

Impacts of Climate Change on Pig Genetic Diversity and Selection

種豬育種策略 Pig Breeding

種用登錄 **Genetic**
全胎檢定 **Reproduction**
基因選種 **Evaluation**
市場拓展 **Auction**
創新增值 **Taiwan-value**

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第二屆台非種豬聯合育種研討會
Pig Genetic Networking - Philippines & Taiwan 1

Amills, Marcel, Clop, Alex, Ramirez, Oscar, and Pérez-Enciso, Miguel (Sep 2010) **Origin and Genetic Diversity of Pig Breeds**.
In: eL.S. John Wiley & Sons Ltd, Chichester. <http://www.els.net> [doi: 10.1002/9780470015902.a0022884]

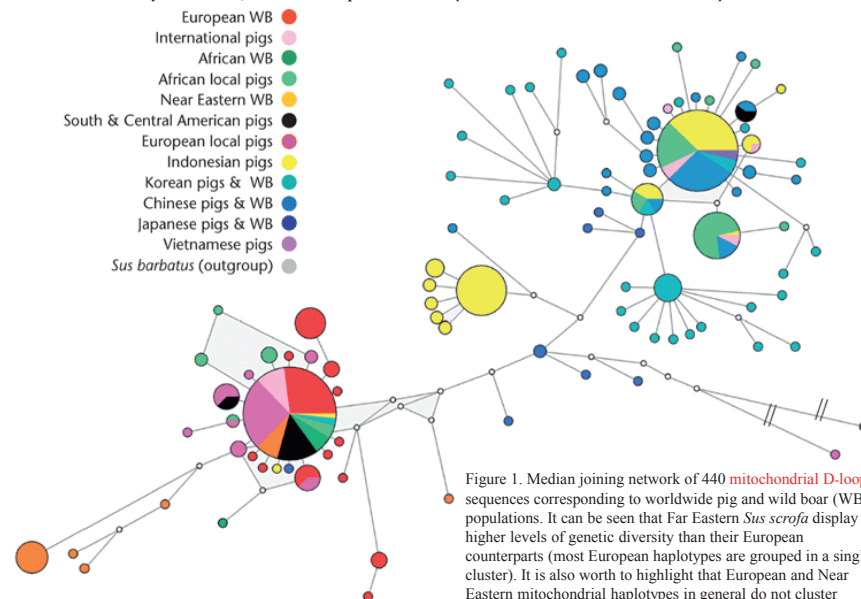


Figure 1. Median joining network of 440 mitochondrial D-loop sequences corresponding to worldwide pig and wild boar (WB) populations. It can be seen that Far Eastern *Sus scrofa* display higher levels of genetic diversity than their European counterparts (most European haplotypes are grouped in a single cluster). It is also worth to highlight that European and Near Eastern mitochondrial haplotypes in general do not cluster together suggesting that both populations have distinct origins.

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http://www.angrin.tlri.gov.tw/pig_all.htm

畜產種原資訊網 Animal Genetic Resources Information Network

豬 牛 水牛 山羊 綿羊 梅花鹿 水鹿 兔 雞 火雞 鵝 鴨 鵪鶉 天鵝 雜物 微生物

種原資料庫 圖鑑分布 基因圖 刊物 保種場 DNA庫 種原普查 檢索 生物資訊

035 75 TWpig

- 基因型鑑定
- 熱門種豬
- 年報種豬
- 登錄場名次
- 豬耳號碼查詢
- 種畜登錄查詢
- 基因檢核檢測速度
- 北美會第一台種豬
- 檢定地家系種豬
- 港口水產產仔紀錄
- 產豬達萬隻公程種
- 特種種
- 種豬進出口統計

