

# Meat Quality Genes for Pig Breeding in Taiwan



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# Outline

1. Breed Resources
2. Growth Performance Test
3. Pig Genomics and Industry Applications
4. Meat Quality
5. Conclusion

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[http://www.angrin.tlri.gov.tw/pig\\_all.htm](http://www.angrin.tlri.gov.tw/pig_all.htm)



Pig Web

Animal Genetic Resources Information Network

種原資料庫 | 圖鑑分布 | 基因圖 | 刊物 | 供種場 | DNA庫 | 種原資源 | 檢索 | 生物資訊

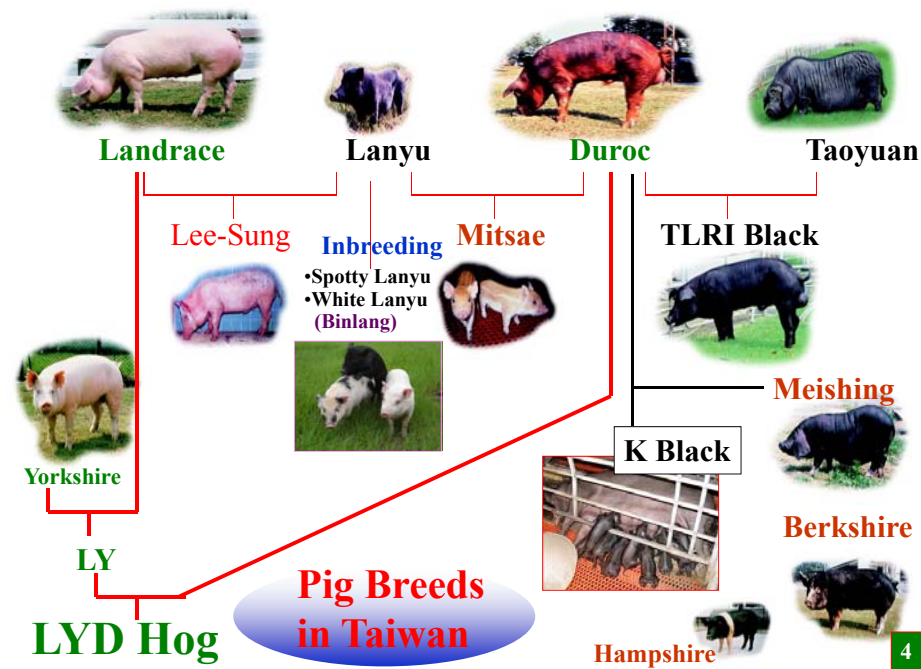
- 獲得特異性的影像 Photo and Movie
- 舉辦種原巡迴 Top Events
- 培育種原紀錄項目 Pig Breeding Program (2005-2014)
- 世界豬的網頁 Web page before 2012/13/1
- 檢定公佈種原 Performance Test Data

種豬產業發展里程

1960 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 種豬品質提升年

http://www.angrin.tlri.gov.tw/english/index\_pig.htm

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## Technology Chain for Breeding Pig Industry

Birth recording	Trait performance test	Pedigree registration	Auction
Mating date of female (NS/AI) Farrowing date of sows (F/AF) Birth pedigree: Sire Dam Sire of Sire Dam of Sire Sire of Dam Dam of Dam	Pigs born (male/female) Teat number (left/right) Birth weight 3-week body weight 5-month body weight Day of age at 110(100) kg BW (male/female) Back fat thickness at 110(100) kg BW (M/F) 40~110 (100) kg body weight (male/female) – Average daily gain <b>Feed efficiency (FE)</b> Body conformation evaluation Conformation trait (length, width, height, depth) <b>Semen quality (sperm counts, normality)</b> <b>Hoof evaluation (toe balance)</b>	Basic Pedigree Growth Performance (GP) Reproductive Performance (RP) Superb GP Superb RP Plum Blossom Award <b>Genotype –</b> Hal-1843(CRC) ESR HFABP IGF2in7 IGF2in3 PRLR XY-markers	<b>Test Station</b> (7.5 months old)– Duroc Landrace Yorkshire  FFASI (8~10 months old) – <b>Duroc</b> <b>Landrace</b> <b>Yorkshire</b> <b>Berkshire</b> <b>Formosan</b>

Pedigree Registration: NAIF

Performance Test Station: Hsinhua (Farm should have at least 30 registered sows of one breed.)

