results, various approaches including creation of a composite dam line, discontinuous and continuous crossing plans are studied and compared at demographic equilibrium. Two criteria have been used for comparison.

1 - a profit function P (MOAV, 1966) has been constructed using DICKERSON's crossbreeding genetic parameters :

$$P = y - c / nx$$

y : gross margin from fattening slaughter pigs. y as been evaluated as a linear function of average daily gain (ADG), food conversion ratio (FCR), muscle weight (MW) and meat quality index (MQI).

$$y = \underset{\sim}{a}'.\underset{\sim}{Y}$$

$\underset{\sim}{a}$ vector of economic weights, $\underset{\sim}{a}' = (0.136 \; -127.5 \quad 8 \quad 3.8)$

$\underset{\sim}{Y}$ vector of predicted production performances of slaughter pigs

$$\underset{\sim}{Y}' = (ADG \; FCR \; MW \; MQI)$$

c : yearly cost of a sow. In order to take into account the reduction in food intake during lactation for Chinese crossbred sows (LEGAULT & CARITEZ, 1983), c is supposed to have the following form :

$$c = Co - n.P_{MS}.f$$

Co : yearly cost of a European sow

P_{MS} : proportion of MS genes in the sow

f : economic value of the reduction in food intake in pure MS sows.

n : number of litters/sow/year

x : predicted prolificacy of slaughter pigs dam

y and x are functions of crossbreeding genetic parameters - see next section for an example.

2 - a criterion defined by DICKERSON (1973) :

$$R = N_f / (1000.N_{PC})$$

N_f : total number of breeding females at the different levels of the crossbreeding system

N_{PC} : number of market pigs of standard net value sold per year.

Values of crossbreeding genetic parameters for the different breeds involved have been inferred from Table 3 and data from SELLIER (1986 - table 17 and 18), assuming mean values of (SELLIER, 1976) for heterosis on production traits.

A - Creation of a composite line including Chinese genes.

Profit function approach has been used to assess the optimum percentage of Chinese genes in a composite dam line. Under the hypothesis of no recombination loss and with n breeds contributing to the line, the two components x and y of the profit function can be written as follows (KINGHORN, 1982) :

$$x = x_M + 0.5\, x_T + \underset{\sim}{P}'\underset{\sim}{X} + \underset{\sim}{P}'\underset{\sim}{H}\,\underset{\sim}{P}$$

where

$$\underset{\sim}{P} = \begin{bmatrix} p_1 \\ p_2 \\ . \\ . \\ p_n \end{bmatrix} \qquad \underset{\sim}{X} = \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ x_n \end{bmatrix} \qquad \underset{\sim}{H} = \begin{bmatrix} 0 & h_{12} & \cdots & h_{1n} \\ h_{21} & 0 & & \\ . & & & . \\ . & & & h_{n-1n} \\ h_{n1} & \cdots & & 0 \end{bmatrix}$$

- x_M : general mean

- x_T : direct additive genetic effect of terminal sire breed T

- $\underset{\sim}{P}$: proportion of breed genes in the dam line

- x_i : $0{,}5\, x_i^o + x_i^m + x_i^n + h_{Ti}^o$

with x_i^o, x_i^m, x_i^n direct, maternal and grand-maternal additive effects respectively for breed i, and h_{Ti}^o the direct heterosis in crosses between T and i breeds

h_{ij} : maternal heterosis effect between i and j breeds (as expressed in F1 crosses)

The expression of y is simpler as production traits are supposed not to be affected by maternal heterosis :

with $y = \underset{\sim}{a}' . (Y_1\ Y_2\ Y_3\ Y_4)$

$$Y_j = Y_{Mj} + 0.5\, Y_{Tj} + \underset{\sim}{P}'\, \underset{\sim}{Y}_{Dj} \qquad j = 1, \ldots, 4$$

Y_j : performance of slaughter pigs for trait j

Y_{Mj} : general mean for trait j

Y_{Tj} : direct additive genetic effect of T for trait j

$\underset{\sim}{Y}'_{Dj} = (Y_{1j} \ldots\ Y_{nj})$

with $Y_{ij} = 0{,}5\, Y_{ij} + h_{Tij}$,

Y_{ij} : direct additive genetic effect for breed i and trait j

h_{Tij} : direct heterosis between T and i breeds for trait j

The optimum $\underset{\sim}{P}$ vector is obtained by derivating the profit function with respect to $\underset{\sim}{P}$ and equating the first derivatives to 0. This procedure generally (but not always) leads to the optimal solution (see KINGHORN, 1982, for a discussion).

Only two breeds composite lines have been investigated under various economical and management conditions. The different breeds involved have been supposed to exhibit the same levels of heterosis when

Table 7 : Proportion of Meishan genes in a synthetic two-breed dam line leading to an optimal profit under various economic and management conditions.

Terminal sire breed	LB				B(*)	
Breed B of the other component of the synthetic line	Co = 4500		Co=4000	Co=5000	Co = 4500	
	n=2	n=2,3	n = 2,3		n=2	n=2,3
LW	0,25	0,20	0,16	0,24	0,34	0,29
LF	0,29	0,24	0,20	0,28	0,39	0,34
DU	0,34	0,29	0,25	0,32	0,43	0,39
LWH	0,13	0,08	0,05	0,12	0,23	0,19

LW : Large White LF : French Landrace DU : Duroc
LWH : "hyperprolific" Large White LB : Belgian Landrace
Co : yearly cost of a European sow (see text)
n : number of litters/sow/year
(*) terminal sire breed is the same as B component of MS x B synthetic dam line.

crossed with MS breed. Main results are shown in table 7 and figure 6.

When linearity between gross margin and carcass lean percentage (CLP) is assumed optimal proportion of MS genes (p_{opt}) varies over a wide range of values (5-43%) with two main sources of variation.

- the second component of dam line
- the crossbreeding system (e.g. utilization of a third breed as sire breed or not).

