PROSPECTS FOR THE COMMERCIAL USE OF CHINESE PIGS

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SUMMARY
The Meishan seems to offer the best prospect for use in commercial crosses. Levels of heterosis between Meishan and Western crosses are higher than seen in crosses between Western breeds, and this can be exploited in cross-breeding programmes. The most likely route for use is through production of a synthetic between prolific white breeds and Meishan. Figures are presented for one breeding programme that suggest that the Meishan can be used succesfully commercially, with an economic advantage in most markets.

INTRODUCTION

"Chinese pigs (especially the Meishan) will farrow large litters. So, I guess what we really need in this country is not just a few fat, light muscled hogs but a whole bunch of them. Right?" - G. Conaster, Yorkshire Journal, 1986.

There is considerable debate about the potential use of Chinese pigs in Western breeding programmes. Three major importations of Chinese genes have occurred in the last 11 years, into France in 1983, into the UK in 1987 and into the US in 1989. Most of these pigs were representative of the prolific Taihu breeds, with Meishan being the most numerous. Limited studies on the Fengjing, and the Minzhu (from NE China) in the US, and Jiaxing Black in France suggest that these have little extra to offer in terms of either prolificacy or growth and carcass characteristics relative to the Meishan (Bidanel et al, 1990, Young, 1992, Lan et al 1993), and therefore subsequent comments are restricted to Meishan. Much work repeated across different populations in France (eg Bidanel et al, 1990), in the UK (Haley et al, 1990, 1992) and in the USA (McLaren et al, 1990, Young, 1990) has suggested that relative to the European Large White, the Meishan has an advantage of 3-5 more live piglets, possess more teats with which to rear them, and reaches maturity some 60-90 days sooner. Conversely, the difference in lean content between two lines might be as high as 20 percentage points, whilst growth rate is 25-30% slower up to conventional slaughter ages, and food conversion ratios 0.8-1.0 worse (eg Bidanel et al 1990). There has been some suggestion, notably by the Chinese, that the Meishan has a superior eating quality (eg Cheng, 1983). This has met with limited support in trials using Western palettes (Touraille, 1990), and in Japan (Suzuki et al, 1991), but does not appear to have applied in the US, where the barrows were taken up to heavier weights, and the non-Chinese pigs were fatter (Wheeler and Young, 1992, Lan et al, 1993), or in the UK (Ellis et al, 1990). The dilemma facing breeders is how to take advantage of the positive aspects of reproductive performance, whilst avoiding a reduction in growth, efficiency and lean output.

RESULTS OF CROSSBREEDING STUDIES

Crosses between Meishan and Large White appear to benefit from a high degree of heterosis, relative to that normally seen in crosses between European breeds. Results from the French and UK populations are broadly in agreement in the size of crossbreeding parameters, which are summarised in Table 1. Litter size appears to be determined by genes acting in the dam and not the embryos, although there are both additive and maternal effects influencing the subsequent performance of the progeny (Haley and Lee, 1993). First cross sows are likely to have as high a litter size or greater than pure Meishan, will have a higher number of teats than the midparent value, but the piglets will be smaller than in White breeds. Lee and Haley (1994) have shown that survivability in first cross piglets is greater than in the pure white pigs at a constant litter size. Table 1. also shows that as a result of both maternal and direct heterosis, a higher weight of piglets can be expected to be weaned from first cross sows, relative to the midparent mean.

Table 1. Summary of Crossbreeding Parameters for Reproductive Traits

	BRITISH[1]					FRENCH[2]				
	mean	α	γ	αm	γm	mean	α	γ	αm	γm
No. Teats	15.85	-	-	1.16	0.54	-	-	-	1.8	ns
age at puberty d.	-	-	-	-	-	145	-	-	-51	-50
no born alive	12.24	ns	ns	2.06	2.33	11.1	ns	ns	1.8	1.4
litter birthwt kg	14.08	ns	1.16	ns	3.22	12.5	-1.0	0.7	ns	1.6
mean birthwt kg	1.21	ns	0.14	-0.23	ns	1.08	ns	0.08	-0.33	.05
survival pre-wean	.831	.061	.043	-.076	ns	-	-	-	-	-
l.s. at weaning	10.10	ns	ns	0.80	2.20	10.1	ns	ns	1.35	1.3
l.wt. at wean kg	77.1	5.8	11.2	-5.6	20.1	45.8[3]	ns	2.8	ns	10.1
ADG post wean g	417	ns	60	ns	-	383	-32	33	ns	ns
ADG test/grower g	590	-118	81(♀)	-114(♂)	-	631	-116	187	ns	29
FCR kg/kg	3.03	.39	-.15ns	.15	-	-	.30	-	-	ns
pen DFI kg	1.76	-.22	.15	ns	-	-	-	-	-	-
Killing Out kg/kg	.758	ns	-.009	ns	-	-	-.019	-	-	ns
Est. Lean %	-	-	-	-	-	43.8	-7.9	-	-	ns
Backfat mm	31.88	9.97	ns	1.36	-	-	5.9	-	-	ns
EMA cm^2	28.13	-7.71	ns	ns	-	-	-	-	-	-

