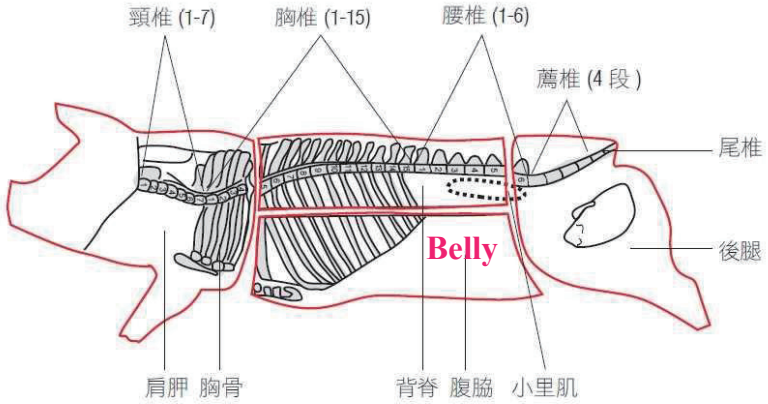
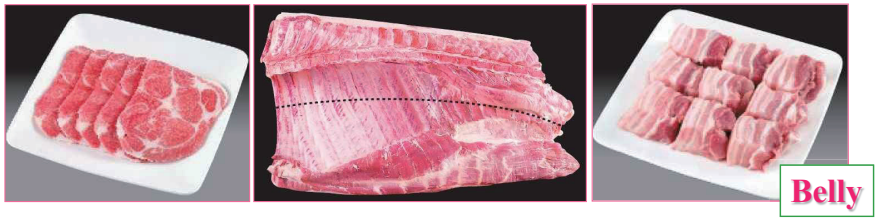
Needs on Omega-3 Pork

Mr. Ming-Che WU, Ph.D.
Division Chief of Breeding and Genetics
Livestock Research Institute (TLRI)
mcwu@mail.tlri.gov.tw

1

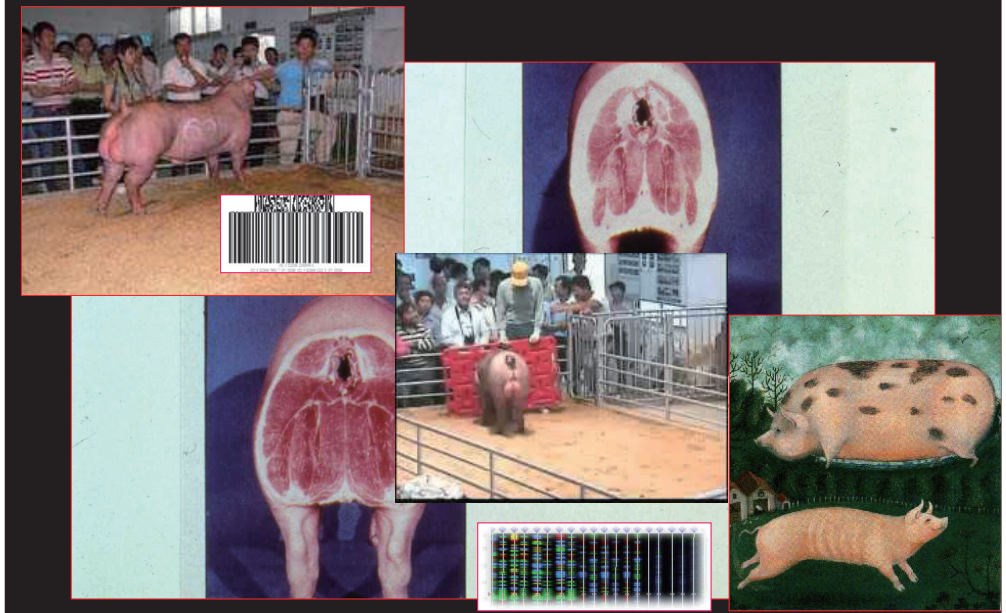
Pork belly is popular in Asian cuisine!