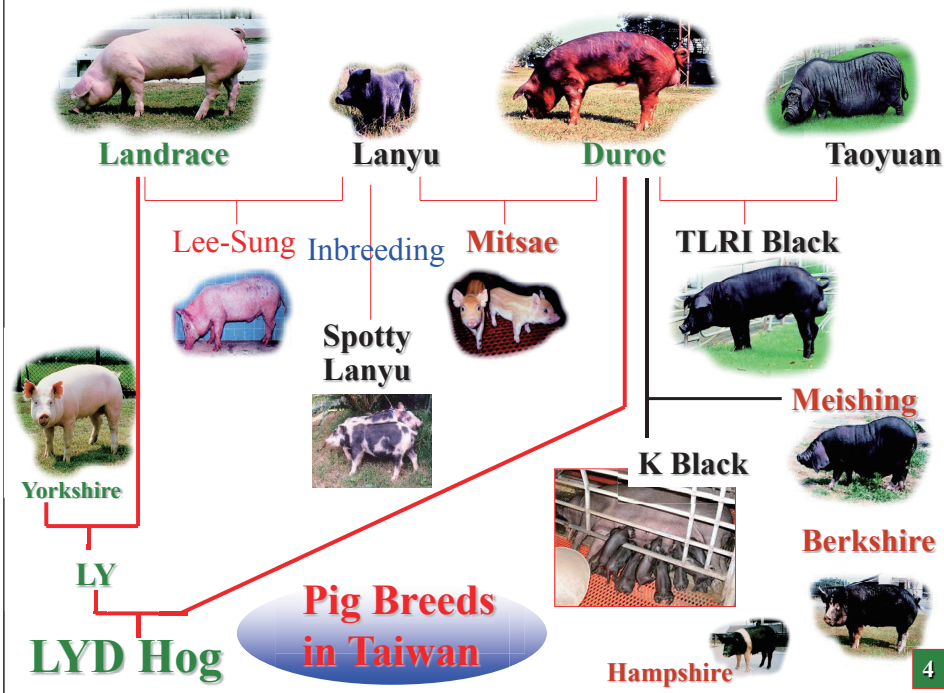
種豬產業發展里程

19 20 30 40 50 60 75 80 85 88 89 93 96 99 2012 13 08 10 11 13

2014 種豬品質提升年

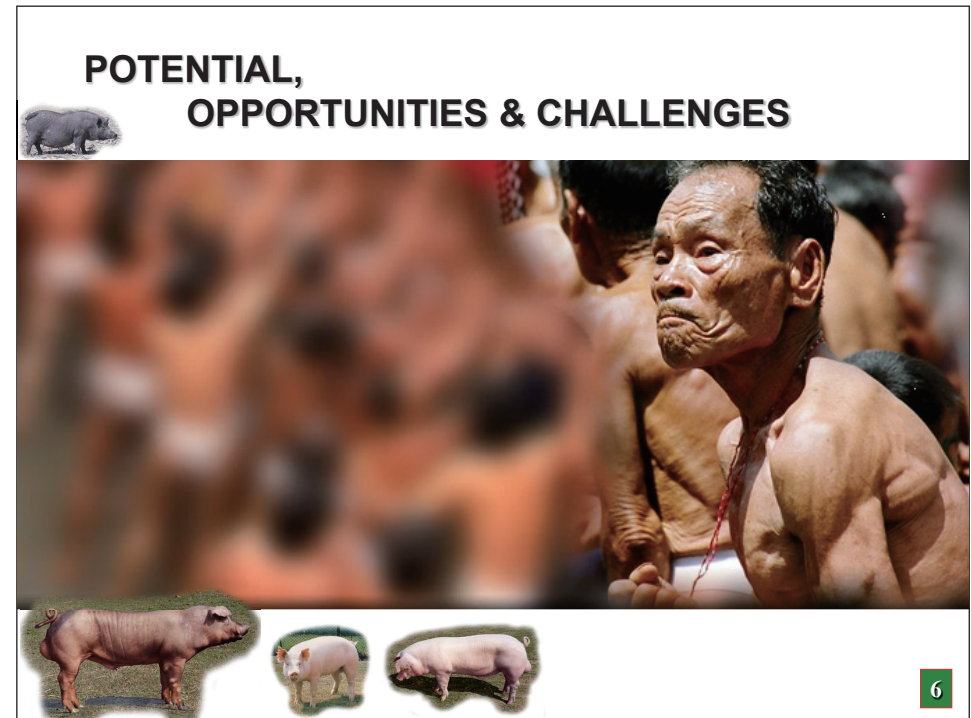
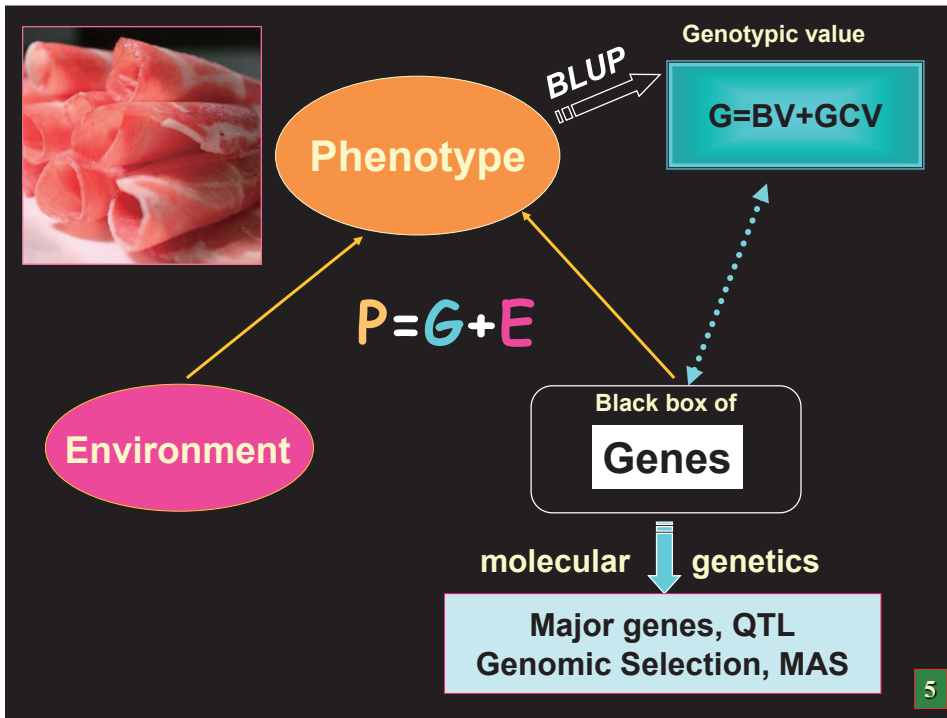
http://www.angrin.tlri.gov.tw/english/index_pig.htm

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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 Feed efficiency (FE) Body conformation evaluation Conformation trait (length, width, height, depth) Semen quality (Total sperm counts , normality) Day age to be sire or dam (Age at first litter)	Basic Pedigree Growth Performance (GP) Reproductive Performance (RP) Superb GP Superb RP Plum Blossom Award Genotype — Hal-1843(CRC) ESR HFABP IGF2in7 IGF2in3 PRLR XY-markers	Test Station (7.5 months old)— Duroc Landrace Yorkshire FFASI (8~10 months old) — Duroc Landrace Yorkshire Berkshire Black

Pedigree Registration: NAIF
Performance Test Station: Hsinhua (Farm should have at least 30 registered sows of one breed.)
Genotyping: TLRI, NPTU (Prof. HL Chang), NAIF
Conformation Evaluation: YY Sung, LC Hsia, RC Weng, YY Lai, PH Wang
Hoof Evaluation: TLRI (NT Yen, KC Liu, KY Lin)
Selection Index: TLRI (MC Wu and YC Huang)