Genotyping: TLRI, NPUST (Prof. HL Chang), NAIF

Conformation Evaluation: YY Sung, LC Hsia, RC Weng, YY Lai, PH Wang

Selection Index: TLRI (MC Wu and YC Huang)

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## Application of Selection Index for Landrace, Yorkshire and Duroc Breeds of Pig

( 66% : 18% : 16% )

1975~1980  $I = 250 + 110 \text{ ADG} - 50 \text{ FE} - 19.7 \text{ BF}$

1981~1991  $I = 100 + 60 \text{ ADG} - 40 \text{ FE} - 45 \text{ BF}$   
33% : 40% : 27%

1992~2004  
(L, Y)  $I = 100 + 130 \text{ ADG} - 40 \text{ FE} - 40 \text{ BF}$   
66% : 18% : 16%

2005~Present  
L, Y  $I = 100 + 140 \text{ ADG} - 60 \text{ FE} - 30 \text{ BF}$   
42% : 43% : 15%

D  $I = 100 + 120 \text{ ADG} - 55 \text{ FE} - 50 \text{ BF}$   
40% : 40% : 20%

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## Off-age (day of age) to 110 Kg body weight at Hsinhua Station for growth performance test

Off Age (Day)	Off-test Boar (Hd)			In total (Hd)	%	Cum. (Hd)	Cum. (%)
	Duroc	Landrace	Yorkshire				
143	3	0	0	3	0.19	3	0.19
146	0	0	1	1	0.06	4	0.25
147	102	34	16	152	9.61	156	9.87
148	159	74	32	265	16.76	421	26.63
149	195	50	28	273	17.27	694	43.90
150	163	55	14	232	14.67	926	58.57
151	57	31	11	109	6.89	1035	65.46
152	43	42	19	104	6.58	1139	72.04
153	78	37	14	129	8.16	1268	80.20
154	27	10	5	42	2.66	1310	82.86
155	53	24	15	92	5.82	1402	88.68
156	21	3	1	25	1.58	1427	90.26
157	19	4	1	24	1.52	1451	91.78
158	13	0	1	14	0.89	1465	92.66
159	9	7	4	20	1.27	1485	93.93
160	7	1	1	9	0.57	1494	94.50
161	17	7	4	28	1.77	1522	96.27
162	27	2	2	31	1.96	1553	98.23
163	1	0	0	1	0.06	1554	98.29
164	2	1	1	4	0.25	1558	98.55
165	1	0	0	1	0.06	1559	98.61
166	2	1	0	3	0.19	1562	98.80
168	6	2	0	8	0.51	1570	99.30
169	3	2	1	11	0.70	1581	100.00

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## Growth performance and auction price grouped by off-age (days old) at Hsinhua Station

Off Age (Day)	Growth Performance					Price sold (NT\$)
	70D BW(Kg)	ADG(Kg)	FE(F/G)	BF of 110Kg(cm)	Age of 110Kg	
143	38.0	1.048	2.043	1.323	144	44000
146	30.4	1.079	2.010	1.330	143	20000
147	34.1	1.151	2.059	1.281	140	41037
148	33.1	1.143	2.070	1.290	142	46285
149	33.4	1.154	2.074	1.238	140	39174
150	33.5	1.136	2.075	1.241	141	41944
151	34.5	1.114	2.071	1.235	141	41234
152	32.8	1.134	2.064	1.245	143	38416
153	32.5	1.130	2.070	1.226	143	45541
154	27.3	1.111	2.072	1.366	154	31176
155	27.1	1.105	2.072	1.355	154	34166
156	25.0	1.096	2.060	1.330	155	27700
157	24.6	1.091	2.057	1.330	156	31777
158	25.1	1.123	2.041	1.330	157	31250
159	26.1	1.071	2.080	1.337	158	26090
160	24.8	1.112	2.063	1.340	160	22500
161	24.8	1.075	2.076	1.334	159	31818
162	23.8	1.080	2.074	1.313	160	26724
163	27.2	1.043	2.060	1.350	160	23000
164	21.8	1.061	2.062	1.260	161	28000
165	24.0	1.043	2.050	1.340	163	15000
166	23.3	1.033	2.070	1.340	164	30500
168	24.2	1.035	2.065	1.256	165	25428
169	23.6	1.047	2.085	1.308	167	28222

