Supplementary Materials for

Bio-economic Modeling for Swine Genomic Selection Index Design and Multi-Generational Response Simulation

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Figures

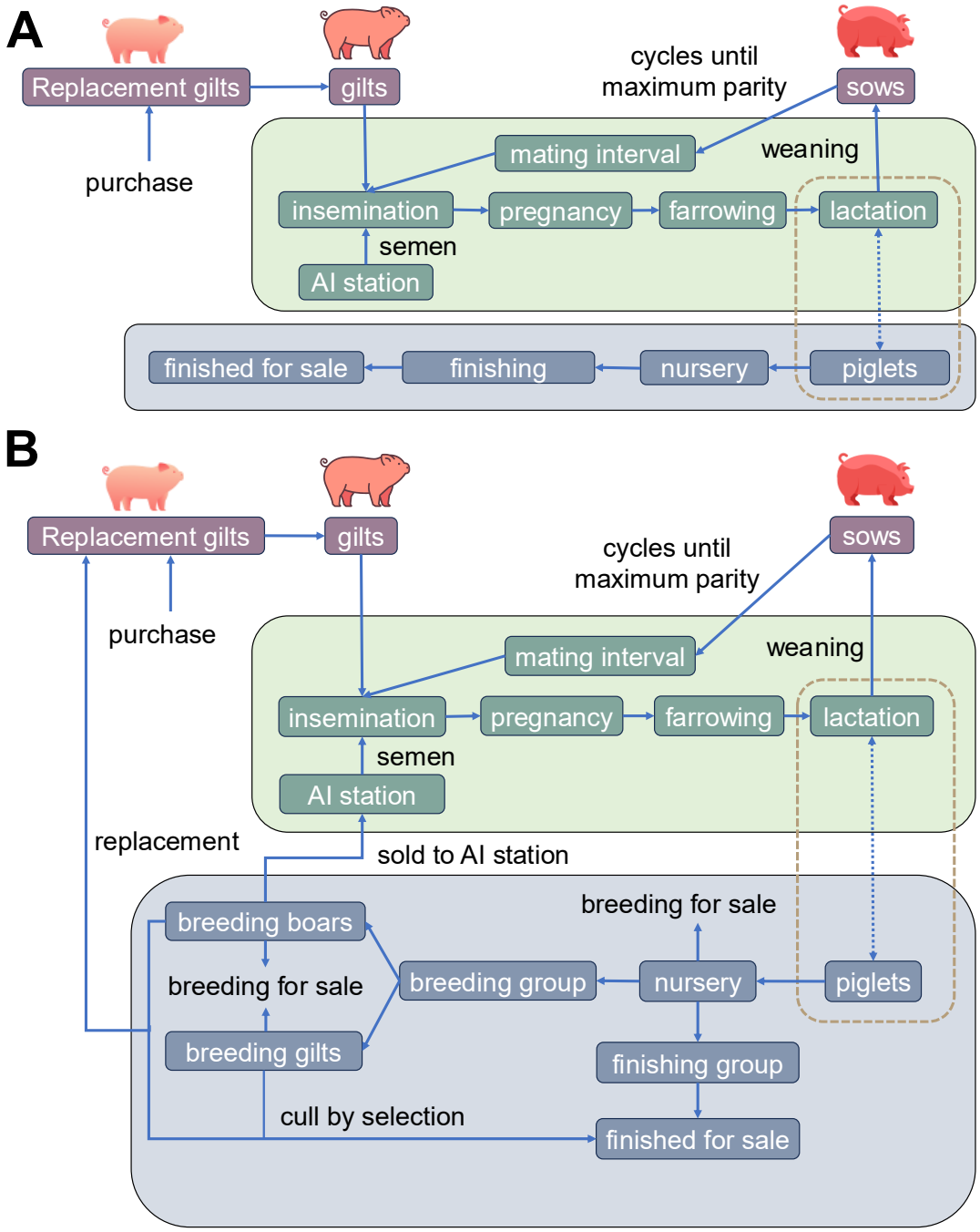

Figure S1. Schematic frameworks characterizing the workflows for farrow-to-finish and pure-line herds. (A) Farrow-to-finish herd bio-economic model. The diagram illustrates the standard commercial production cycle, tracing the biological flow from reproductive phases to the growth and finishing of offspring for market sale. (B) Pure-line bio-economic model. The workflow represents the breeding nucleus structure. In addition to the fundamental reproductive

and growth phases, this model integrates the genetic selection process (distinguishing breeding boars and gilts). Superior animals are retained for internal herd replacement or sold as breeding stock, while culled individuals are diverted to the finishing group for slaughter.

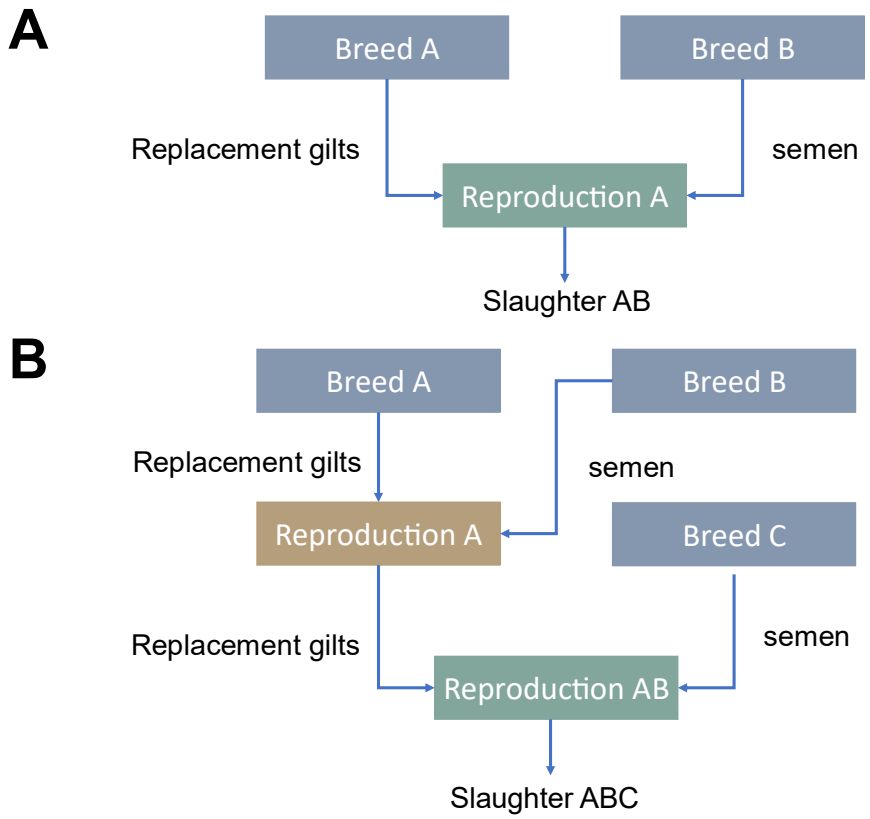

Figure S2. Schematic framework of the bio-economic models for crossbreeding systems. (A) Two-way crossbreeding system. The diagram illustrates the production flow where Breed A serves as the maternal line (providing replacement gilts) and Breed B contributes semen to produce the terminal Slaughter AB group. (B) Three-way crossbreeding system. The workflow represents the hierarchical structure where the F1 crossbred sows are mated with Breed C to generate the final commercial population (Slaughter ABC).