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Pig Breeding Database of Taiwan

www.angrin.tlri.gov.tw

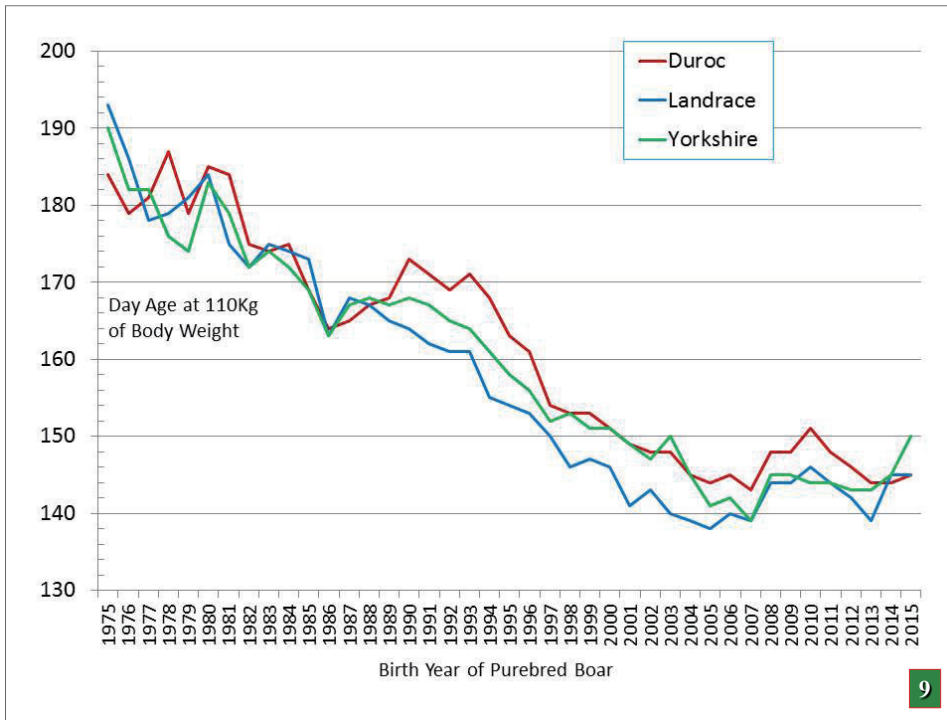
AID-COA
TLRI
NAIF
FFASI
NPTU
ATIT

Goal:
Feed efficiency (Feed/Gain) of growing boars from 40 to 110 kg of body weight
FE=3.17 in 1975 and upgraded to FE=2.08 in 2005,
projected to FE=1.80 in 2015

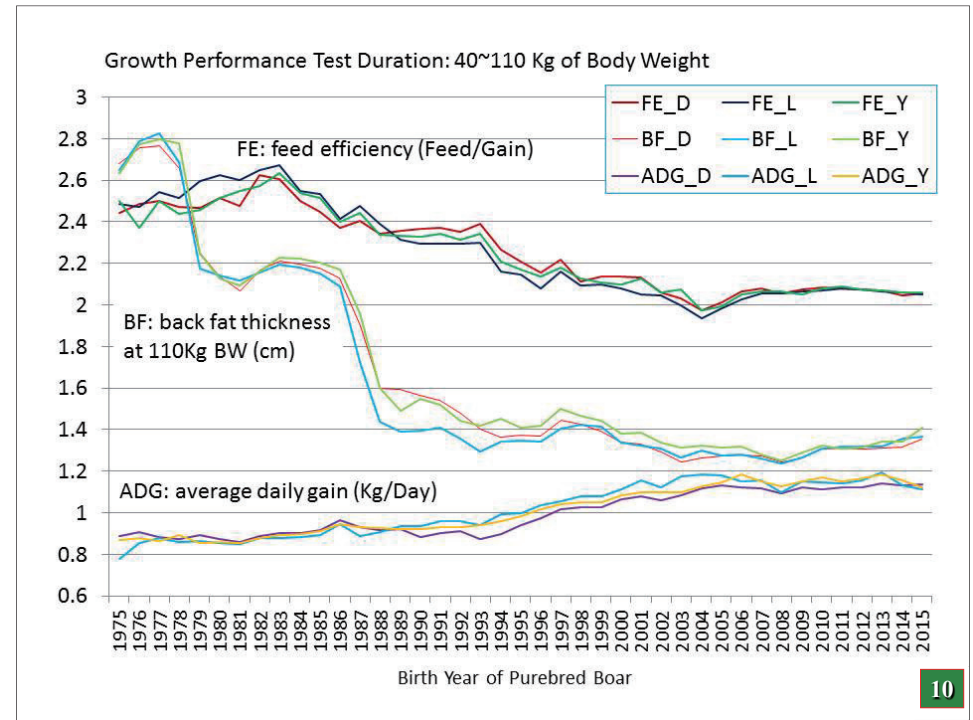
Major breed: Duroc

<p>Hsinhua Station D gilt, The Best</p> <p>Fortune D0634-11 (FE=1.95) 2005/3/13</p>	<p>Hsinhua Station D boar, The Best</p> <p>Hwei Huang D0329-05 (FE=1.90) 2003/8/26</p>	<p>Zhunan Station D boar, The Best</p> <p>Shun An D0785-01 (FE=1.51) 2004/6/29</p>
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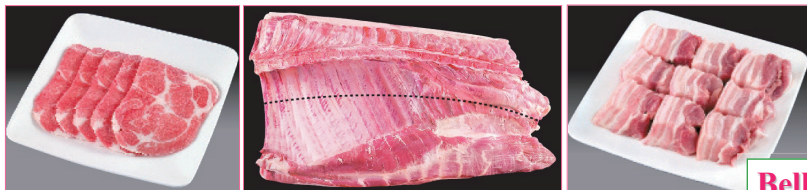
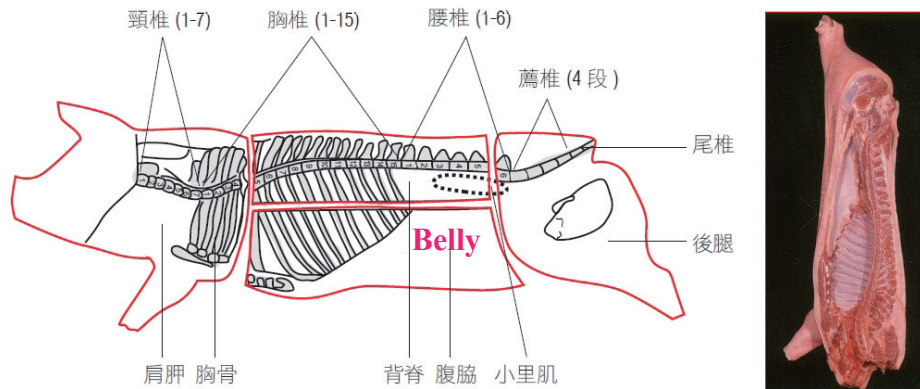