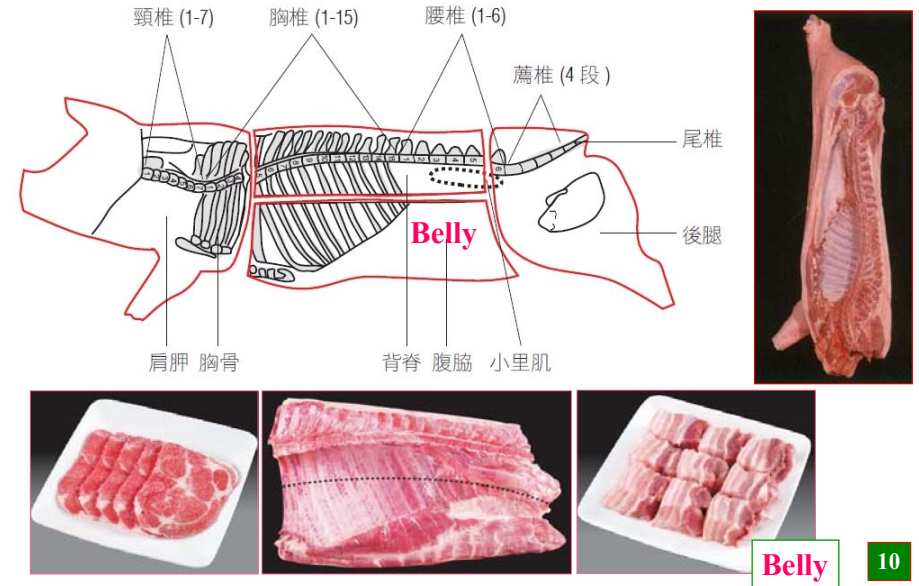
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# Marker Genotype Screened by Pig Industry in Taiwan

Favorable genotype	Chr.	Start year
Hal-1843 AA	6	1996
ESR MM + MN	1	2001
HFABP HH6 + HL5	6	2002
IGF27 FF	2	2005
IGF23 QQ	2	2005
PRLR PP+LP	16	2008
XY-marker Sw1325	XY	2012

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## Pork belly is popular in Asian cuisine!



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	Color	Firmness/Wetness	Marbling (IMF)	(HFABP genotyping)
<b>PSE</b> (Hal-1843 Test) AA AB BB				1
<b>RSE</b>				2
<b>RFN</b>				3
<b>DFD</b>				4
				5

**Pork marbling is gene expression!**

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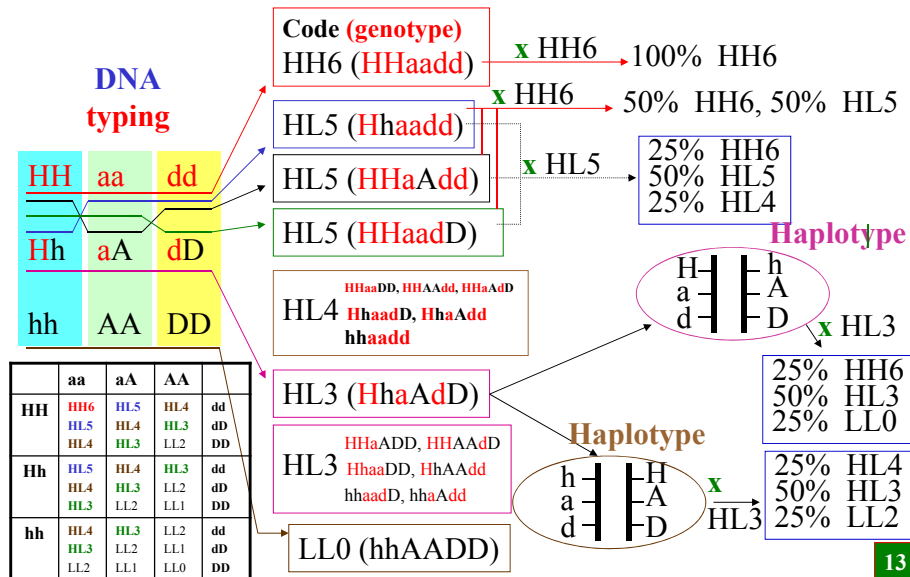
- Meat quality (intramuscular fat or marbling) of pork is related to meat eating quality.
- Fat marbling is designed as the percentage of intramuscular fat.