means - estimated midparent value of Meishan and LW, α - additive direct, γ - dominance, αm - additive matenal, γm - dominant maternal gene effects, ls - litter size, l.wt - litter weight, ADG - average daily gain, FCR - food conversion ratio, DFI - daily feed intake, EMA - eye muscle area (longissimus dorsi)

1. Haley et al (1994) Lee and Haley (1994), Haley et al (1992), Serra et al, 1992
2. Bidanel et al (1991), Legualt and Bidanel (1992), Bidanel (1993)
3. weights recorded at 21 days

Once weaned, the Meishan crosses also grow very well initially, with a daily gain which is at least as good as that of Western breeds up to around 3 months old (Bidanel et al, 1991, Young, 1992). Thereafter Western pigs outperform the crosses, although the level of mainly direct heterosis is sufficient to bring performance to a level which is close to that of the Western breed. This may be partly a consequence of direct hetrosis in feed intake. There is little evidence for heterosis in feed efficiency, although the pen FCR values recorded by Haley et al (1992) are close to being significant, and there are suggestions from a comparison with Duroc crosses that there may be hybrid vigour for efficiency (Young, 1992). Little significant heterosis has been found for any of the carcass compositional traits or meat quality tratis. If this is the case then the major disadvantages of using Meishan are related to their poor carcass composition, and the associated feed costs of large fat deposits.

GENERAL PROSPECTS FOR COMMERCIAL USE OF CHINESE PIGS

French results have suggested to date that there is an economic disadvantage in producing commercial slaughter pigs out of 1/2 and 1/4 Chinese sows, of 69F and 47F, respectively per finishing pig (Gueblez et al, 1990). This loss was reduced when lean Pietrain boars were used as a terminal sire, but one of the main problems encountered was that the lift in prolificacy in the 1/4 Meishan was only 1.6 pigs sold/s/y relative to a LWxLR sow. Bidanel (1990) has suggested that the best economic strategy in the long term is to carry out improvement in the purebred Meishan, which can then be used in a conventional crossing system, producing F1s. This strategy would take at least 6 years before there was any economic advantage. This largely ignores the costs of producing pure-bred Meishan, which have effectively no slaughter value in the West. Use of Meishan as part of a synthetic breed has been considered a more likely route for commercial exploitation. McLaren (1990) has suggested that use of Meishan Synthetics (MS) has a place to play in the US industry, and that a 3 or 4 breed terminal crossing scheme with a MS grandparent will provide the lowest production costs per kilo of pork. This work largely preceded radical changes in the US hog industry, however, which is very rapidly changing its objective to one of lean meat production.

There is some debate about the type of synthetic that should be produced. French breeding companies have focused on the production of synthetics incorporating genes from lean genotypes such as the Pietrain (Naveau, 1992, Looft, 1990). Although both Pen-ar-lan and France Hybrides have been successful in improving the lean content of these synthetic lines, the average prolificacy does not appear to be much greater than that of European white lines, and indeed, the latter line has since been discontinued. There does not appear to have been any loss in heterosis in litter size in these lines from the F2 onwards (eg Naveau, 1992), which suggests that recombination loss is not important. An alternative strategy is that Meishan should be crossed to highly prolific lines of European pig, so that as high an advantage in litter size is retained in the synthetic, which can then be selected for improved carcass characteristics. This approach has been adopted by some UK breeding companies (eg van der Steen, 1992). The NPD work is presented here.