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Pork belly is popular in Asian cuisine!

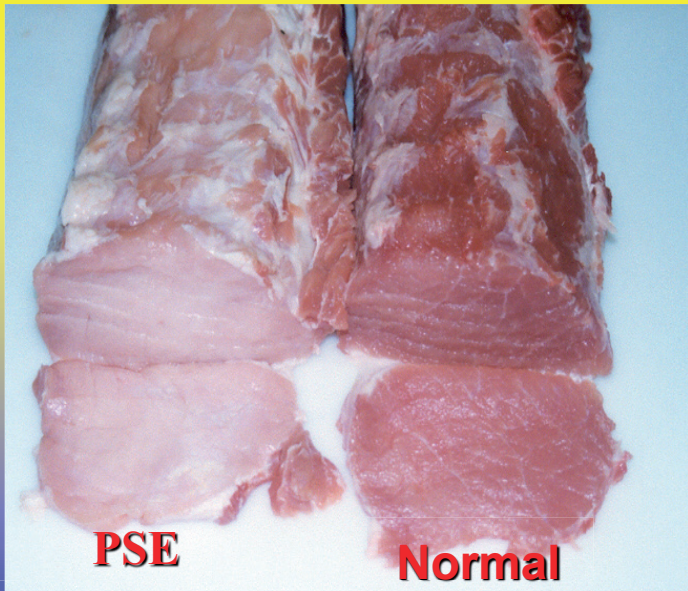


Belly

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Lean meat is gene expression!

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Pork quality is gene expression

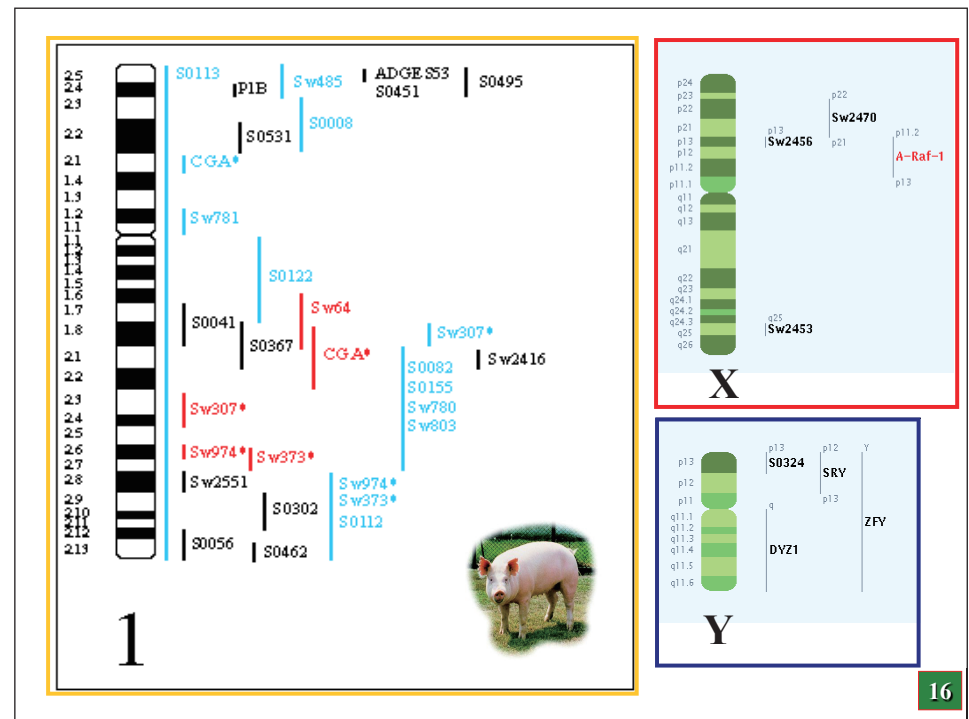
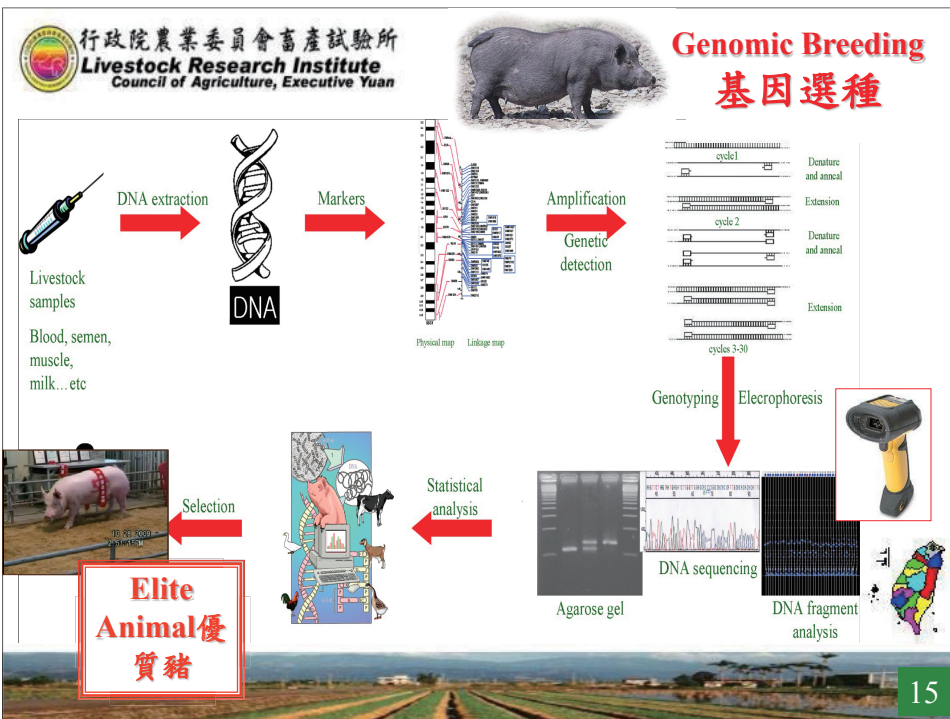
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	Color	Firmness/ Wetness	Marbling (IMF)
PSE (Hal-1843 Test) AA AB BB			
RSE			
RFN			
DFD			