- H, a and d allele from three loci of heart fatty acid-binding protein (HFABP) gene are favorable alleles to fat marbling.
- Marker group of LL, HL or HH is based upon favorable allele counts:
  - 0~2 for lower quality (LL)
  - 3~5 for average quality (HL)
  - 6 for higher quality (HH)

	aa	Aa	AA		
<b>HH</b>	<b>HH6</b>	HL5	HL4	<b>dd</b>	
		HL5	HL4	<b>Dd</b>	
		HL4	HL3	LL2	DD
<b>Hh</b>		HL5	HL4	<b>HL3</b>	
		HL4	HL3	LL2	<b>Dd</b>
		HL3	LL2	LL1	DD
<b>hh</b>		HL4	HL3	LL2	<b>dd</b>
		HL3	LL2	LL1	<b>Dd</b>
		LL2	LL1	LL0	DD

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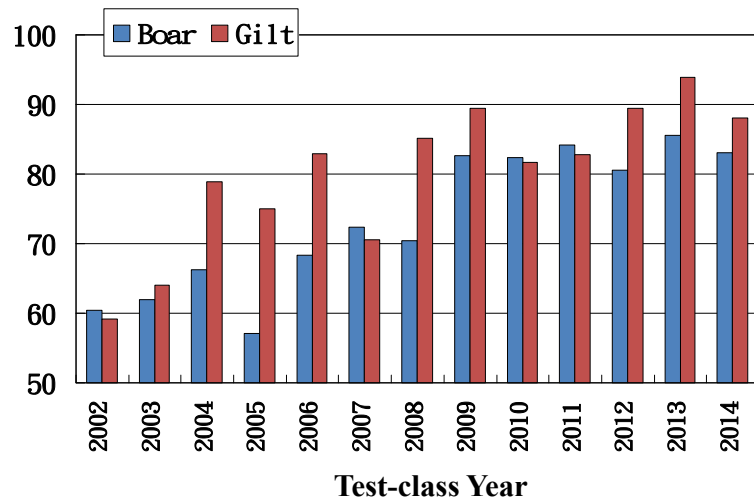
### Breeding on Heart Fatty Acid-Binding Protein (H-FABP) Gene for Improvement of Pork Quality



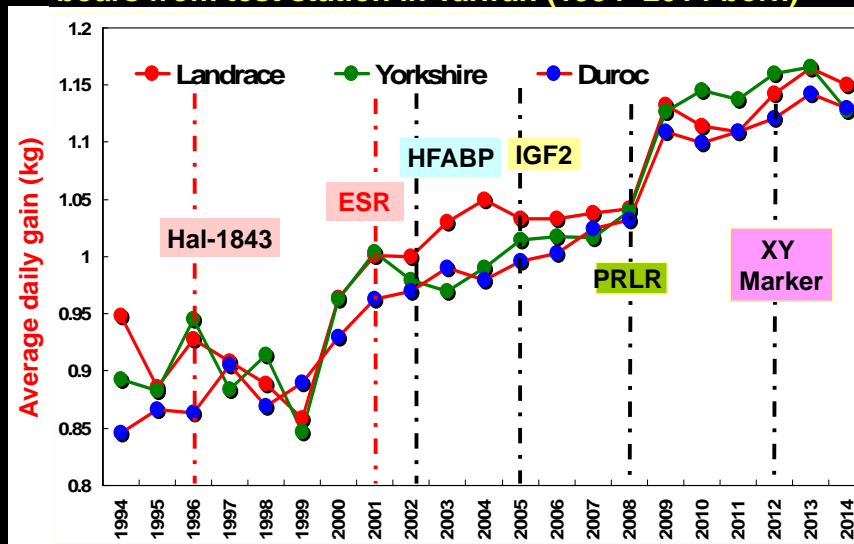
### HH6 Genotype frequency of HFABP gene in Duroc pigs at GGP+GP breeding farms