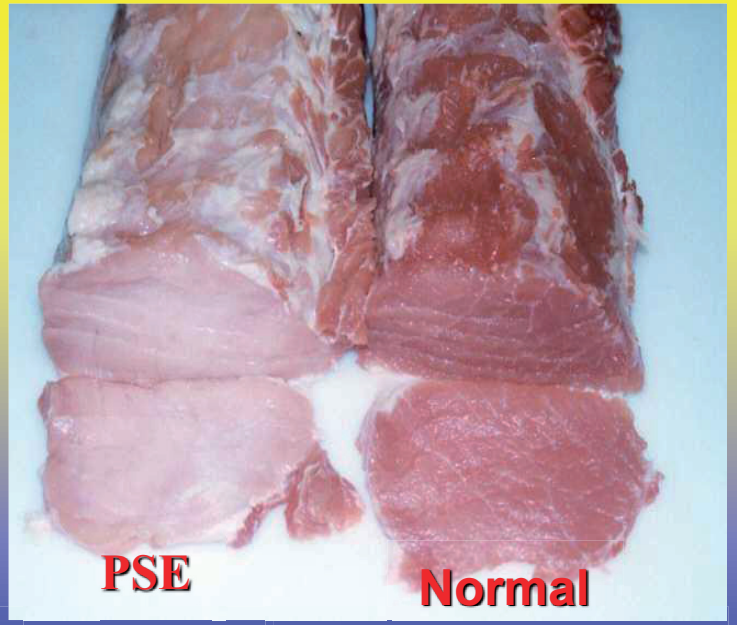
Belly

2



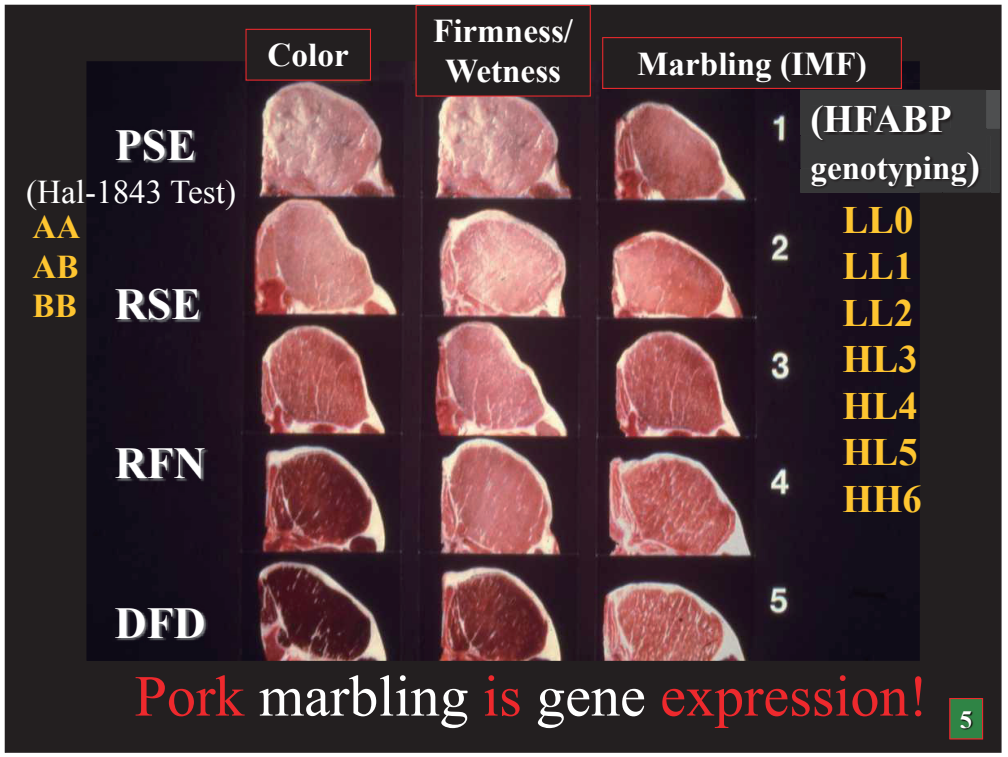
Lean meat is gene expression!