1 (HFABP genotyping)
LL0
LL1
LL2
HL3
HL4
HL5
HH6

Pork marbling is gene expression!

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Remarks for Genomic Breeding/MAS

DNA information can help pig industry to fix a specific desirable major mutation, such as the normal **Halothane or PSS** allele.

Molecular information can increase **phenotypic** selection accuracy and response.

The successful breeding program via genomic information mainly depends on the fragment size of **DNA information**, accurate and reliable **pedigree** recording system of breeding stocks, and the integrating efficiency among them.

New genomic information is expanding and become more promising for further **application**.

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Regulation for Genomic Breeding of Farm Animals in Taiwan

Animal Industry Act Article 17

The competent authority may dispatch inspector to examine or test **the breeding flock**, breeding stock, facilities, pedigree registry and related records of breeders, and the breeders shall not evade, interfere with or object to such **examination** or **testing**.

Breeding flock or breeding stock found to have contracted notified disease or have **hereditary disease** during the aforesaid examination or testing shall be **banned from breeding**. The aforesaid inspectors shall present their identification when carrying out their duty.

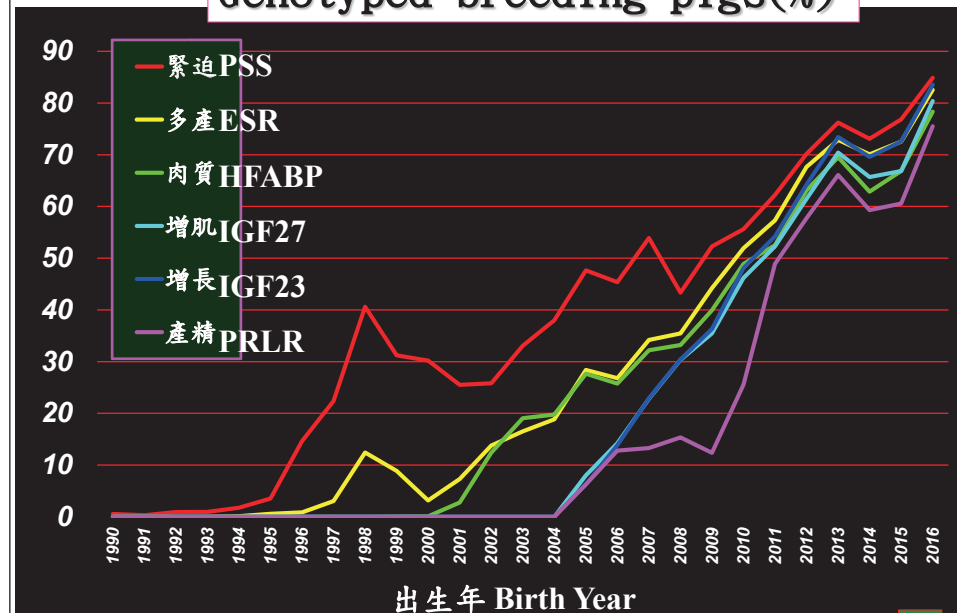
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Marker Genotype Screened by Pig Industry in Taiwan

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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Genotyped breeding pigs(%)



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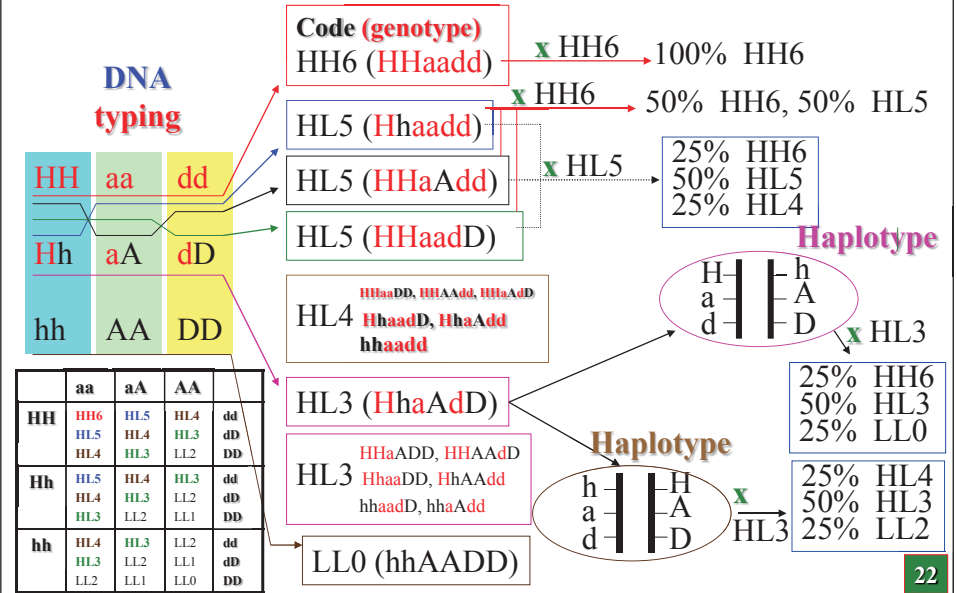
- **Meat quality (intramuscular fat or marbling) of pork is related to meat eating quality.**
- **Fat marbling is designed as the percentage of intramuscular fat.**