出生年 Birth	品種 Breed	場數 Farms	HFABP 肉質基因檢測										
			總頭數(N)	LL0	LL1	LL2	HL3	HL4	HL5	HH6	HH6(%)	H--	H--(%)
2014	D	11	241	0	3	3	3	19	0	213	88.4	235	97.5
2013	D	23	1345	2	8	4	68	92	7	1164	86.5	1331	99.0
2012	D	25	1584	2	2	4	104	66	13	1393	87.9	1576	99.5
2011	D	25	1841	5	19	5	189	134	46	1443	78.4	1812	98.4
2010	D	27	1994	22	19	7	230	130	30	1556	78.0	1946	97.6
2009	D	25	1674	10	16	5	220	121	31	1271	75.9	1643	98.1
2008	D	27	1437	8	22	13	182	127	31	1054	73.3	1394	97.0
2007	D	22	1332	12	11	11	151	145	25	977	73.3	1298	97.4
2006	D	23	1582	20	13	8	238	162	43	1098	69.4	1541	97.4
2005	D	22	1766	38	17	21	291	231	96	1065	60.3	1683	95.3
2004	D	24	528	10	6	12	116	63	12	308	58.3	499	94.5
2003	D	22	244	7	6	1	37	41	5	131	53.7	230	94.3

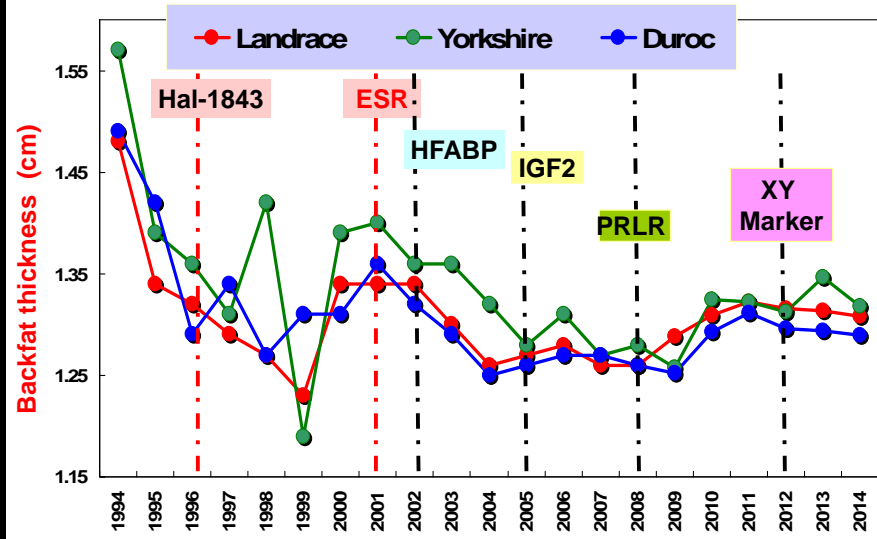
### HH6 Genotype frequency of HFABP gene in Duroc pigs at Hsinhua Station