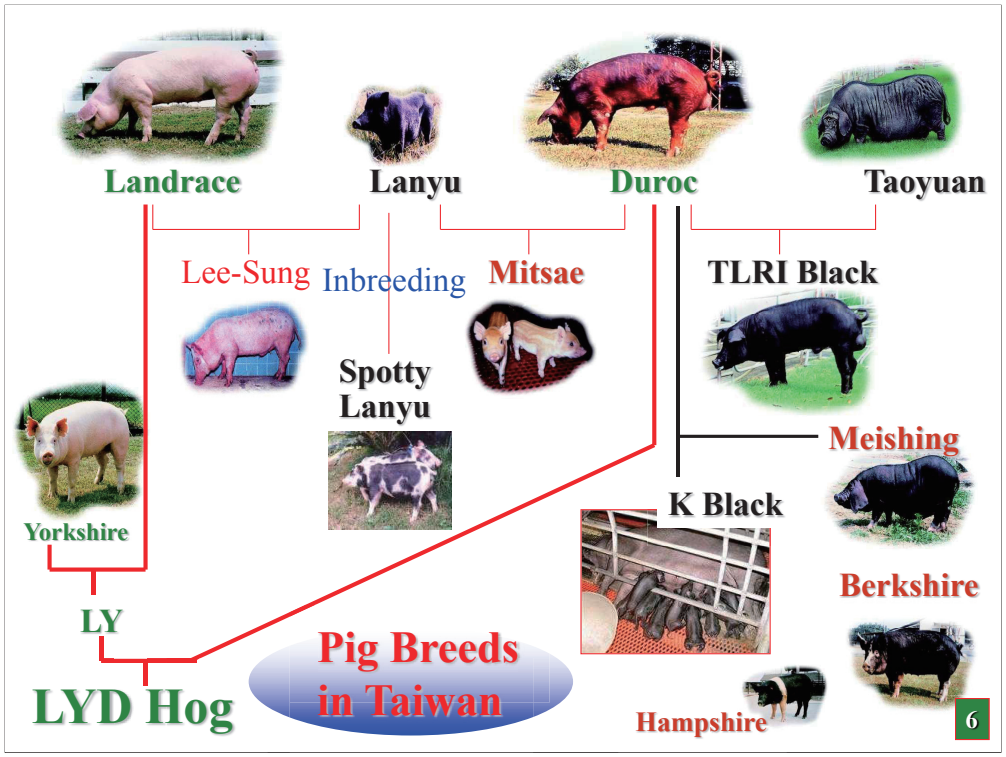
3



Pork quality is gene expression

4





Trait Measurements of Purebred Pigs in Taiwan

1971	Color																					
1975	Color	ADG	BF	FE																		
1980	Color	ADG	BF	FE	110Kg Age																	
1990	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843															
1996	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP													
2000	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen											
2002	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type										
2005	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type	D70 BW	Tall Pig								
2007	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type	D70 BW	Tall Pig	Teats	IGF27						
2011	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type	D70 BW	Tall Pig	Teats	IGF27	Sperm Elite	Hoof				
2013	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type	D70 BW	Tall Pig	Teats	IGF27	Sperm Elite	Hoof	D18 BW	D270 TSC		
2015	Color	ADG	BF	FE	110Kg Age	Ribs	Hal-1843	ESR	HFABP	D150 BW	D210 Semen	D210 Type	D70 BW	Tall Pig	Teats	IGF27	Sperm Elite	Hoof	D18 BW	D270 TSC	First Litter	
	1971	1975	1975	1975	1980	1990	1990	1996	1996	2000	2000	2002	2005	2005	2007	2007	2011	2011	2013	2013	2015	

種豬登錄執行要點(2012年版)
Rules of Breeding Pig Registration in Taiwan (2012 version)