OTHER MEANS OF UTILISING MEISHAN GENES

Alternative means of exploiting the Meishan were considered by Bidanel, 1990. Foremost of these is use of growth promoters to enhance the carcass of Meishan crosses. Use of porcine somatotrophin (PST) has been found to have a greater effect in Chinese crosses than in European in all centres of study (eg Kanis et al, 1990). Prospects for use of PST may not be as limited as they were once thought to be. Direct incorporation of genes controlling growth into animals with a Chinese background may not be feasible in the immediate future. There is perhaps more chance of utilising QTLs with an effect on prolificacy through marker assisted selection in a European x Chinese or synthetic population (Haley and Archibald, 1992). In order for such selection to be useful, the QTLs have to be of large effect, but the existence of such QTLs has yet to be established in the Meishan. There is no evidence that the prolificacy in the Meishan, in terms of numbers born alive, is controlled by a single gene (Mandonnet et al, 1992). Other immediate use of Chinese pigs may be possible in tropical or semi-tropical countries where the prolificacy of the indigenous breeds is poor and slaughter weights low (Delate, 1990). A further prospect that must be considered is that other breeds of Chinese pigs may have even more to offer in litter size, as has been suggested for the Erhualian Black (Jiang, 1990).

COMMERCIAL USE OF MEISHAN AT NPD

It would appear that one immediate solution to the problem of how to exploit Chinese genes, is to form a synthetic population using European animals which are both lean and prolific. This would minimise the loss in prolificacy, enabling the production of an F1 parent female containing 1/4 Chinese genes, which is still prolific, and therefore may be able to carry some disadvantage in carcass quality. This strategy has been used by NPD in the development of a synthetic population (Upton Meishan - UM). The white breeds at NPD have had demonstrable advantages in leanness (+4% points lean in white pigs on ad libitum feeding relative to the mean of 3 other breeding companies - MLC, 1989, Company J). Within the Large White (LW) and Landrace (LR) populations high litter size (HLS) sublines were developed through a hyperprolific selection scheme (Legault and Gruand, 1976) which had an advantage of 0.8 and 0.5 piglets born alive relative to contemporaries, respectively ($p<0.05$, Mercer, unpublished). First crosses between the HLS LW line and Meishan were produced in 1988. Results of the reproductive performance of the resultant synthetic, taken from the last 3 years (mostly F3 generation plus), and five parities are shown in Table 2. There is a clear advantage in litter size of some 3-4 piglets born per parity relative to the least squares mean of contemporary LW and LR sows. This was seen on both nucleus and multiplication farms, with purebred and crossbred litters, respectively ($p < 0.05$ for numbers born and weaned). Piglets are smaller at birth, but there is no significant difference in size between LW and UM if litter size is taken into account. Haley and Lee (1994) have shown that at a constant birthweight Meishan crosses have an advantage in survivability, and therefore at the birthweights likely to be encountered at commercial level, survival would be expected to be as good as that of conventional white piglets.

One of the most encouraging aspects of the UM performance is its ability to reproduce regularly, as shown in figures taken from farrowed sows in Table 3. Sows containing Meishan genes return to oestrous and hold to service better than conventional white sows, and suckle for longer periods (an indication of superior milking ability). It should be noted that numbers and weights weaned refer to piglets taken off the sow on the day she was weaned, and is probably an underestimate of total piglets weaned, because of early-weaning, cross-fostering and extra suckling. On one nucleus farm a 92.2% farrowing rate is being achieved, which is 8.6% points better than in the contemporary white sows - $p<0.05$. Using these figures together with estimates of heterosis presented above a prediction of performance of UM crossed with LR suggests that there should be an advantage in live birth size of 2-2.5 piglets per litter relative to a conventional white hybrid.

Table 2 Litter Size of UM and Estimated Difference between UM and (LW+LR)/2 by Parity[1].

Parity	1	2	3	4	5
no. UM litters	958	745	548	297	96
Total Born	13.99	15.11	16.64	17.32	17.37
UM-LW/LR	2.97	3.70	4.99	5.41	5.44
Born Alive	13.52	14.46	15.82	16.03	15.90
UM-LW/LR	3.12	3.62	4.78	5.09	4.68
Birth Wt kg	1.205	1.242	1.193	1.113	1.110
UM-LW/LR	-0.150	-0.206	-0.228	-0.278	-0.292