However, this only holds within a limited range of CLP values (47-53%) where above mentioned linearity remains valid. As emphasized by BRUEL et al. (1986), economical calculations involving Chinese breeds should consider the non linearity of this relationship. Figure 7 shows its effects on p_{opt} and stresses the importance of the sire breed choice.

Epistatic recombination losses, if present, tends to decrease MS contribution to the composite line (table 8). Their importance however still remains to be proved.

Table 8 : Effect of epistatic recombination loss on proportion of MS genes in a synthetic LW x MS dam line leading to an optimal profit.

e	$h^m/4$	$h^m/2$	h^m
2	0.21	0.15	0
2.3	0.15	0.09	0

n : number of litters/sow/year
e : maximum epistatic recombination loss (see (KINGHORN, 1980 ; X and Z hypothesis)
h^m : maternal heterosis.

Profit loss due to using non optimal proportions of MS genes also needs to be considered. This has been done with 3 p values : 0, 0.25 and 0.5. As shown in figure 7, the use of MS genes in a composite dam line provides an additional profit ranging from 1.6 to 18% according to the second component of the dam line. The deviation from maximal profit when using "1/2 Chinese" composite lines range from 1.8 to 5%, whereas "1/4 Chinese" lines lead to nearly optimal profit in most cases. Moreover, mean superiority of "1/2 Chinese" lines over purebreeds is only 2.3 % while it is 9.4% for "1/4 Chinese" lines. 25% may therefore be considered as a basic proportion for two breed composite lines.

Some limits to this approach have yet to be pointed out

- subsequent selection of the composite line is not considered, though it might influence the choice of p.
- more precise estimates of genetic parameters are still missing.

B - Comparison of different crossing plans

Comparisons of discontinuous (e.g. MS, 1/2 MS, "1/4MS" and LW x LF dams with either LW or LB sires) and continuous (crisscrossing) crossing plans with those using synthetic dam lines are presented in figure 8.

DICKERSON's and MOAV's criteria lead to quite similar results with a rank correlation of 0,72.

Plans with a specialized sire breed reach the highest profits mainly due to a better utilization of heterosis effects. Their mean superiority over plans using LW boars is around 4%.

Ranking of dam genotypes is in descending order : LWxMS, "1/4MS", LW composite line, LF composite line, DU composite line, LWxLF. Poor ranking of dam composite lines with regard to discontinuous crossing plans has to be counterbalanced by other considerations such as - discontinuous crossing plans require the maintenance and selection of a purebred Chinese nucleus of sufficient effective size, and this may cause problems as emphasized by SELLIER & LEGAULT (1986)

-an increase in genetic variance and therefore in selection response for production traits may be expected in a composite line.

When compared to LWxLF, results are undoubtedly in favour of types including MS genes, with an advantage over LWxLF ranging from 0.9% to 9,9%, but need to be tempered :

- the non linearity of CP-gross margin relationship acts in favor of LWxLF when no high muscled sire breeds are used.

- epistatic recombination is not considered

- as pointed out by KING & AVALOS (1986), breeds cannot be regarded as non changing entities. This is particularly true for production traits in European breeds, so that difference with Chinese breeds (in which no selection presently occurs) is increasing each year, thus reducing their interest under current economic conditions. Based on data of TIXIER & SELLIER (1986), advantage of "1/2MS" sows has been reduced by around 14% between 1980 and 1986.

C - Searching for a "major gene"

Several hypothesis have been brought forward to explain the origin of the high prolificacy of Taihu breeds (SELLIER & LEGAULT, 1986). Among them, the involvement of a major gene is an attractive one whose interest is greatly enhanced by recent developments of genetic engineering techniques.

ROBERTS % SMITH (1982) have reviewed methods for detecting individual genes with large effects on quantitative traits ; more recently, FAMULA (1986) has proposed techniques for traits described by mixed models. However, all these methods require large numbers of data and considerable experimental means will undoubtedly be needed for testing this hypothesis.

V - CONCLUSION

Because of its economic importance, prolificacy has been the main axis of French studies on Chinese breeds. Numerous data are now available ; experimental results indicate that MS breed can bring an additional profit of 9% ; field records, which are presently only preliminary results are less favourable. Further investigations are needed to determine the cause of these poorer field results and to define the optimal use of MS prolificacy. They include a more precise estimation of crossbreeding genetic parameters which is in process at the present time.

Other capacities of these Chinese breeds, such as their early maturity or their ability to eat rough fourrage are worth being more precisely studied. Those extreme genotypes also offer a very interesting tool for more accurate investigations, for instance physiological studies on embryonic mortality.

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Figure 1 : Comparative variation of litter size according to parity in different genotypes of sows.