- **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	
HH	HH6	HL5	HL4	dd
	HL5	HL4	HL3	Dd
	HL4	HL3	LL2	DD
Hh	HL5	HL4	HL3	dd
	HL4	HL3	LL2	Dd
	HL3	LL2	LL1	DD
hh	HL4	HL3	LL2	dd
	HL3	LL2	LL1	Dd
	LL2	LL1	LL0	DD

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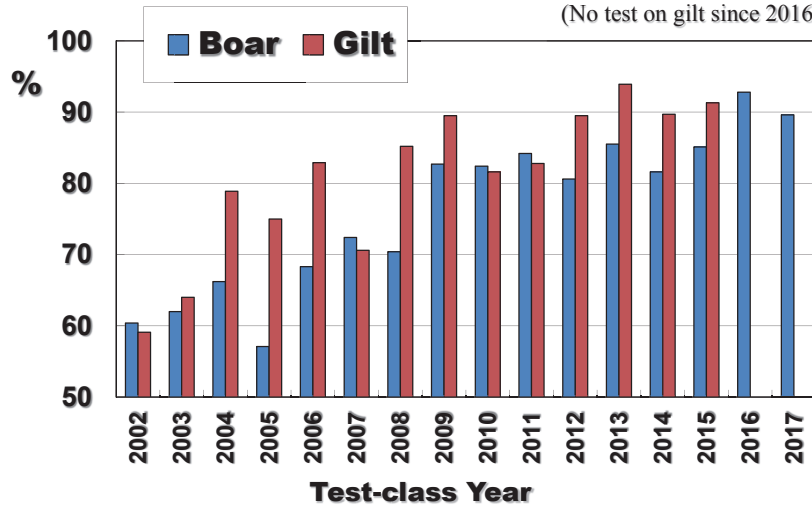
Breeding on Heart Fatty Acid-Binding Protein (H-FABP) Gene for Improvement of Pork Quality



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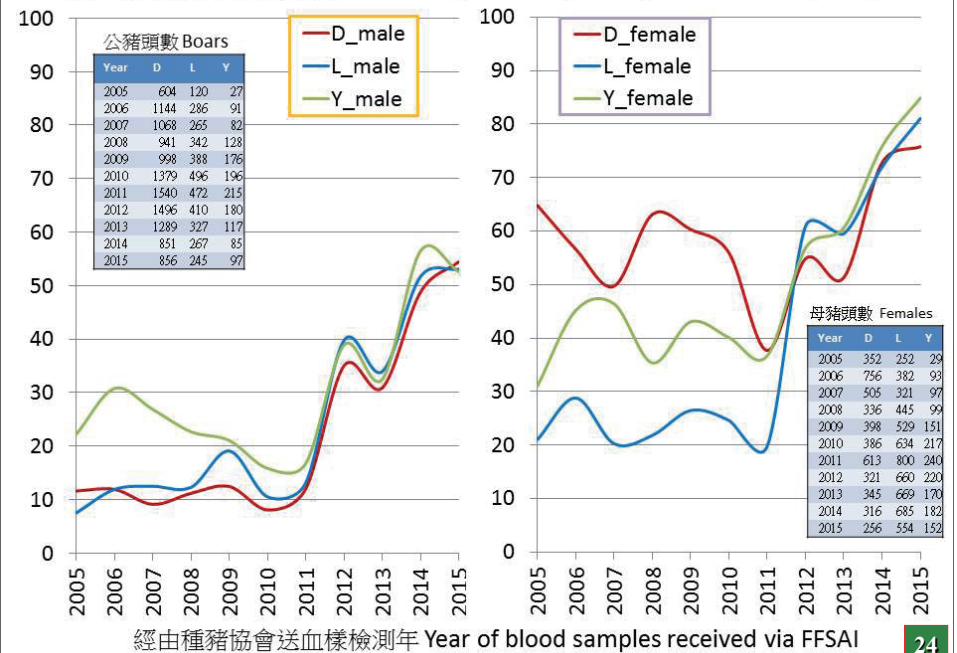
HH6 Genotype frequency of HFABP gene in Duroc pigs at Hsinhua Station

(No test on gilt since 2016)



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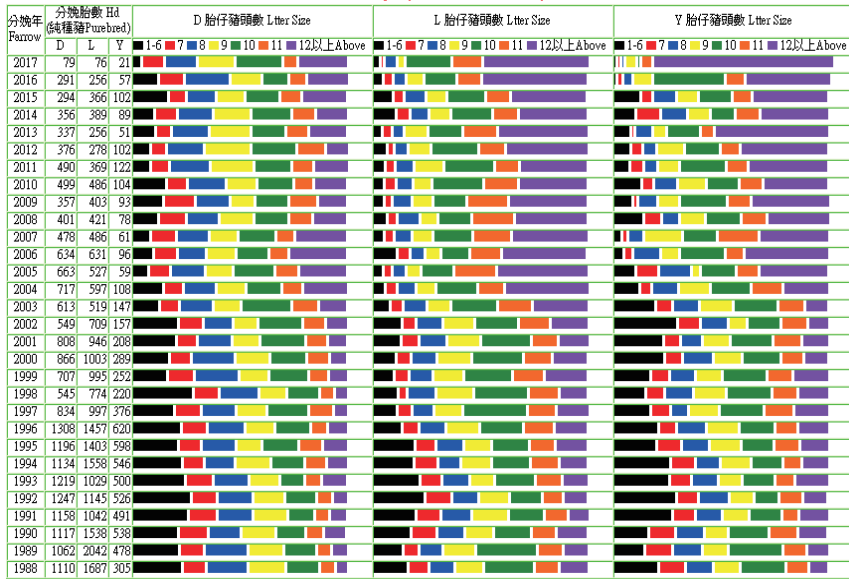
基因檢測後血統登錄完成率 Percentage of Pedigree Registration with genotypes