1. All differences between UM and (LW/LR)/2 significant ($p<0.05$)

Table 3. Reproductive Performance of Meishan Synthetics

	Purebred performance		Crossbred Performance	
	UM	UM-(LW+LR)/2	LRxUM	UM-LW/LR
Age 1st served days	245.7	-13.8 ***	252.7	-17.7 ***
Age 1st farrowed	361.7	-16.7 ***	370.0	-22.1 ***
Av. BWT_c kg[1]	1.30	0.06 ns	1.29	-0.08 ***
Lact Length days	30.6	1.2 ***	28.9	2.65 ***
No weaned	10.72	1.49 ***	11.92	2.51 ***
Weaning Wt kg	75.56	10.94 ***	73.35	16.38 ***
W-Eff Serv Int days	6.52	-1.23 *	4.55	-3.29 ***
Degrees Freedom	4335		5311	

1. Birthwt corrected for numbers born. *** $p<0.001$ * $p<0.05$
W-Eff Serv Int - weaning to effective service interval

Synthetic pigs grow more slowly, are less efficient and more than 50% fatter than white contemporaries at present (Table 4.), albeit little selection pressure has been put on these traits to date. Predictions of performance for a 1/8 Meishan slaughter pig using these figures suggest that relative to other NPD stock, these pigs will grow just as quickly, convert at less than 0.1 worse, and produce an extra 1.5-2mm P2 backfat at UK slaughterweights.

Table 4. Growth and Carcass performance[1] of Upton Meishan

	EWTkg	DGkg	DFIkg	FCRkg/kg	SHmm	BFATmm	MDmm
UM ♂	85.0	0.88	2.22	2.62	37.4	17.2	42.0
UM ♀	77.8	0.75	2.20	3.01	39.6	17.7	43.0
UM-(LW+LR)/2	-5.3	-0.10	0.11	0.47	8.01	6.0	-11.0

1. All figures are least squares means, and all differences in performance of UM relative to (LW/LR)/2 are significant ($p<0.05$)
EWT - end test weight, DG daily gain, DFI daily food intake,
SH ultrasonic shoulder fat, BFAT - weighted average ultrasonic backfat at 4 positions, MD muscle depth at last rib

The synthetic is being crossed with HLS LR to produce a commercial parent female, the Manor Meishan (MM). The first MM were sold in 1992, and are being evaluated in the field. Initial results suggest that there is an advantage of 1.25 to 1.5 piglets born alive per litter (BA - Table 5.), taking into account the apparent dip in second litter sows (this should be readily overcome by correct feeding of MM sows). This is rather lower than the predicted values of 2-2.5, and may be a consequence of loss of heterosis, or simply a result of low numbers of field results having been sampled to date.

Table 5. Reproductive Performance of MM Sows Relative to Commercial Hybrids (C) (All differences shown are significant, $p<0.05$)

Parity	1		2		3		4	
	TB	BA	TB	BA	TB	BA	TB	BA
no MM litters		448		130		48		26
no. born	12.37	11.70	11.85	11.39	13.46	12.50	13.68	12.83
Diff MM-C	1.51	1.41	0.69	0.61	1.39	1.11	1.22	1.23

Carcass quality plays an important part in economic returns, although backfat levels are only important relative to weight if they fall above a certain level in some UK grading system, which gives a discontinuous return for leanness. The fat levels and leanness demonstrated in the progeny of MM mated to a cross-section of UK boars to date are acceptable to many markets, across a range of slaughter weights, as can be seen from Table 6. Trial work involving dissections (Table 7.) confirm these findings, although the absolute differences in fat and lean are higher at the heavier weights, carcass quality was still good. Few notable differences in meat quality were found, either in objective scores of meat quality or in taste panel work. The UK market is peculiar in that entire males are slaughtered, at a relatively light weight, and the possibility of boar taint is a potential problem (Ellis et al, 1990). There was conflicting evidence concerning taints in the trial work, with some of the taste panel results suggesting that meat from Meishan stock may be a little more prone to boar flavour. The heavy weights used in these trials, and the small differences involved suggest that this is not likely to be a practical problem. Taint does not seem to be an issue where barrows are concerned (Wheeler and Young, 1992, Lan et al, 1993).

Table 6. Carcass Quality of MM Progeny Relative to a Commercial Control (C - All Least Squares Means for P2 and L% different from C. p<0.05)

	No.	MMeishan			MMeishan - Control		
		wt kg	P2 mm	L%	wt	P2	L%
1.	56	69.6	10.48	58.7	-1.4	1.15	-1.5
2.	258	71.4	11.37	57.5	-1.0	1.61	-1.8
3.	476	71.9	13.54	55.1	-1.2	2.45	-2.8
4.	47	72.2	9.43	59.5	1.5	1.14	-2.5
5.	28	83.3	12.08	57.9	3.4	1.70	-2.0
6.	50	88.7	13.76	56.2	-1.8	2.60	-3.0
Ave.		76.2	11.77	57.5	-0.1	1.80	-2.2
UK Ave 1992		69.0	11.5	57.5			
Europe Estimate		85	15-17	53-55			
US Estimate		90	22-30	40-48			

1-3 field results, results in 2 are taken from 5 producers, 4-6 trial results.