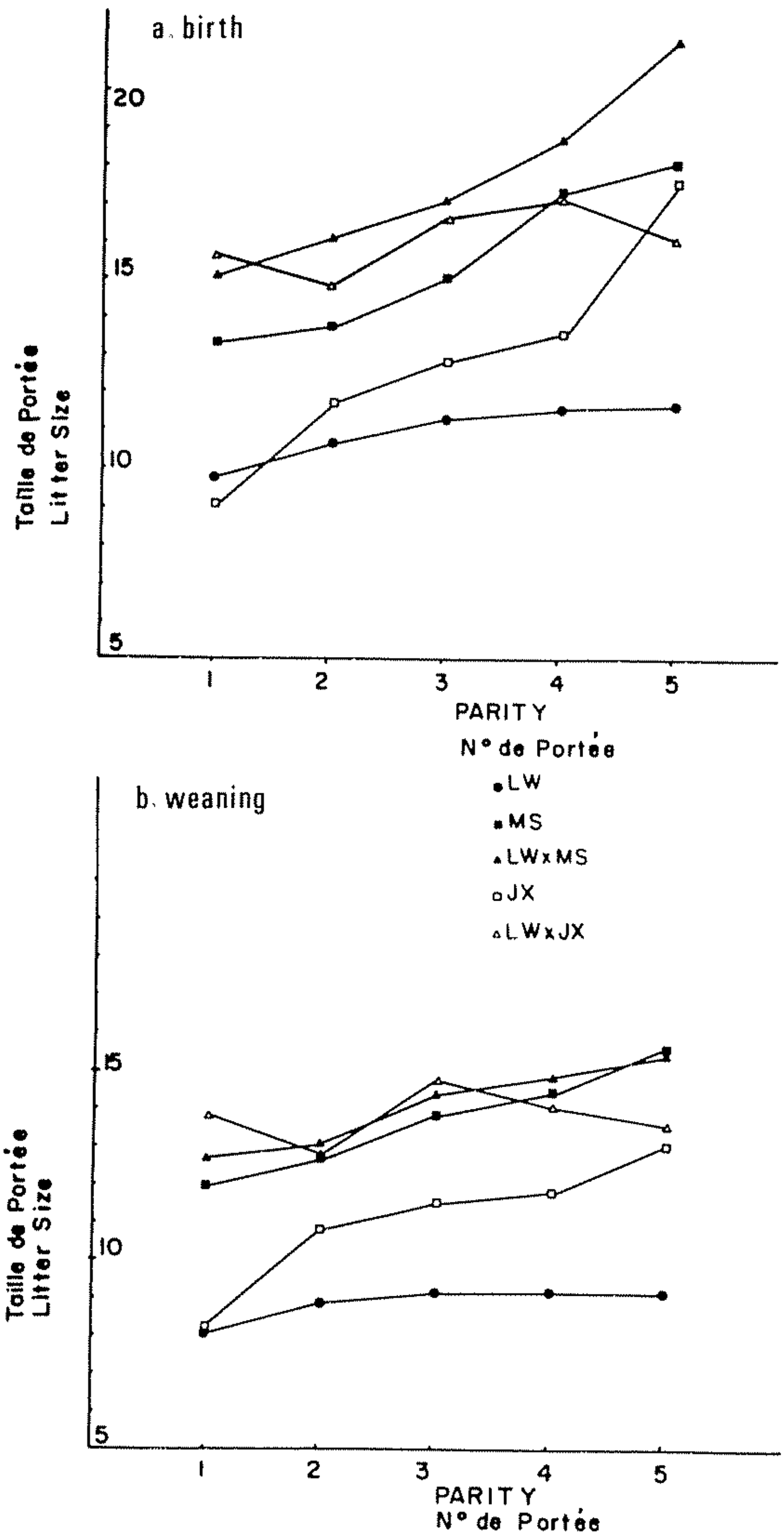
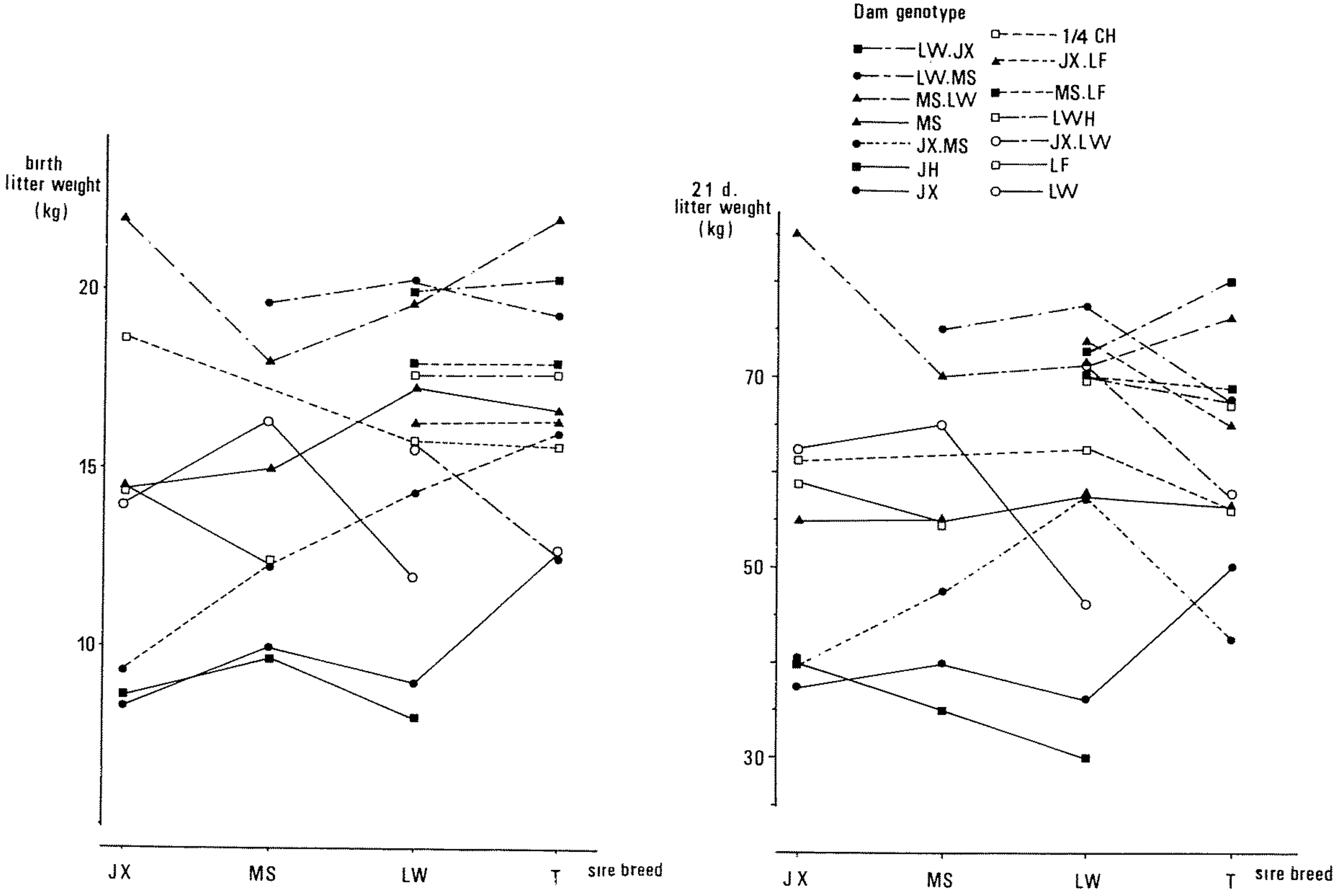


FIGURE 2 : Variation in litter weight according to sire and dam genotypes.