種豬性能檢定規章(2014年版)
Guidelines of Pig Performance Testing in Taiwan (2014 version)

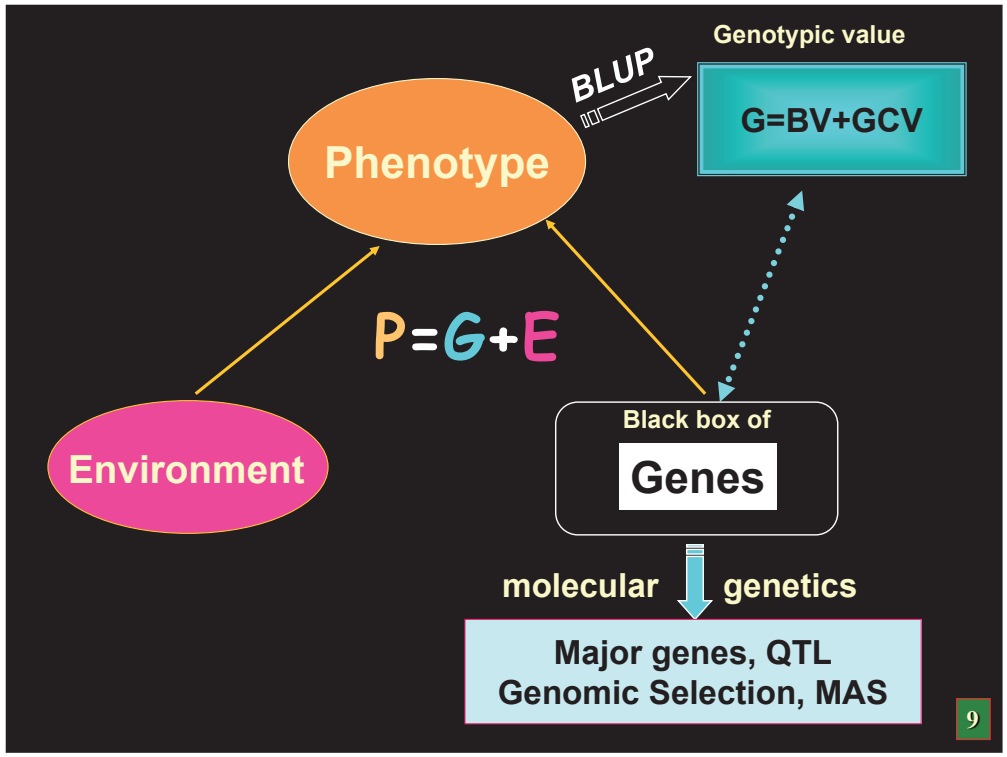
7

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

Pig Web

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

8



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.

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.

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 (sperm counts, normality)	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**

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
Selection Index: TLRI (MC Wu and YC Huang)

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

Hsinhua Station
D gilt, The Best

Fortune D0634-11
(FE=1.95) 2005/3/13

Hsinhua Station
D boar, The Best

Huei Huang D0329-05
(FE=1.90) 2003/8/26

Zhunan Station
D boar, The Best

Shun An D0785-01
(FE=1.51) 2004/6/29

13

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

(66% : 18% : 16%)