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Litter size profile of D, L and Y primiparous sows in percentage of litters

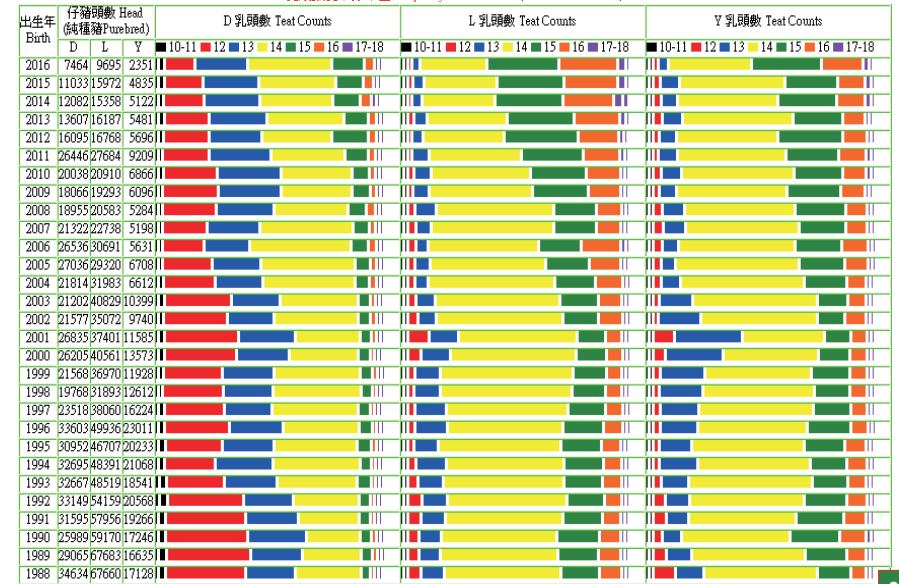
初產胎仔豬頭數比率分布圖 Frequency of Litter Size in First-Parity (查詢日: 2017/7/21)



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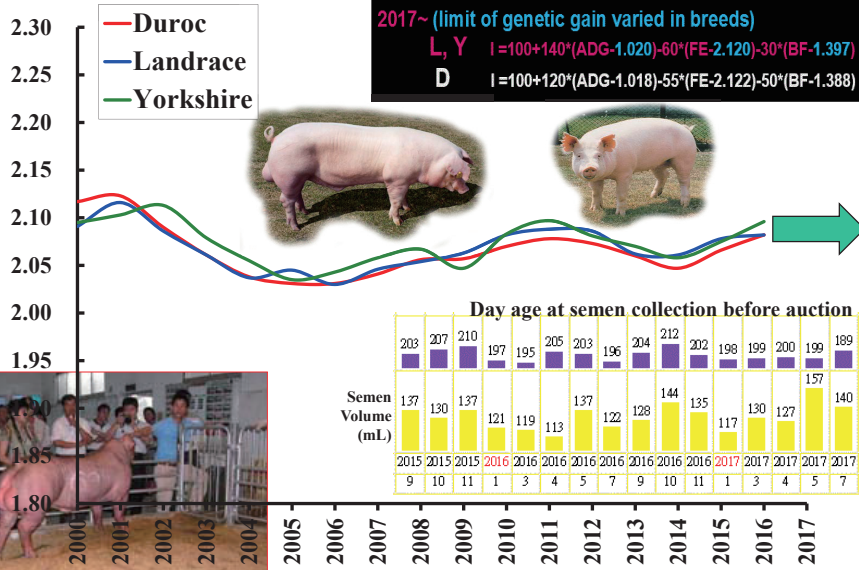
Teat counts of newborn piglets in D, L and Y breeds

乳頭數比率分布圖 Frequency of Teat Counts (查詢日: 2017/7/21)



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Feed Efficiency (feed/gain) from 40 to 110 kg of body weight



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最高價公豬

仙佳 D1759-01 200,000元
名次/指數: 1 體型: 腳蹄: .



福昌 L0770-01 191,000元
名次/指數: 2 體型: 1 腳蹄: 2

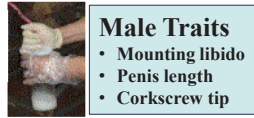


Age: 218 days old
仙佳 Y0019-03 220,000元
名次/指數: 1 體型: 腳蹄: .



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Total sperm count per collection in boars within 300 days of age



Breed (Collection Date: 2011/1/3-2015/12/9) (N=1566)					Breed (Collection Date: 2016/1/4-2017/6/3) (N=406)						
TSC (Billion) (10E9)	Head	Duroc	Landrace	Yorkshire	Black	TSC (Billion) (10E9)	Head	Duroc	Landrace	Yorkshire	Black
230-239	1		1			230-239					
160-169	1		1			160-169					
150-159	3	2	1			150-159					
140-149	4	2	2			140-149					
130-139	3	1	2			130-139	1	1			
120-129	12	9	3			120-129	7	5	2		
110-119	35	24	8	3		110-119	18	17	1		
100-109	52	38	11	2	1	100-109	37	26	10	1	
90-99	116	86	21	5	4	90-99	56	44	12		
80-89	210	140	47	17	6	80-89	82	65	17		
70-79	283	207	53	15	8	70-79	80	55	20	4	1
60-69	330	231	64	27	8	60-69	63	48	10	3	2
50-59	260	192	46	10	12	50-59	42	34	6	2	
40-49	144	95	31	13	5	40-49	17	14	2	1	
30-39	87	66	10	6	5	30-39	1	1			
20-29	20	13	2	3	2	20-29	1	1			
10-19	5	4	1			10-19	1	1			