MS : Meishan,   JX : Jia Xing   LW : Large White   LWH :"hyperprolific"Large White

LF : French Landrace   T : Terminal sire breed (Piétrain + Belgian Landrace)

Figure 3 : Comparative ovulation rate and embryonic mortality of control Large White, "hyperprolific" Large White and Meishan sows (from BOLET et al., 1986).

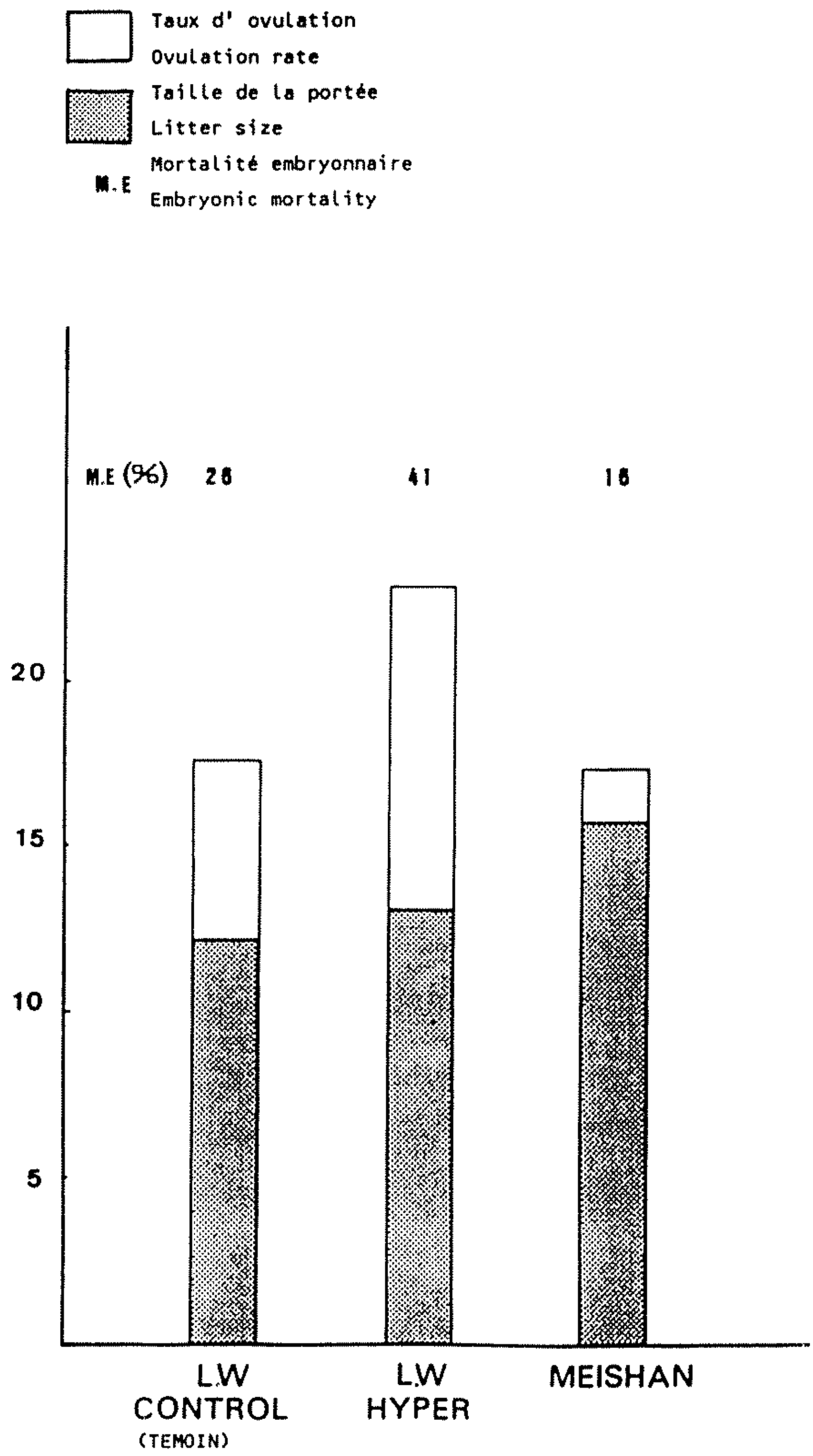


Figure 4 : Presumed position of the 3 Chinese pure breeds, as compared to the main breeds used in France, in killing out percentage and estimated lean percentage (EEC reference)