1975～1980 I = 250 + 110 ADG – 50 FE – 19.7 BF

1981～1991 I = 100 + 60 ADG – 40 FE – 45 BF
33% : 40% : 27%

1992～2004
(L, Y) I = 100 + 130 ADG – 40 FE – 40 BF
66% : 18% : 16%

2005～Present
L, Y I = 100 + 140 ADG – 60 FE – 30 BF
42% : 43% : 15%

D I = 100 + 120 ADG – 55 FE – 50 BF
40% : 40% : 20%

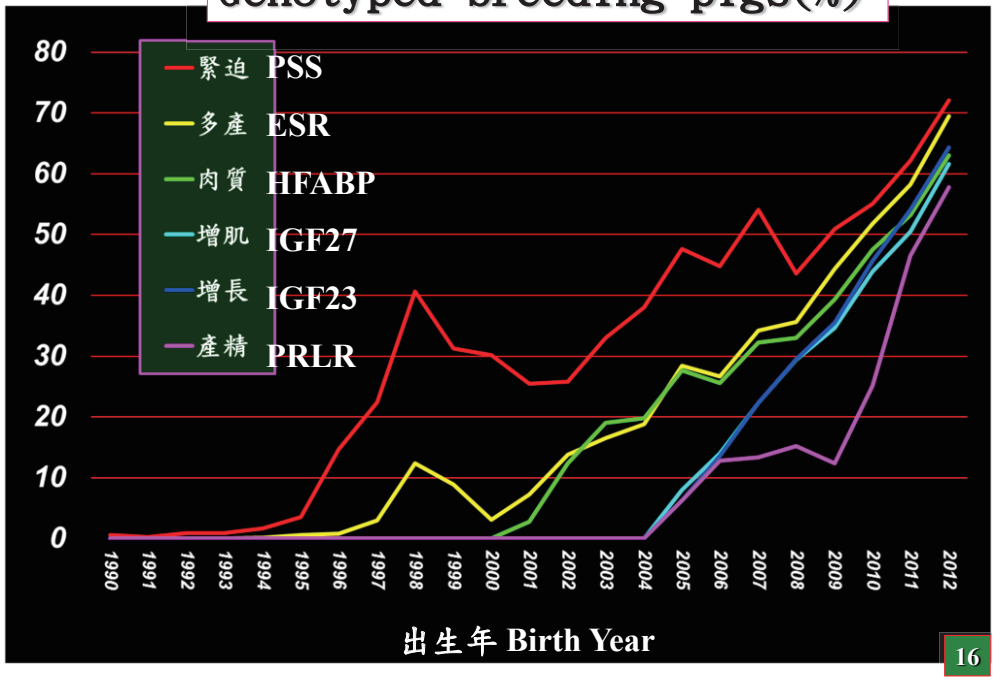
14

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

15

Genotyped breeding pigs(%)