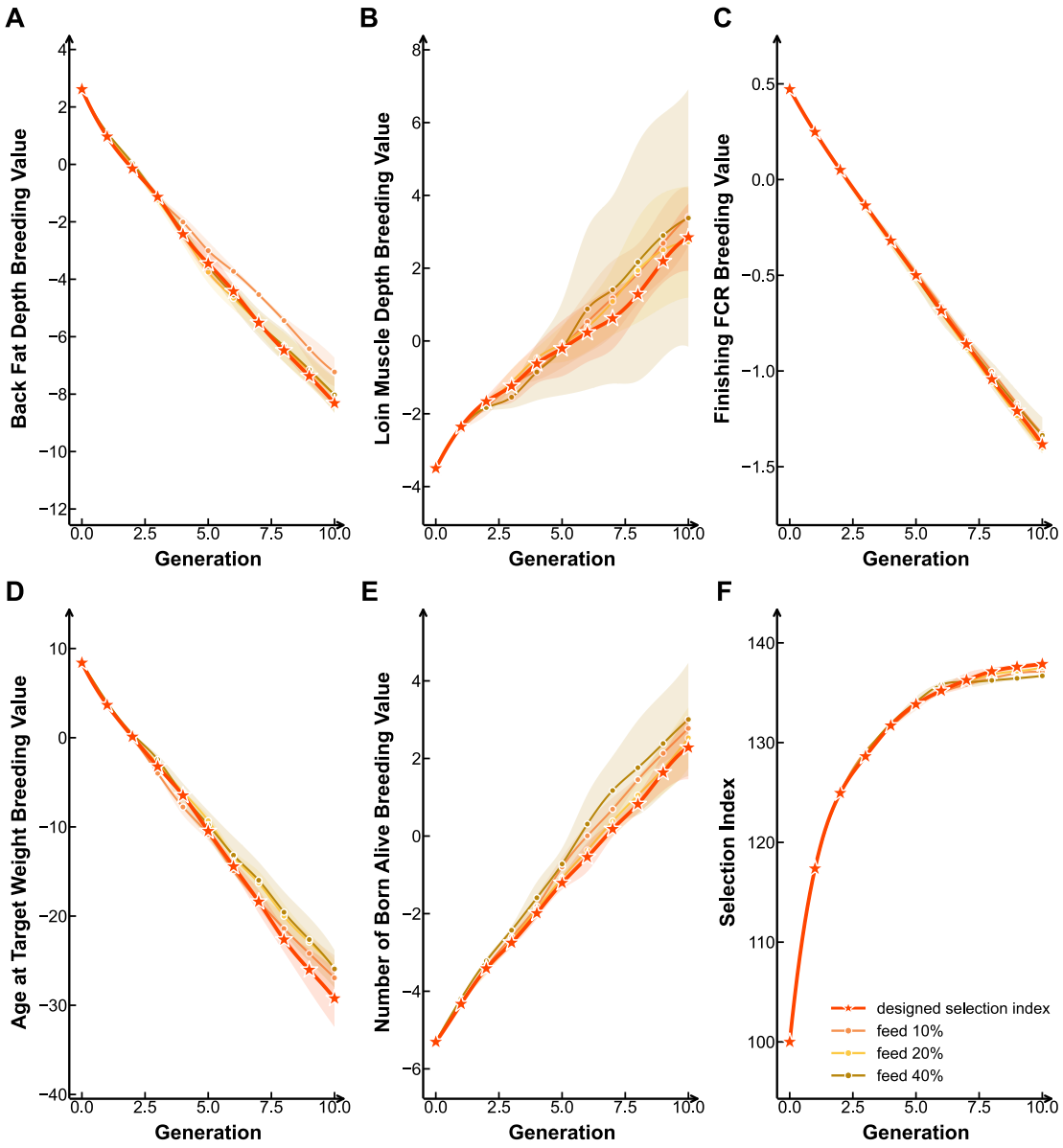

Figure S3. Sensitivity analysis of genetic gain and selection index trends under feed price variations. The plots visualize the trajectories of True Breeding Values (TBVs) for the five target traits (A-E) and the aggregate Selection Index (F) over 10 generations. Scenarios: The comparisons are specific to increases in feed prices (e.g., 10%, 20%, etc.). The orange line with star markers serves as the baseline (designed selection index), while the other lines represent the impact of rising feed costs on genetic gain. Shaded regions indicate the standard deviation.