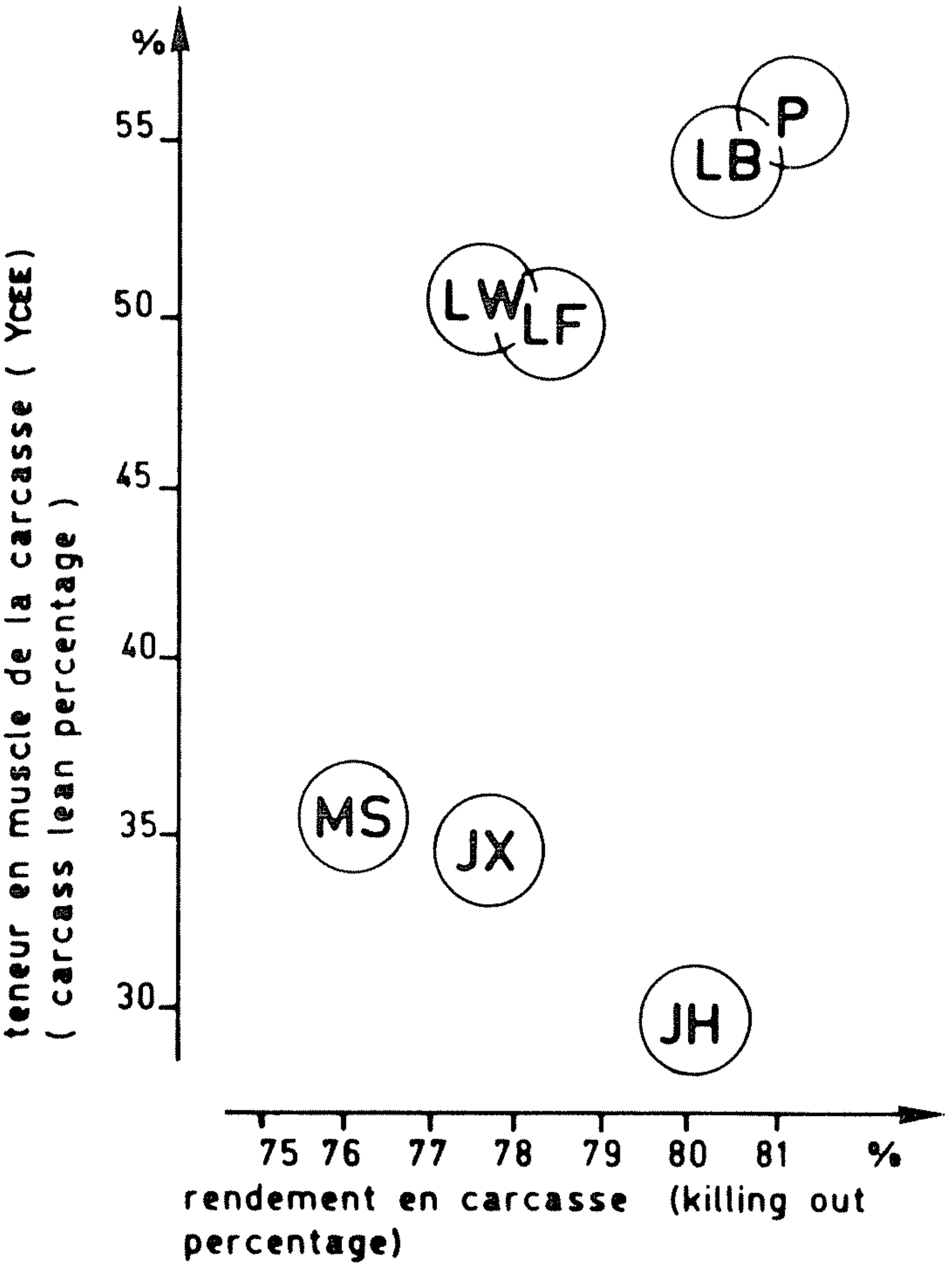


Figure 5 : Profile of the backfat layer in the Meishan, Jiaxing, Large White and Piétrain pure breeds.