Elite Boar



Boar Trait Sheet

Sperm Quality Sheet of Boar at 9 Month Old (Query Date : 2015/1/7)

Breed Ear No	Birth Date	Breeding Pig Farm
D0745-02	2014/2/7	Shui Po

FSS Genotype	ESR Genotype	Meat Quality Genotype	IGF2-RG Genotype
AA	NN	HH6(HHsald)	FF

Collection Date	Collection Age, Days
2014/1/5	271

Mounting Desire	Penis Appearance	Penis Length(cm)	Hind Leg Strength
High	正常	25	Normal

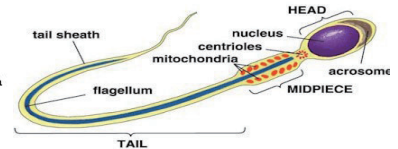
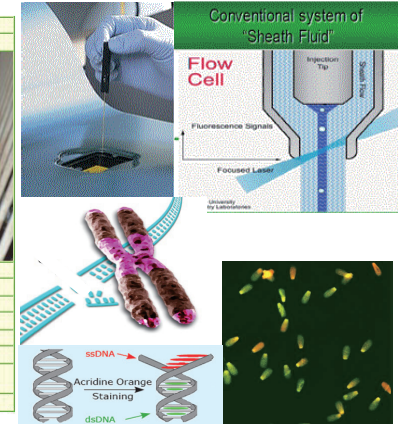
Semen Volume (mL)	Semen Color	Sperm Activity (90+++ Active)	Sperm Conc. Level (+++ Thickness)
150	Milk White	90+++	+++

V75Q	A40G	M30B	C500B	CH90B	SC95G	OX90B	EO
(>74)	(>39)	(<31)	(<501)	(<91)	(>94)	(<91)	(<1)
91	52	18	351	69	98	2	0.42

Sperm Quality Assay: Measuring key physiological functions for insights in the fertilisation potential of semen and/or its genitor

- V75Q Viability** - Indicator of the sperm membrane integrity as percentage of viable spermatozoa
- A40G Viability & Acrosome integrity** - Indicator of the acrosome integrity and it is essential for fertilization
- M30B Mitochondrial Potential** - Indicator of the mitochondrial status to show the integrity of the mitochondria
- CH90B Calcium level** - Indicator of the level of Ca in the sperm head - One of the signs of capacitation of sperm
- SC95G DNA fragmentation & DNA TUNEL assay** - Indicator of the condensation of the DNA structure but that are harmful at a high level
- OX90B Oxidation level** - Indicator of intracellular level of reactive oxygen species needed for sperm function
- EO Bacterial count** - Total bacterial count

Sperm Quality Assay



性品種別	名號	種別	耳號	父(種)	母(種)	出生日期	拍賣日期	乳頭數	基因型	產豬性狀
公	D1302-01	福昌	1302-01	福昌	1209-11	213467	26501	1285	AA-NN-HH6-FQ-QQ-LP	228 918 25
公	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	205 899 25
公	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	205 899 25
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	210 630 25
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -
母	D1309-04	福昌	1309-04	福昌	1519-12	216072	26501	1080	AA-NN-HH6-FQ-QQ-LP	- - -

<p>福昌 D1302-01 公 父: 20193-05 母: 1209-11 生日: 2016/8/14 基因條碼: AA-NN-HH6-FQ-QQ-LP 標購者: 黃清富 成交價: 62,000元</p>	<p>福昌 D1309-04 公 父: 21144-04 母: 1519-12 生日: 2016/8/17 基因條碼: AA-NN-HH6-FQ-QQ-LP 標購者: 李明忠 成交價: 49,000元</p>	<p>福昌 L1027-05 公 父: 20449-04 母: 0382-13 生日: 2016/8/29 基因條碼: AA-MN-LL0-FF-QQ-PP 標購者: 邱一慶 成交價: 67,000元</p>	<p>福昌 L1081-11 母 父: 21711-06 母: 1745-12 生日: 2016/4/23 基因條碼: AA-NN-LL2-FF-QQ-LL 標購者: 羅復興 成交價: 17,000元</p>	<p>福昌 Y1270-12 母 父: 21121-04 母: 1158-13 生日: 2016/9/30 基因條碼: AA-MM-HL4-FF-QQ-LP 標購者: 周慧玉 成交價: 22,000元</p>	<p>金龍 L0640-02 母 父: 21384-09 母: 1484-07 生日: 2016/7/8 基因條碼: AA-NN-HL4-FF-QQ-LL 標購者: 羅復興 成交價: 32,000元</p>
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2005~2014 Two Trait Index for L, Y, and D Breeds at 270 Days of Age

$$\text{Adjusted ADG (aADGkg)} = (\text{Body Weight in Kg} / \text{Age in days old}) + ((\text{Day} - \text{BWkg}) / (\text{Day} + \text{BWkg}))$$

Double Traits of **Body weight** and **Backfat thickness** Index (BAG index)

$$\text{BAG} = (\text{BWkg} / \text{ABFcm}) + 250 * (\text{aADGkg} - \text{mean aADGkg}) - 60 * (\text{ABFcm} - \text{mean ABFcm})$$

2015~Present

$$\text{BAG}_{\text{new}} = 1.52 * (\text{BWkg} / \text{BFcm at the fourth rib}) + 250 * (\text{aADGkg} - \text{mean aADGkg}) - 60 * (\text{ABFcm} - \text{mean ABFcm})$$

種豬育種頒獎

Awarding Activity for Elite Pigs

2016年腳蹄獎種豬場
Hoof Elite Pig Breeder Award 2016

2016年精力獎種豬
Sperm Quality Elite Boar Award 2016