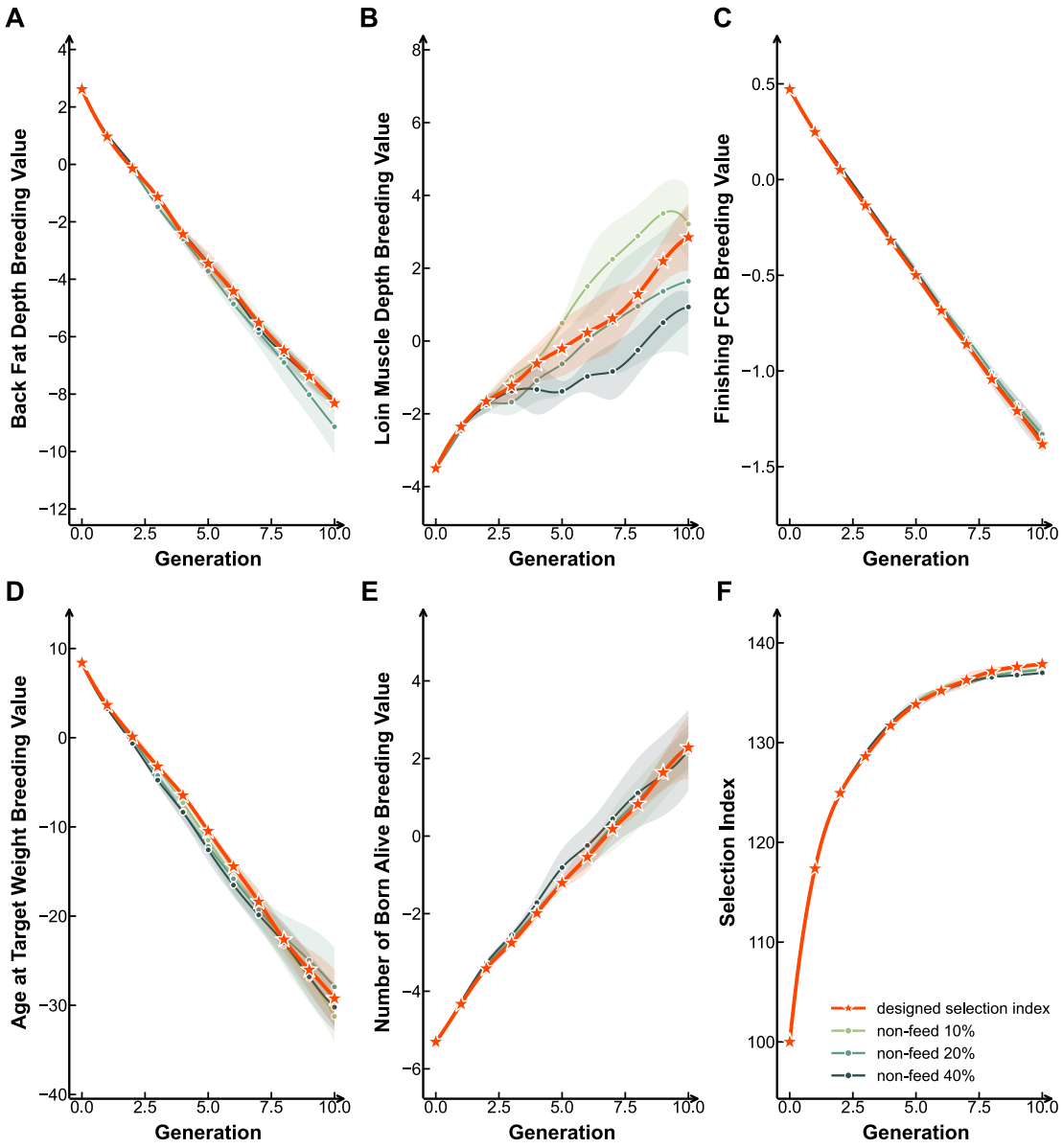

Figure S4. Sensitivity analysis of genetic gain and selection index trends under non-feed price variations. The plots visualize the trajectories of True Breeding Values (TBVs) for the five target traits (A-E) and the aggregate Selection Index (F) over 10 generations. Scenarios: The comparisons are specific to increases in non-feed prices. The orange line with star markers represents the baseline (designed selection index), while the other lines represent the impact of rising non-feed costs on genetic gain. Shaded regions indicate the standard deviation.

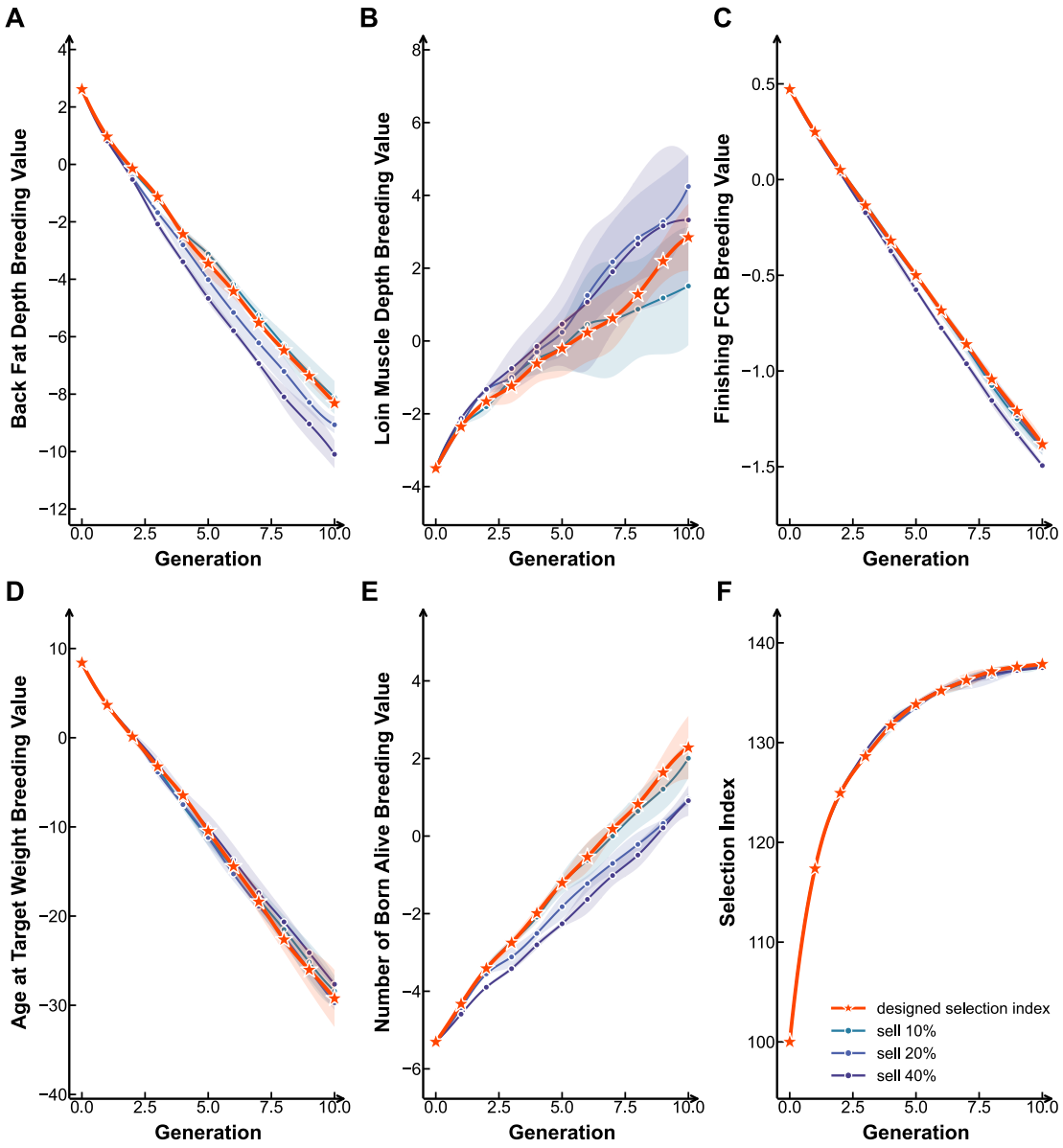

Figure S5. Sensitivity analysis of genetic gain and selection index trends under sell price variations. The plots visualize the trajectories of True Breeding Values (TBVs) for the five target traits (A-E) and the aggregate Selection Index (F) over 10 generations. Scenarios: The comparisons focus on the effect of increases in market sell prices. The orange line with star markers denotes the baseline (designed selection index), while the remaining lines illustrate the sensitivity of genetic response to fluctuations in market sell parameters. Shaded regions indicate the standard deviation.