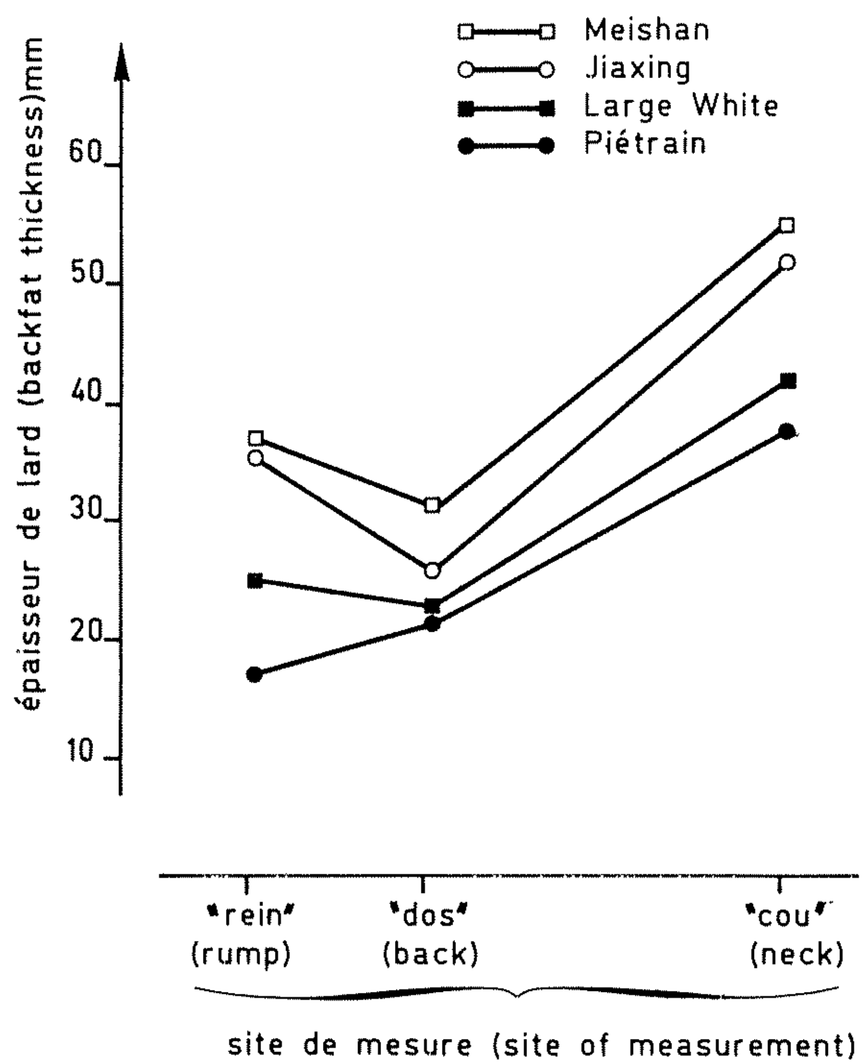
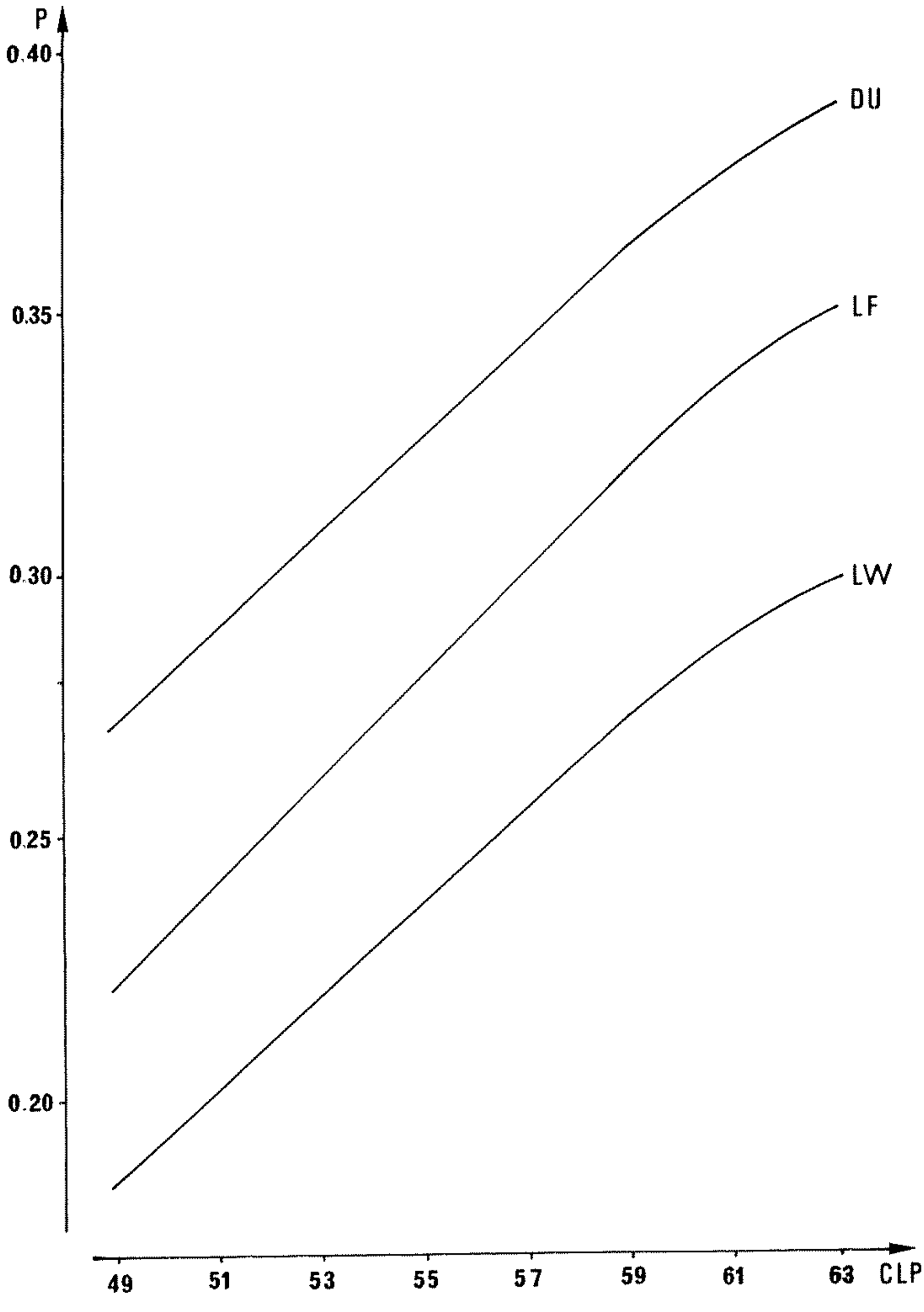
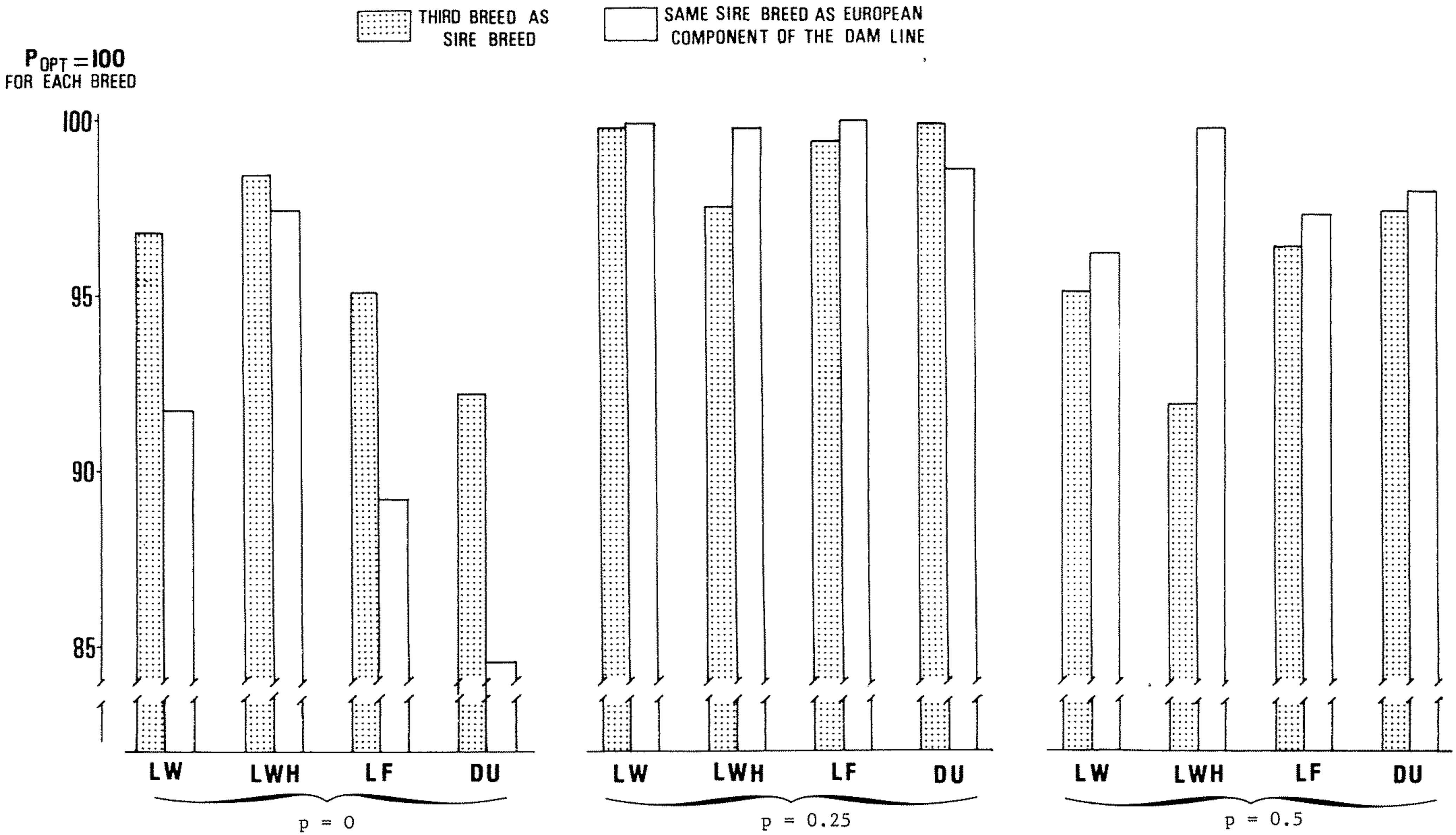