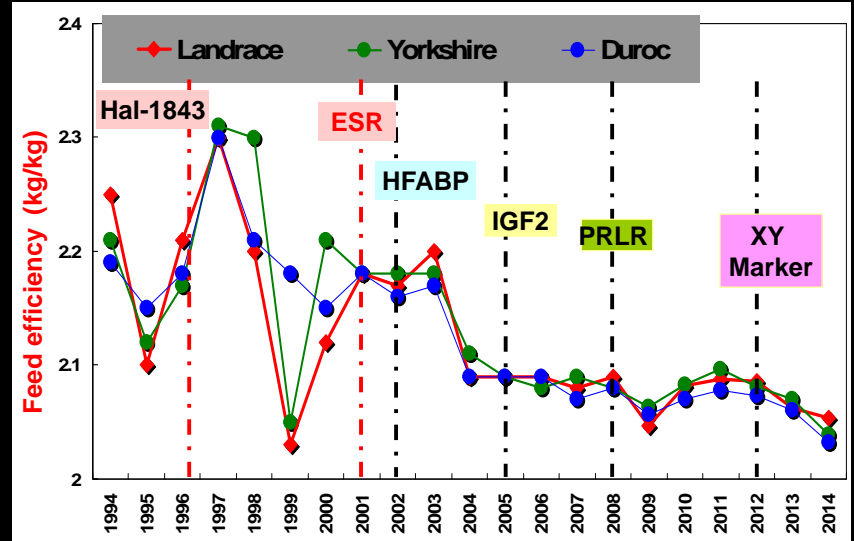
### Phenotypic trends of average daily gain for off-test boars from test station in Taiwan (1994~2014 born)



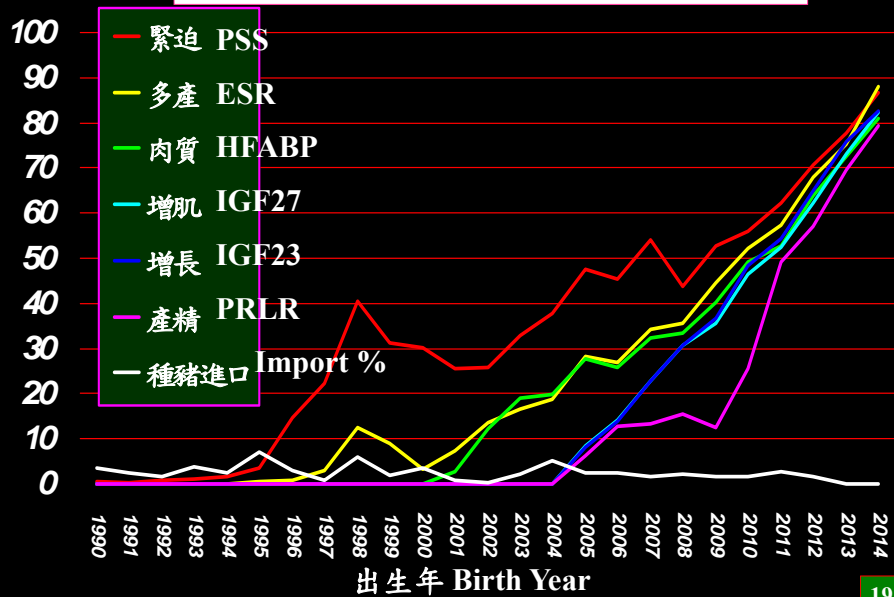
### Phenotypic trends of backfat thickness at 110 kg for off-test boars from test station in Taiwan (1994~2014 born)



### Phenotypic trends of feed efficiency (feed/gain) for off-test boars from test station in Taiwan (1994~2014 born)



### Genotyped breeding pigs(%)



### Total Sperm Count of Boar Semen Collected at 270 days of age (Query date: 2015/1/7)

TSC (Billion (10E9))	Head	Breed			
		Duroc	Landrace	Yorkshire	Formosan Black
10~19	4	3	1	0	0
20~29	18	12	2	3	1
30~39	76	58	9	6	3
40~49	124	83	24	13	4
50~59	221	165	36	8	12
60~69	257	173	53	23	8
70~79	219	155	45	12	7
80~89	158	106	34	14	4
90~99	89	64	17	5	3
100~109	35	23	9	2	1
110~119	20	12	5	3	0
120~129	6	4	2	0	0
130~139	3	1	2	0	0
140~149	3	2	1	0	0
150~159	2	1	1	0	0
160~169	1	0	1	0	0
230~239	1	0	1	0	0