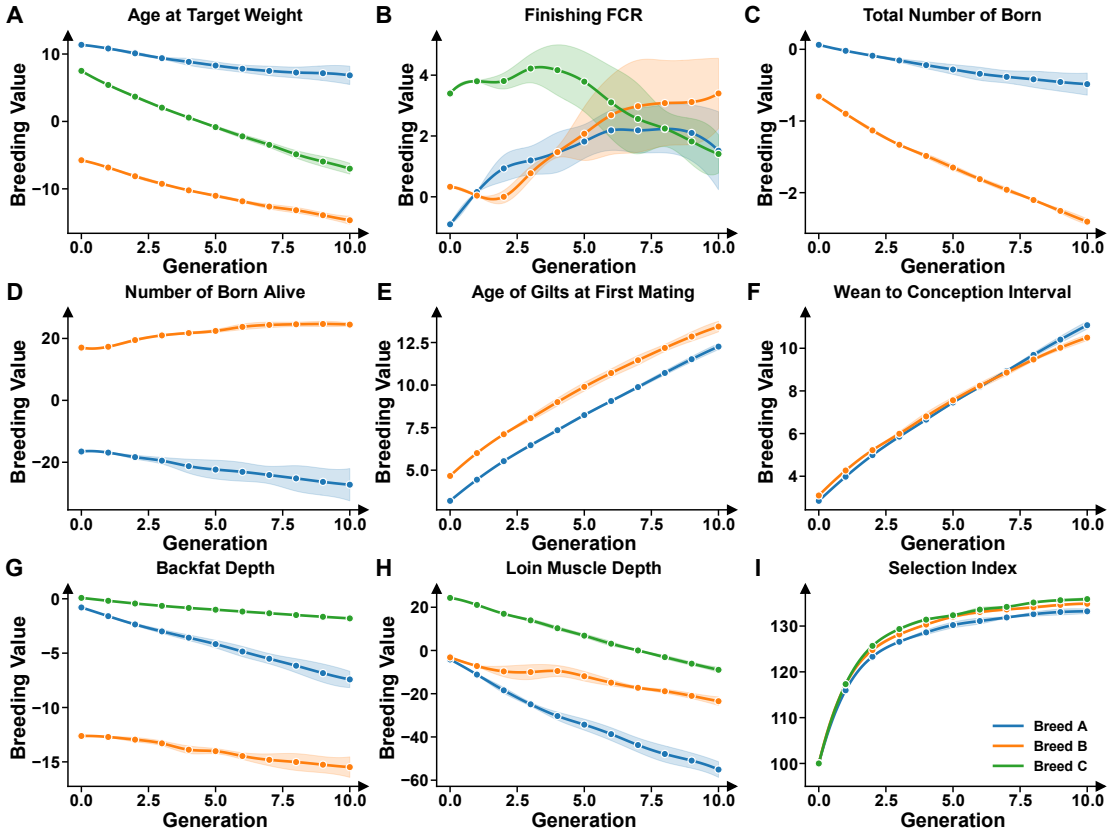

Figure S6. Multi-generational genetic gain and selection index trends for the three-way crossbreeding system. (A-H) Trajectories of True Breeding Values (TBVs). The plots visualize the genetic gain over 10 generations for the three breeds: Breed A (blue line), Breed B (orange line), and Breed C (green line). Traits include: (A) Age at Target Weight, (B) Finishing FCR, (C) Total Number of Born, (D) Number of Born Alive, (E) Age of Gilts at First Mating, (F) Wean to Conception Interval, (G) Backfat Depth, and (H) Loin Muscle Depth. (I) Selection Index. Shaded regions indicate the standard deviation of the simulation.

Tables

Table S1 Example parameters of pig production system in the farrow-to-finish (commercial) herd

Parameter name	Value	Unit	Parameter name	Value	Unit
Gilt mortality	0.050		Feed price of lactating piglet	0.655	$/kg
Gilt culling rate	0.050		Feed price of gilt	0.420	$/kg
Average conception rate of sow	0.950		Feed price of sow duing mating interval	0.470	$/kg
Sow conception to farrowing mortality	0.12		Feed price of sow during pregnancy	0.470	$/kg
Sow farrowing to weaning mortality	0.050		Feed price of sow during lactation	0.470	$/kg
Sow weaning to mating culling rate	0.150		Disposal cost of lactating dead piglet	0.700	$/per
Total number of piglets born	14.300		Disposal cost of nursery dead pig	0.700	$/per
Number of piglets born alive	12.900		Disposal cost of finishing dead pig	2.800	$/per
Lactation mortality of piglet	0.120		Disposal cost of dead sow	4.200	$/per
Nursery mortality of pig	0.050		Fixed cost of piglet during lactation	1.218	$/d·per
Finishing mortality of pig	0.040		Fixed cost of pig during nursery	0.420	$/d·per
Finishing feed conversion rate	2.650	kg feed/kg weight	Fixed cost of pig during finishing	0.154	$/d·per
Daily feed intake of gilt	3.000	kg/d	Fixed cost of gilt	0.280	$/d·per
Daily feed intake of sow weaning to conception	2.500	kg/d	Fixed cost of sow	0.280	$/d·per
Daily feed intake of sow during pregnancy	2.500	kg/d	Cost of selling finished pig	0.700	$/per
Daily feed intake of sow during lactation	6.000	kg/d	Sow mating cost	4.900	$/per
Number of sows	3000.000		Sow farrowing cost	4.200	$/per
Maximum number of matings per parity of sow	3.000		Number of nursery phases	3.000	
Maximum parity of sow	6.000		Number of finishing phases	3.000	
Age of gilt purchase	180.000	d	Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Mating age of gilt	230.000	d	Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Gilt mating to conception interval	2.000	d	Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Sow mating to conception interval	2.000	d	Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Sow weaning to conception interval	7.000	d	Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Pregnancy days of sow	114.000	d	Finished pig sale type	sold by carcass quality	
Lactation days of piglet	22.000	d	Slaughter rate	0.750	
Nursery days of pig	50.000	d	Average price of backfat thickness	3.500	$/kg
Finishing days of pig	108.000	d	Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)
Weaning weight of piglet	6.500	kg	Average price of loin muscle depth	3.500	$/kg
End of nursery weight	28.000	kg	Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)
Finished weight of pig	110.000	Kg	Cull pig sale type	sold by live weight	
Feed intake of piglet during lactation	0.150	kg/per	Price of culling sow live weight	1.890	$/kg
Average weight of gilt culling	140.000	kg	Price of culling gilt live weight	2.240	$/kg
Average weight of sow culling	220.000	kg			