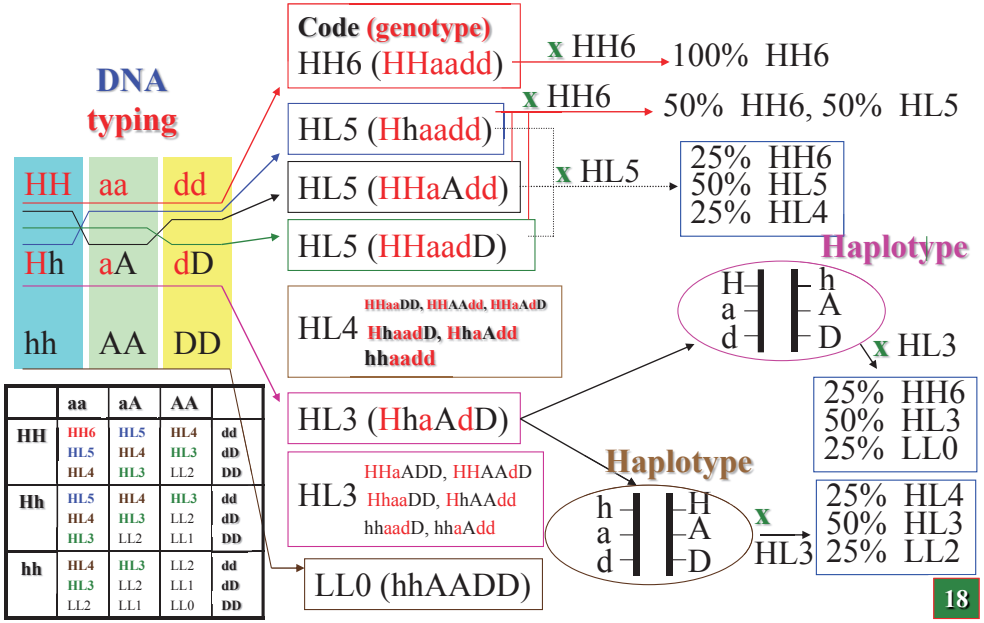
16

- **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)**

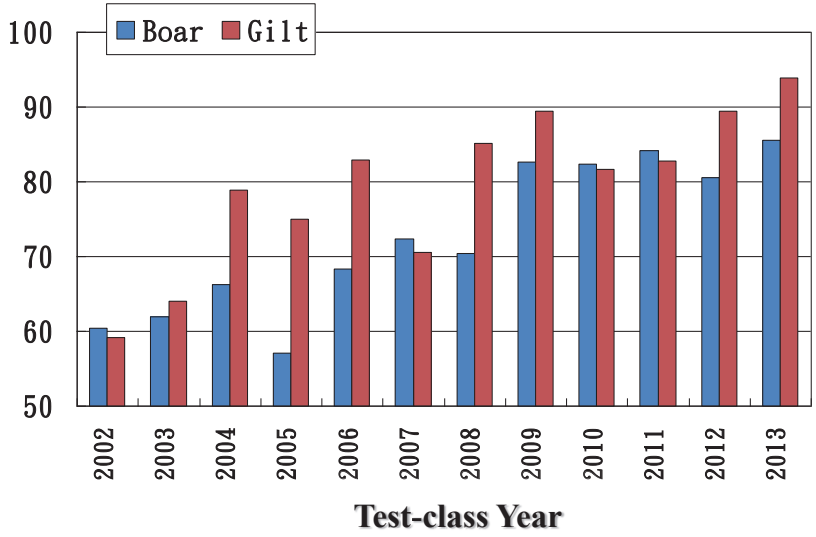
	aa	Aa	AA	
HH	HH6	HL5	HL4	dd
	HL5	HL4	HL3	Dd
	HL4	HL3	LL2	DD
Hh	HL5	HL4	HL3	dd
	HL4	HL3	LL2	Dd
	HL3	LL2	LL1	DD
Hh	HL4	HL3	LL2	dd
	HL3	LL2	LL1	Dd
	LL2	LL1	LL0	DD

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



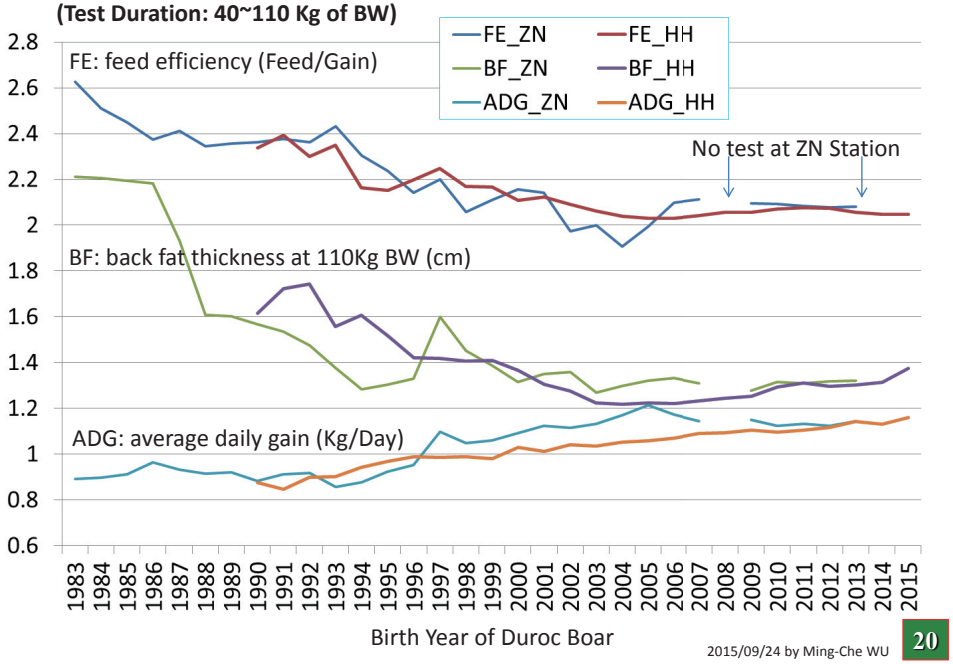
	aa	aA	AA	
HH	HH6 HL5 HL4	HL5 HL4 HL3	HL4 HL3 LL2	dd dD DD
Hh	HL5 HL4 HL3	HL4 HL3 LL2	HL3 LL2 LL1	dd dD DD
hh	HL4 HL3 LL2	HL3 LL2 LL1	LL2 LL1 LL0	dd dD DD