FIGURE 6 : Effect of carcass lean percentage of the terminal sire breed (CLP) on optimum proportion of MS genes (P) in a composite dam line



LW, LF, DU : second component of the dam line
LW : Large White   LF : French Landrace   DU : Duroc

FIGURE 7 : Compared efficiency of various proportions of MS genes (P) in a dam composite line.

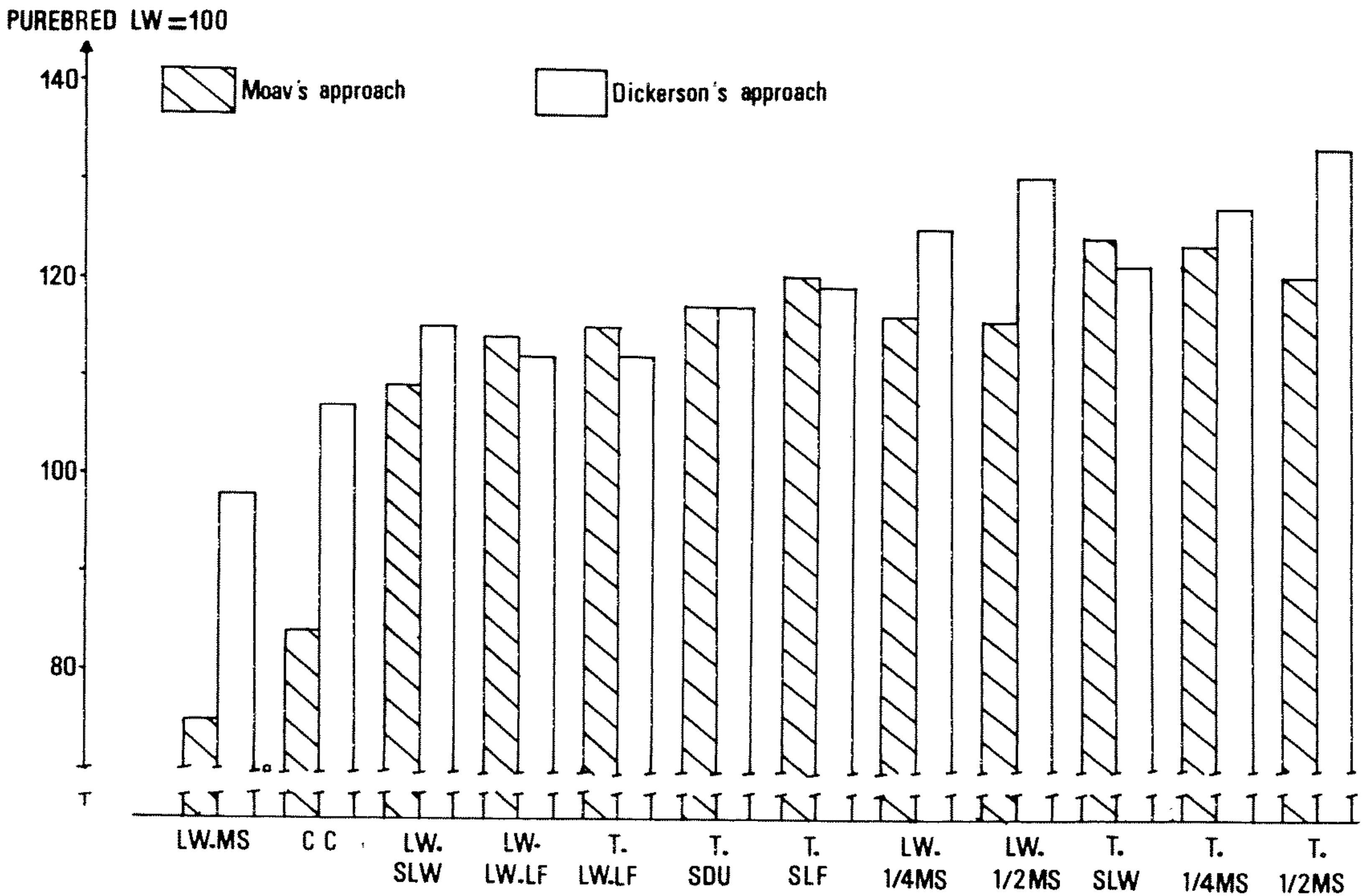


LW, LWH, LF, DU : other component of the dam line

LW : Large White LWH : "Hyperprolific" Large White LF : French Landrace DU : Duroc

Popt : proportion of MS genes leading to an optimal profit

Figure 8 : Comparative efficiency of different crossing plans.