Table S2 Example parameters of pig production system in the three-way crossbreeding system

Parameter name	Value	Unit	Parameter name	Value	Unit
Breed A			Breed B		
Average conception rate of sow	0.950		Average conception rate of sow	0.950	
Sow farrowing to weaning mortality	0.050		Sow farrowing to weaning mortality	0.050	
Sow weaning to mating culling rate	0.150		Sow weaning to mating culling rate	0.150	
Sow conception to farrowing mortality	0.120		Sow conception to farrowing mortality	0.120	
Gilt conception to farrowing mortality	0.100		Gilt conception to farrowing mortality	0.100	
Total number of piglets born	16.900		Total number of piglets born	15.400	
Number of piglets born alive	15.300		Number of piglets born alive	14.000	
Lactation mortality of piglet	0.120		Lactation mortality of piglet	0.120	
Nursery mortality of pig	0.050		Nursery mortality of pig	0.050	
Finishing mortality of pig	0.040		Finishing mortality of pig	0.040	
Finishing mortality of breeding gilt	0.040		Finishing mortality of breeding gilt	0.040	
Finishing mortality of breeding boar	0.040		Finishing mortality of breeding boar	0.040	
Gilt culling rate	0.050		Gilt culling rate	0.050	
Gilt mortality	0.050		Gilt mortality	0.050	
Feed intake of piglet during lactation	0.150	kg/per	Feed intake of piglet during lactation	0.150	kg/per
Finishing feed conversion rate of breeding gilt	2.120	kg feed/kg weight	Finishing feed conversion rate of breeding gilt	2.310	kg feed/kg weight
Finishing feed conversion rate of breeding boar	2.120	kg feed/kg weight	Finishing feed conversion rate of breeding boar	2.310	kg feed/kg weight
Finishing feed conversion rate of finisher	2.120	kg feed/kg weight	Finishing feed conversion rate of finisher	2.310	kg feed/kg weight
Daily feed intake of gilt	3.000	kg/d	Daily feed intake of gilt	3.000	kg/d
Daily feed intake of sow weaning to conception	2.500	kg/d	Daily feed intake of sow weaning to conception	2.500	kg/d
Daily feed intake of sow during pregnancy	2.500	kg/d	Daily feed intake of sow during pregnancy	2.500	kg/d
Daily feed intake of sow during lactation	6.000	kg/d	Daily feed intake of sow during lactation	6.000	kg/d
Number of sows	3000.000		Number of sows	1000.000	
Maximum parity of sow	6.000		Maximum parity of sow	6.000	
Maximum number of matings per parity of sow	3.000		Maximum number of matings per parity of sow	3.000	
Mating age of gilt	230.000	d	Mating age of gilt	230.000	d
Gilt mating to conception interval	2.000	d	Gilt mating to conception interval	2.000	d
Sow weaning to conception interval	7.000	d	Sow weaning to conception interval	7.000	d
Pregnancy days of sow	114.000	d	Pregnancy days of sow	114.000	d
Probability of selling breeding boars during nursery	0.000		Probability of selling breeding boars during nursery	0.000	
Probability of selling breeding gilts during nursery	0.000		Probability of selling breeding gilts during nursery	0.000	
Probability of selling finisher during nursery	0.000		Probability of selling finisher during nursery	0.000	
Percentage of finishing group at the end of nursery	0.200		Percentage of finishing group at the end of nursery	0.200	
Percentage of breeding group at the end of nursery	0.800		Percentage of breeding group at the end of nursery	0.800	
Percentage of boars in the breeding group	0.300		Percentage of boars in the breeding group	0.300	
Percentage of gilts in the breeding group	0.700		Percentage of gilts in the breeding group	0.700	
Probability of culling during selection of breeding gilts	0.200		Probability of culling during selection of breeding gilts	0.500	
Percentage of breeding gilts transferred to multiplying herd	0.800		Percentage of breeding gilts for sale	0.000	
Percentage of breeding gilts for sale	0.000		Number of gilts purchased	0.000	
Number of gilts purchased	0.000		Probability of culling during selection of breeding boars	0.800	

Parameter name	Value	Unit
Probability of culling during selection of breeding boars	0.800	
Percentage of breeding boars for sale	0.000	
Percentage of breeding boars transferred to AI	1.000	
Lactation days of piglet	22.000	d
Nursery days of pig	50.000	d
Finishing days of pig	98.000	d
Weaning weight of piglet	6.500	kg
End of nursery weight	28.000	kg
Finished weight of pig	110.000	Kg
Average weight of gilt culling	140.000	kg
Average weight of sow culling	220.000	kg
Boar's first mating age	200.000	d
Average age of boar culled	500.000	d
Boar semi-annual renewal rate	0.250	
Number of nursery phases	3.000	
Number of finishing phases	3.000	
Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Feed price of lactating piglet	0.660	$/kg
Feed price of breeding gilt	0.450	$/kg
Feed price of breeding boar	0.450	$/kg
Feed price of gilt	0.420	$/kg
Feed price of sow during mating interval	0.470	$/kg
Feed price of sow during pregnancy	0.470	$/kg
Feed price of sow during lactation	0.470	$/kg
Disposal cost of lactating dead piglet	0.700	$/per
Disposal cost of nursery dead pig	0.700	$/per
Disposal cost of finishing dead pig	2.800	$/per
Disposal cost of dead gilt	2.800	$/per
Disposal cost of dead sow	4.200	$/per
Fixed cost of piglet during lactation	1.220	$/d·per
Fixed cost of pig during nursery	0.420	$/d·per
Fixed cost of pig during finishing	0.150	$/d·per
Fixed cost of gilt	0.280	$/d·per
Fixed cost of sow	0.280	$/d·per
Sow farrowing cost	4.200	$/per
Sow mating cost	4.900	$/per
Cost of selling finished pig	0.700	$/per
Sale price of breeding boar during nursery	0.000	$/per
Sale price of breeding gilt during nursery	0.000	$/per