Elite Boar

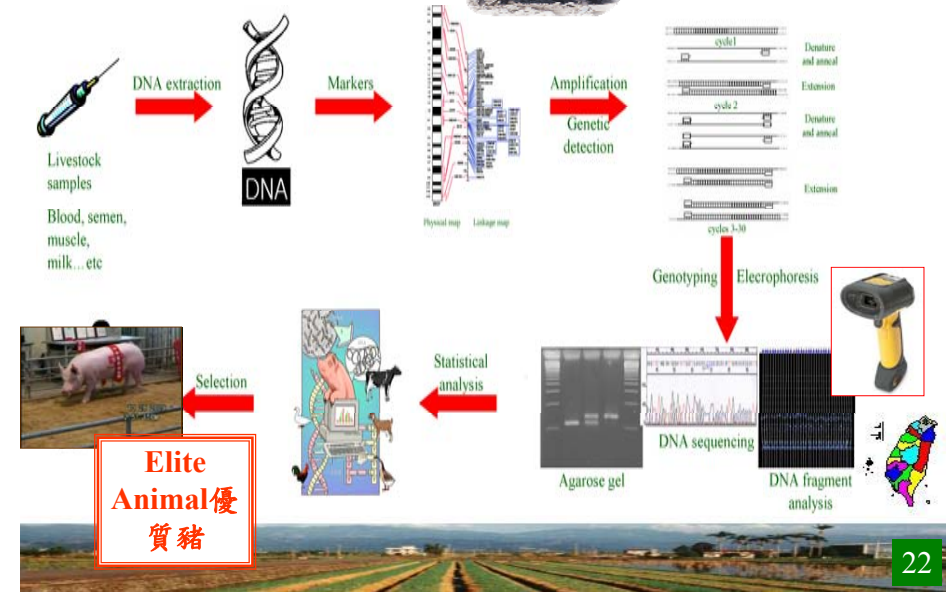
## PP Genotype frequency of PRLR gene in Duroc pigs at GGP+GP breeding farms

出生年 Birth	品種 Breed	場數 Farms	基因檢測			PRLR 產精基因登錄(Reg.)						
			總頭數	PP(頭)	PP(%)	頭數	LL	LP	PP	PP(%)	-P	-P(%)
2014	D	15	472	88	18.6	193	70	83	40	20.7	123	63.7
2013	D	24	1811	335	18.5	1233	385	627	221	17.9	848	68.8
2012	D	25	2034	358	17.6	1338	479	624	235	17.6	859	64.2
2011	D	27	2211	309	14.0	1274	501	589	184	14.4	773	60.7
2010	D	25	1098	122	11.1	657	269	309	79	12.0	388	59.1
2009	D	20	472	45	9.5	309	130	146	33	10.7	179	57.9
2008	D	23	510	45	8.8	331	178	124	28	8.5	152	45.9
2007	D	17	459	38	8.3	300	156	119	25	8.3	144	48.0
2006	D	17	472	28	5.9	324	184	119	21	6.5	140	43.2
2005	D	17	253	20	7.9	169	83	71	15	8.9	86	50.9

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## Genomic Breeding 基因選種



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## DNA barcoding for pigs

Hal-1843 gene for stress (AB), ESR gene for prolificacy (MN) and 16,613bp mtDNA for maternal origin, especially on D-loop region (1,175bp) of 29 SNPs and UTRn (tacacgtgcg 10bp)<sub>17-27</sub> in various breeds of pigs.



**CRC+ESR+18SNP+UTR+11SNP**

mtDNA D-Loop

A0021-02 Lanyu	AAMNcaattgctcgtttctcag24tgcctgaaacc
T0596-01 Taoyuan	AAMMcaattgctgttttcag24tgcctgaaact
L0074-10 Landrace	AAMNttgccattcaccctcaa27tgetttaaatt
Y0150-03 Yorkshire	AAMNcaattgctgttttcag25tcccgaacc
D0167-05 Duroc	AANNttgccattcaccctcaa26tgetttaaate

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## Conclusion & Vision



- Marker-assisted selection rests on a wide base of pedigree registration.
- Growth performance test of progeny pigs is served as genetic evaluation of breeding stocks in Taiwan.
- Taiwan [www.angrin.tlri.gov.tw](http://www.angrin.tlri.gov.tw) web-networking system is for pig breeders to view the profile of economic traits of breeding stocks on-line.



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