LW: Large White ; MS: Meishan ; LF: French Landrace ;
CC: Crisscrossing ; SLW: Composite LW line ; SDV: Composite Duroc line ;
SLF: Composite LF line ; T: Terminal sire breed.

37th Annual Meeting of the European Association for Animal Production - Budapest, Hungary, September 1-4, 1986.

EXPERIMENTAL AND PROSPECTIVE ASPECTS OF THE UTILIZATION OF PROLIFIC CHINESE PIG BREEDS IN EUROPE.

Commission on Animal Genetics
Session III - Selection for reproductive performance in pigs.

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SUMMARY :

A study of Chinese pig breeds has been conducted in France since 1980 on INRA research farms and recently a field evaluation program was set up in a sample of French commercial farms.

Experimental results show that using an F1 (Large White x Meishan) sow may lead to an increase of 3.7 and 3.5 piglets born and weaned per litter and to an increase of 8.4 piglets weaned per sow and per year. Corresponding values for 18 production herds were 2.9, 2.0 and 5.4 piglets, respectively. This improvement of numerical productivity of F1 sows reduced the cost per weaned piglet within a range of 25 to 35 %. From the comparisons available so far, the use of 1/4 Chinese and 3/4 European sows has led to an increase of 2.5 units or so in the number of piglets weaned/sow/year, thus reducing the piglet cost by about 11 %.

Production performances of 1/4 and 1/8 chinese terminal products analysed in research herds and progeny testing stations were rather homogeneous. The growth delay was generally low and non significant (2 to 5 %). Feed conversion ratio increased by 0.07 to 0.23 kg in 1/4 chinese and by 0.06 in 1/8 chinese. Carcass lean percentage was reduced by 4 to 4.2 % in 1/4 chinese and by 2.5 % in 1/8 chinese. The handicap of purebred chinese breeds relative to their Large White and Landrace counterparts was located between 16 and 20 % in carcass lean content. Meat quality was improved, moderately for technological yield (about 1 %) and more markedly for organoleptic qualities.

On the basis of these results, we studied the optimization of crossbreeding schemes, involving the Meishan breed as component of a maternal line. Various crossbreeding systems, either discontinuous (1/2 or 1/4 chinese dams) or continuous (composite dam line) were compared in demographic equilibrium conditions. Using current crossbreeding parameters, MOAV'S (1960) and DICKERSON'S (1973) approaches led to similar results. The optimal proportion (p) of chinese genes in the dam of the terminal product varied considerably (p ranging from 0.1 to 0.5) depending on the numerical productivity of the other components of the dam line, the sire line used as well as on the payment system of the terminal product. Various possibilities of valorizing the Meishan breed are discussed in the light of these findings.

37ème Réunion annuelle de la Fédération Européenne de Zootechnie - Budapest, Hongrie, 1-4 Septembre 1986.

ASPECTS EXPERIMENTAUX ET PROSPECTIFS DE L'UTILISATION DES RACES PORCINES PROLIFIQUES DE CHINE EN EUROPE.

Commission de Génétique animale
Séance III - Sélection pour les performances de reproduction chez le porc.

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RESUME :

L'étude des races porcines chinoises conduite depuis 1980 dans les troupeaux expérimentaux de l'INRA a été complétée récemment par un programme d'évaluation dans un échantillon d'élevages de production français.

Les résultats expérimentaux montrent que la mise à la reproduction d'une truie F1 (Large White x Meishan) peut conduire à une augmentation de 3,7 , 3,5 et 8,4 porcelets nés par portée, sevrés par portée et sevrés par truie et par an respectivement. Les chiffres correspondants observés dans 18 élevages de production sont respectivement de 2,9 , 2,0 et 5,4 porcelets. Cette amélioration de la productivité numérique des truies F1 diminue le prix de revient des porcelets sevrés dans des limites qui se situent entre 25 et 35 %. Dans l'état actuel des comparaisons, le recours aux truies (1/4 chinoises, 3/4 européennes) se traduit par une augmentation du nombre de porcelets sevrés/truie/an de l'ordre de 2,5 unités, réduisant ainsi le prix de revient des porcelets d'environ 11 %.

Les performances de production des produits terminaux 1/4 et 1/8 chinois analysés dans les troupeaux expérimentaux et dans les stations publiques de contrôle de la descendance sont relativement homogènes. Le retard de croissance est généralement faible et non significatif (2 à 5 %). L'indice de consommation est augmenté de 0,07 à 0,23 kg chez les 1/4 chinois et de 0,06 chez les 1/8 chinois. La teneur en muscle dans la carcasse est réduite de 4 à 4,2 points de pourcentage chez les 1/4 chinois et de 2,5 points de pourcentage chez les 1/8 chinois. Ces observations permettent de situer le handicap des races pures chinoises sur leurs homologues Large White et Landrace dans des limites comprises entre 16 et 20 points de pourcentage. La qualité de la viande est améliorée dans son ensemble, d'une manière modérée pour le rendement technologique (d'environ 1 point de pourcentage), d'une manière plus sensible pour les qualités organoleptiques.

A partir de ces résultats, le problème de l'optimisation de plans de croisement utilisant la race Meishan comme composante d'une lignée maternelle est ensuite abordé. Différents systèmes de croisement discontinus (femelle 1/2 ou 1/4 chinoise) ou continus (lignée femelle synthétique) sont comparés à l'équilibre démographique. Sur la base des paramètres du croisement usuels, les deux approches utilisées, celle de MOAV (1966) et celle de DICKERSON (1973), conduisent à des résultats voisins ; la proportion optimale p de gènes chinois chez la mère du produit terminal varie considérablement (p = 0,1 à 0,5) en fonction notamment de la productivité numérique des autres composantes de la lignée maternelle, de la lignée paternelle utilisée et du système de paiement du produit terminal. Différentes alternatives de valorisation de la race Meishan sont discutées à la lumière de ces résultats.