Parameter name	Value	Unit
Percentage of breeding boars for sale	0.000	
Percentage of breeding boars transferred to AI	1.000	
Lactation days of piglet	22.000	d
Nursery days of pig	50.000	d
Finishing days of pig	98.000	d
Weaning weight of piglet	6.500	kg
End of nursery weight	28.000	kg
Finished weight of pig	110.000	Kg
Average weight of gilt culling	140.000	kg
Average weight of sow culling	220.000	kg
Boar's first mating age	200.000	d
Average age of boar culled	500.000	d
Boar semi-annual renewal rate	0.250	
Number of nursery phases	3.000	
Number of finishing phases	3.000	
Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Feed price of lactating piglet	0.660	$/kg
Feed price of breeding gilt	0.450	$/kg
Feed price of breeding boar	0.450	$/kg
Feed price of gilt	0.420	$/kg
Feed price of sow during mating interval	0.470	$/kg
Feed price of sow during pregnancy	0.470	$/kg
Feed price of sow during lactation	0.470	$/kg
Disposal cost of lactating dead piglet	0.700	$/per
Disposal cost of nursery dead pig	0.700	$/per
Disposal cost of finishing dead pig	2.800	$/per
Disposal cost of dead gilt	2.800	$/per
Disposal cost of dead sow	4.200	$/per
Fixed cost of piglet during lactation	1.220	$/d·per
Fixed cost of pig during nursery	0.420	$/d·per
Fixed cost of pig during finishing	0.150	$/d·per
Fixed cost of gilt	0.280	$/d·per
Fixed cost of sow	0.280	$/d·per
Sow farrowing cost	4.200	$/per
Sow mating cost	4.900	$/per
Cost of selling finished pig	0.700	$/per
Sale price of breeding boar during nursery	0.000	$/per
Sale price of breeding gilt during nursery	0.000	$/per
Sale price of finisher during nursery	0.000	$/per

Parameter name	Value	Unit
Sale price of finisher during nursery	0.000	$/per
Purchase price of gilt	0.000	$/per
Price of breeding gilt transferred to multiplying herd	1120.000	$/per
Sale price of breeding gilt during finishing	0.000	$/per
Sale price of breeding boar during finishing	0.000	$/per
Breeding boar transferred to AI price	1260.000	$/per
Finished pig sale type	sold by carcass quality	
Slaughter rate	0.750	
Average price of lean meat rate	3.500	$/kg
increase 1% lean meat rate price difference	0.017	$/(kg·%)
Average price of backfat thickness	3.500	$/kg
Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)
Average price of loin muscle depth	3.500	$/kg
Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)
Average price of loin muscle area	3.500	$/kg
Increase 1mm^2 loin muscle area difference	0.003	$/(kg·mm^2)
Cull pig sale type	sold by live weight	
Price of culling sow live weight	1.890	$/kg
Price of culling gilt live weight	2.240	$/kg
Breed C		
Average conception rate of sow	0.950	
Sow farrowing to weaning mortality	0.050	
Sow weaning to mating culling rate	0.150	
Sow conception to farrowing mortality	0.120	
Gilt conception to farrowing mortality	0.100	
Total number of piglets born	10.600	
Number of piglets born alive	9.700	
Lactation mortality of piglet	0.120	
Nursery mortality of pig	0.050	
Finishing mortality of pig	0.040	
Finishing mortality of breeding gilt	0.040	
Finishing mortality of breeding boar	0.040	
Gilt culling rate	0.050	
Gilt mortality	0.050	
Feed intake of piglet during lactation	0.150	kg/per
Finishing feed conversion rate of breeding gilt	2.040	kg feed/kg weight
Finishing feed conversion rate of breeding boar	2.040	kg feed/kg weight
Finishing feed conversion rate of finisher	2.040	kg feed/kg weight
Daily feed intake of gilt	3.000	kg/d
Daily feed intake of sow weaning to conception	2.500	kg/d
Daily feed intake of sow during pregnancy	2.500	kg/d
Daily feed intake of sow during lactation	6.000	kg/d
Number of sows	300.000	

Parameter name	Value	Unit
Purchase price of gilt	0.000	$/per
Sale price of breeding gilt during finishing	0.000	$/per
Sale price of breeding boar during finishing	0.000	$/per
Breeding boar transferred to AI price	1260.000	$/per
Finished pig sale type	sold by carcass quality	
Slaughter rate	0.750	
Average price of lean meat rate	3.500	$/kg
increase 1% lean meat rate price difference	0.017	$/(kg·%)
Average price of backfat thickness	3.500	$/kg
Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)
Average price of loin muscle depth	3.500	$/kg
Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)
Average price of loin muscle area	3.500	$/kg
Increase 1mm^2 loin muscle area difference	0.003	$/(kg·mm^2)
Cull pig sale type	sold by live weight	
Price of culling sow live weight	1.890	$/kg
Price of culling gilt live weight	2.240	$/kg
Reproduction A		
Average conception rate of sow	0.950	
Sow farrowing to weaning mortality	0.050	
Sow weaning to mating culling rate	0.150	
Sow conception to farrowing mortality	0.120	
Gilt conception to farrowing mortality	0.100	
Total number of piglets born	16.900	
Number of piglets born alive	15.300	
Lactation mortality of piglet	0.120	
Nursery mortality of pig	0.050	
Finishing mortality of pig	0.040	
Finishing mortality of breeding gilt	0.040	
Gilt culling rate	0.050	
Gilt mortality	0.050	
Feed intake of piglet during lactation	0.150	kg/per
Finishing feed conversion rate of breeding gilt	2.500	kg feed/kg weight
Finishing feed conversion rate of finisher	2.500	kg feed/kg weight
Daily feed intake of gilt	3.000	kg/d
Daily feed intake of sow weaning to conception	2.500	kg/d
Daily feed intake of sow during pregnancy	2.500	kg/d
Daily feed intake of sow during lactation	6.000	kg/d
Number of sows	3000.000	
Maximum parity of sow	6.000	
Maximum number of matings per parity of sow	3.000	

Parameter name	Value	Unit
Maximum parity of sow	6.000	
Maximum number of matings per parity of sow	3.000	
Mating age of gilt	230.000	d
Gilt mating to conception interval	2.000	d
Sow weaning to conception interval	7.000	d
Pregnancy days of sow	114.000	d
Probability of selling breeding boars during nursery	0.000	
Probability of selling breeding gilts during nursery	0.000	
Probability of selling finisher during nursery	0.000	
Percentage of finishing group at the end of nursery	0.200	
Percentage of breeding group at the end of nursery	0.800	
Percentage of boars in the breeding group	0.300	
Percentage of gilts in the breeding group	0.700	
Probability of culling during selection of breeding gilts	0.500	
Percentage of breeding gilts for sale	0.000	
Number of gilts purchased	0.000	
Probability of culling during selection of breeding boars	0.800	
Percentage of breeding boars for sale	0.000	
Percentage of breeding boars transferred to AI	1.000	
Lactation days of piglet	22.000	d
Nursery days of pig	50.000	d
Finishing days of pig	93.000	d
Weaning weight of piglet	6.500	kg
End of nursery weight	28.000	kg
Finished weight of pig	110.000	Kg
Average weight of gilt culling	140.000	kg
Average weight of sow culling	220.000	kg
Boar's first mating age	200.000	d
Average age of boar culled	500.000	d
Boar semi-annual renewal rate	0.250	
Number of nursery phases	3.000	
Number of finishing phases	3.000	
Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Feed price of lactating piglet	0.660	$/kg
Feed price of breeding gilt	0.450	$/kg
Feed price of breeding boar	0.450	$/kg
Feed price of gilt	0.420	$/kg
Feed price of sow during mating interval	0.470	$/kg
Feed price of sow during pregnancy	0.470	$/kg