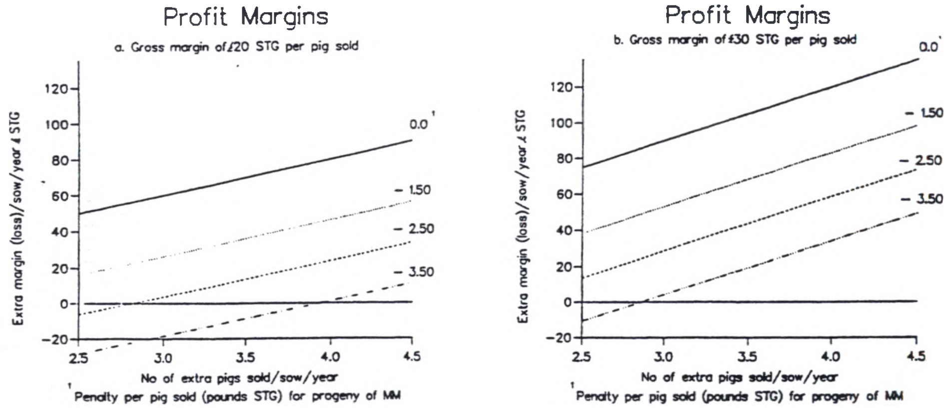
Table 7. Results of Manor Meishan Progeny From Carcass and Meat Quality Trials Compared to Conventional (C) NPD Stock

	A - 72.2 kg CCW		B - 88.0 kg CCW	
	M	M-C	M	M-C
Predicted Lean %	59.5	2.5 ***	58.2	3.96 ***
1.Eye Muscle Area cm^2	38.2	2.1 *	63.8	2.8 *
Intra-muscular fat %	1.44	0.51 ***	0.71	0.13 *
Drip Loss %	4.88	-0.46 ns	-	-
Tenderness 1-8	4.34	0.19 ns	-	-
Juiciness 1-8	4.90	-0.30 *	-	-
Flavour of Lean 1-8 2.	4.18	-0.02 ns	2.56	0.01 ns
Abnormal Odour 1-8	3.88	-0.01 ns	4.51	0.32 ***
Skatole 1-5 3.	1.14	0.02 ns	0.03	0.01 ns

1. B - Muscle Depth, 2. B - Pork Odour Intensity 1-5, 3. B - ppm

The commercial implications of using Meishan genes are considered in Figure 1. This shows the extra margin (or loss) from selling extra pigs per sow each year (relative to a base of 20 pigs), after a reduction in feed efficiency and grading return has been taken into account, at different levels of gross margin per conventional pig sold. Losses per pig compared to conventional NPD stock have been estimated to be around £2.00 ($US3.00) per pig slaughtered, which is rather higher than would be suffered relative to the average UK pig. On this basis, the likely improvement in gross margins per sow per year is £30 ($US45). Figure 1. shows that this assumption is fairly robust to different levels of extra productivity and loss in margins per pig sold. This scenario is different from the French results because the original white population was specifically chosen for properties of leanness and prolificacy, and all subsequent comparisons have been made with pigs of similar leanness. If the whole of the UK industry were to adopt this strategy, then at a £30 per sow benefit, improvements in margins would therefore be some £24m ($US36m) per annum.

Figure 1. Economic Impact of Using Manor Meishan Genes



The above figures ignore other likely benefits from use of Meishan crosses, such as an improvement in general reproductive performance, and possible adaptability to different farrowing environments (English et al, 1990, Legault and Bidanel, 1992). There is also evidence to suggest that the Meishan may be able to utilise fibre in the diet more efficiently (Edwards et al, 1991). It is also possible that more rapid improvement of the carcass can be made in the synthetic populations relative to conventional white pigs (Naveau, 1992) which will cut down on losses from use of Meishan. If the carcass characteristics of the UM can be improved at a faster rate relative to white pigs, which are already near their limits for backfat depth, then the profitability of the MM will increase. On the basis of results to date, however, it is clear that in many markets commercial Meishan crosses have an immediate application.

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