Parameter name	Value	Unit
Mating age of gilt	230.000	d
Gilt mating to conception interval	2.000	d
Sow weaning to conception interval	7.000	d
Pregnancy days of sow	114.000	d
Percentage of finishing group at the end of nursery	0.600	
Percentage of breeding group at the end of nursery	0.400	
Probability of culling during selection of breeding gilts	0.200	
Percentage of breeding gilts transferred to multiplying herd	0.800	
Lactation days of piglet	22.000	d
Nursery days of pig	50.000	d
Finishing days of pig	98.000	d
Weaning weight of piglet	6.500	kg
End of nursery weight	28.000	kg
Finished weight of pig	110.000	Kg
Average weight of gilt culling	140.000	kg
Average weight of sow culling	220.000	kg
Number of nursery phases	3.000	
Number of finishing phases	3.000	
Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Feed price of lactating piglet	0.660	$/kg
Feed price of breeding gilt	0.450	$/kg
Feed price of gilt	0.420	$/kg
Feed price of sow during mating interval	0.470	$/kg
Feed price of sow during pregnancy	0.470	$/kg
Feed price of sow during lactation	0.470	$/kg
Disposal cost of lactating dead piglet	0.700	$/per
Disposal cost of nursery dead pig	0.700	$/per
Disposal cost of finishing dead pig	2.800	$/per
Disposal cost of dead gilt	2.800	$/per
Disposal cost of dead sow	4.200	$/per
Fixed cost of piglet during lactation	1.220	$/d·per
Fixed cost of pig during nursery	0.420	$/d·per
Fixed cost of pig during finishing	0.150	$/d·per
Fixed cost of gilt	0.280	$/d·per
Fixed cost of sow	0.280	$/d·per
Sow farrowing cost	4.200	$/per
Sow mating cost	4.900	$/per
Cost of selling finished pig	0.700	$/per
Purchase price of gilt	0.000	$/per

Parameter name	Value	Unit
Feed price of sow during lactation	0.470	$/kg
Disposal cost of lactating dead piglet	0.700	$/per
Disposal cost of nursery dead pig	0.700	$/per
Disposal cost of finishing dead pig	2.800	$/per
Disposal cost of dead gilt	2.800	$/per
Disposal cost of dead sow	4.200	$/per
Fixed cost of piglet during lactation	1.220	$/d·per
Fixed cost of pig during nursery	0.420	$/d·per
Fixed cost of pig during finishing	0.150	$/d·per
Fixed cost of gilt	0.280	$/d·per
Fixed cost of sow	0.280	$/d·per
Sow farrowing cost	4.200	$/per
Sow mating cost	4.900	$/per
Cost of selling finished pig	0.700	$/per
Sale price of breeding boar during nursery	0.000	$/per
Sale price of breeding gilt during nursery	0.000	$/per
Sale price of finisher during nursery	0.000	$/per
Purchase price of gilt	0.000	$/per
Sale price of breeding gilt during finishing	0.000	$/per
Sale price of breeding boar during finishing	0.000	$/per
Breeding boar transferred to AI price	1260.000	$/per
Finished pig sale type	sold by carcass quality	
Slaughter rate	0.750	
Average price of lean meat rate	3.500	$/kg
increase 1% lean meat rate price difference	0.017	$/(kg·%)
Average price of backfat thickness	3.500	$/kg
Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)
Average price of loin muscle depth	3.500	$/kg
Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)
Average price of loin muscle area	3.500	$/kg
Increase 1mm^2 loin muscle area difference	0.003	$/(kg·mm^2)
Cull pig sale type	sold by live weight	
Price of culling sow live weight	1.890	$/kg
Price of culling gilt live weight	2.240	$/kg
Reproduction AB		
Disposal cost of lactating dead piglet	0.700	$/per
Disposal cost of nursery dead pig	0.700	$/per
Disposal cost of finishing dead pig	2.800	$/per
Disposal cost of dead gilt	2.800	$/per
Disposal cost of dead sow	4.200	$/per
Fixed cost of piglet during lactation	1.220	$/d·per
Fixed cost of pig during nursery	0.420	$/d·per
Fixed cost of pig during finishing	0.150	$/d·per

Parameter name	Value	Unit
Breeding boar transferred to AI price	700.000	$/per
Finished pig sale type	sold by carcass quality	
Slaughter rate	0.750	
Average price of lean meat rate	3.500	$/kg
increase 1% lean meat rate price difference	0.017	$/(kg·%)
Average price of backfat thickness	3.500	$/kg
Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)
Average price of loin muscle depth	3.500	$/kg
Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)
Average price of loin muscle area	3.500	$/kg
Increase 1mm^2 loin muscle area difference	0.003	$/(kg·mm^2)
Cull pig sale type	sold by live weight	
Price of culling sow live weight	1.890	$/kg
Price of culling gilt live weight	2.240	$/kg
Reproduction AB		
Average conception rate of sow	0.950	
Sow farrowing to weaning mortality	0.050	
Sow weaning to mating culling rate	0.150	
Sow conception to farrowing mortality	0.120	
Gilt conception to farrowing mortality	0.100	
Total number of piglets born	15.000	
Number of piglets born alive	13.500	
Lactation mortality of piglet	0.120	
Nursery mortality of pig	0.050	
Finishing mortality of pig	0.040	
Gilt culling rate	0.050	
Gilt mortality	0.050	
Feed intake of piglet during lactation	0.150	kg/per
Finishing feed conversion rate of finisher	2.650	kg feed/kg weight
Daily feed intake of gilt	3.000	kg/d
Daily feed intake of sow weaning to conception	2.500	kg/d
Daily feed intake of sow during pregnancy	2.500	kg/d
Daily feed intake of sow during lactation	6.000	kg/d
Number of sows	9000.000	
Maximum parity of sow	6.000	
Maximum number of matings per parity of sow	3.000	
Mating age of gilt	230.000	d
Gilt mating to conception interval	2.000	d
Sow weaning to conception interval	7.000	d
Pregnancy days of sow	114.000	d
Lactation days of piglet	22.000	d
Nursery days of pig	50.000	d

Parameter name	Value	Unit	Parameter name	Value	Unit
Fixed cost of gilt	0.280	$/d·per	Finishing days of pig	108.000	d
Fixed cost of sow	0.280	$/d·per	Weaning weight of piglet	6.500	kg
Sow farrowing cost	4.200	$/per	End of nursery weight	28.000	kg
Sow mating cost	4.900	$/per	Finished weight of pig	110.000	Kg
Cost of selling finished pig	0.700	$/per	Average weight of gilt culling	140.000	kg
Finished pig sale type	sold by carcass quality		Average weight of sow culling	220.000	kg
Slaughter rate	0.750		Number of nursery phases	3.000	
Average price of lean meat rate	3.500	$/kg	Number of finishing phases	3.000	
increase 1% lean meat rate price difference	0.017	$/(kg·%)	Weight gain of nursery pig at all phases	7.200, 7.200, 7.200	kg
Average price of backfat thickness	3.500	$/kg	Weight gain of finishing pig at all phases	27.000, 27.000, 28.000	kg
Increase 1mm backfat thickness price difference	0.013	$/(kg·mm)	Daily feed intake of nursery pig at all phases	0.390, 0.680, 0.910	kg/d
Average price of loin muscle depth	3.500	$/kg	Feed price of nursery pig at all phases	0.655, 0.650, 0.545	$/kg
Increase 1mm loin muscle depth price difference	0.003	$/(kg·mm)	Feed price of finishing pig at all phases	0.455, 0.449, 0.435	$/kg
Average price of loin muscle area	3.500	$/kg	Feed price of lactating piglet	0.660	$/kg
Increase 1mm^2 loin muscle area difference	0.003	$/(kg·mm^2)	Feed price of gilt	0.420	$/kg
Cull pig sale type	sold by live weight		Feed price of sow during mating interval	0.470	$/kg
Price of culling sow live weight	1.890	$/kg	Feed price of sow during pregnancy	0.470	$/kg
Price of culling gilt live weight	2.240	$/kg	Feed price of sow during lactation	0.470	$/kg

Table S3 Example parameters of pig genetic variance–covariance matrix in the farrow-to-finish (commercial) herd

Trait name	Backfat depth	Loin muscle depth	Finishing FCR	Age at target weight	Number of born alive
Backfat depth	2.510	0.040	0.121	0.431	0.000
Loin muscle depth	0.040	7.734	-0.103	0.417	0.000
Finishing FCR	0.121	-0.103	0.024	0.243	0.000
Age at target weight	0.431	0.417	0.243	23.915	0.000
Number of born alive	0.000	0.000	0.000	0.000	1.965

Table S4 Example parameters of pig genetic variance–covariance matrix for breed A in the three-way crossbreeding system

Trait name	Backfat depth	Loin muscle depth	Finishing FCR	Age at target weight	total number born	number born alive	farrowing interval	age at first farrowing
Backfat depth	2.510	0.040	0.121	0.431	0.000	0.000	0.000	0.000
Loin muscle depth	0.040	7.734	-0.103	0.417	0.000	0.000	0.000	0.000
Finishing FCR	0.121	-0.103	0.024	0.243	0.000	0.000	0.000	0.000
Age at target weight	0.431	0.417	0.243	23.915	0.000	0.000	0.000	0.000
total number born	0.000	0.000	0.000	0.000	0.534	0.469	-0.307	-1.054
number born alive	0.000	0.000	0.000	0.000	0.469	0.428	-0.311	-2.076
farrowing interval	0.000	0.000	0.000	0.000	-0.307	-0.311	1.226	8.783
age at first farrowing	0.000	0.000	0.000	0.000	-1.054	-2.076	8.783	207.996

Table S5 Example parameters of pig genetic variance–covariance matrix for breed B in the three-way crossbreeding system

Trait name	Backfat depth	Loin muscle depth	Finishing FCR	Age at target weight	total number born	number born alive	farrowing interval	age at first farrowing
Backfat depth	2.581	-0.640	0.215	-1.004	0.000	0.000	0.000	0.000
Loin muscle depth	-0.640	6.743	-0.006	0.731	0.000	0.000	0.000	0.000
Finishing FCR	0.215	-0.006	0.049	-0.339	0.000	0.000	0.000	0.000
Age at target weight	-1.004	0.731	-0.339	26.778	0.000	0.000	0.000	0.000
total number born	0.000	0.000	0.000	0.000	0.846	0.702	-0.214	-0.107
number born alive	0.000	0.000	0.000	0.000	0.702	0.646	-0.115	-0.093
farrowing interval	0.000	0.000	0.000	0.000	-0.214	-0.115	3.200	2.287
age at first farrowing	0.000	0.000	0.000	0.000	-0.107	-0.093	2.287	135.096

Table S6 Example parameters of pig genetic variance–covariance matrix for breed C in the three-way crossbreeding system

Trait name	Backfat depth	Loin muscle depth	Finishing FCR	Age at target weight
Backfat depth	2.853	0.199	0.154	0.394
Loin muscle depth	0.199	9.264	0.102	2.074
Finishing FCR	0.154	0.102	0.027	0.138
Age at target weight	0.394	2.074	0.138	23.496

Table S7 Sensitivity analysis of economic weights of different traits for the farrow-to-finish (commercial) herd

Trait name	Economic weight	Feed price increase					Non-feed price increase					Sale price increase				
		10%	20%	30%	40%	50%	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%
Age at target weight ($/d)	0.53	0.55	0.56	0.58	0.59	0.61	0.57	0.61	0.64	0.68	0.72	0.53	0.53	0.53	0.53	0.53
Finishing FCR ($·kg/kg)	37.37	41.11	44.84	48.58	52.32	56.05	37.37	37.37	37.37	37.37	37.37	37.37	37.37	37.37	37.37	37.37
Number of born alive ($/piglet)	1.56	1.74	1.91	2.09	2.27	2.44	1.60	1.64	1.68	1.72	1.76	1.50	1.43	1.37	1.30	1.24
Backfat depth ($/mm)	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.18	1.29	1.39	1.50	1.61
Loin muscle depth($/mm)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.27	0.30	0.32	0.35	0.37

Table S8 Relative economic weights of different traits for the farrow-to-finish (commercial) herd

Trait name	Relative economic weight	Feed price increase			Non-feed price increase			Sale price increase		
		10%	20%	40%	10%	20%	40%	10%	20%	40%
Backfat depth	11.19%	10.38%	9.73%	8.59%	10.97%	10.76%	10.38%	12.29%	13.39%	15.46%
Loin muscle depth	4.59%	4.26%	3.99%	3.52%	4.50%	4.41%	4.26%	4.94%	5.46%	6.33%
Finishing FCR	38.23%	39.01%	39.85%	41.05%	37.46%	36.73%	35.46%	38.07%	37.92%	37.65%
Age at target weight	17.11%	16.47%	15.71%	14.61%	18.04%	18.93%	20.37%	17.04%	16.98%	16.86%
Number of born alive	28.88%	29.88%	30.72%	32.23%	29.03%	29.17%	29.53%	27.65%	26.26%	23.70%