HH6 Genotype frequency of HFABP gene in Duroc pigs



Growth Performance of Taiwan Duroc Boars at ZN and HH Station

(Test Duration: 40~110 Kg of BW)



2015/09/24 by Ming-Che WU

行政院農業委員會畜產試驗所
Livestock Research Institute
Council of Agriculture, Executive Yuan

Genomic Breeding
基因選種

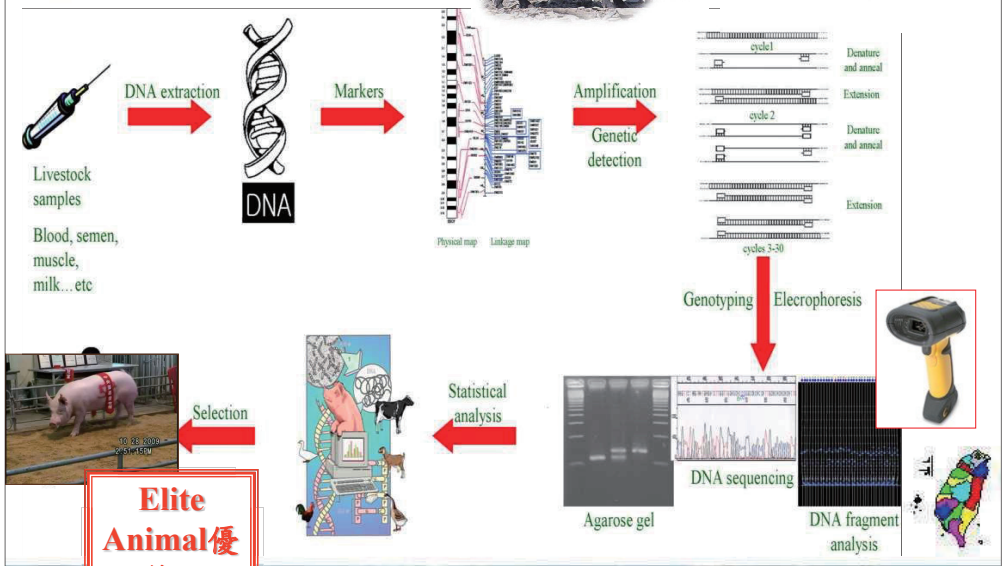


Table 1. Summary of first sequenced genomes for animal species[1]

Species	Genome size (assembly), Gb	Year
Chicken (*Gallus gallus*)	1.05	2004
Dog (*Canis familiaris*)	2.4	2003
Cattle (*Bos taurus*)	2.91	2009
Horse (*Equus caballus*)	2.47	2009
Pig (*Sus scrofa*)	2.2	2009
Sheep (*Ovis aries*)	2.78	2008
Cat (*Felis catus*)	1.64	2006
Rabbit (*Oryctolagus cuniculus*)	2.67	2009
Turkey (*Meleagris gallopavo*)	1.08	2009
Dromedary (*Camelus dromedarius*)	2.2	2011
Medaka (*Oryzias latipes*)	0.7	2011
Honeybee (*Apis mellifera*)	0.236	2011

[1]Modified from Fan et al. (2010).

André Eggen, Animal Frontiers January 2012, Vol. 2, No. 1: 11~15.

DNA barcoding for pigs

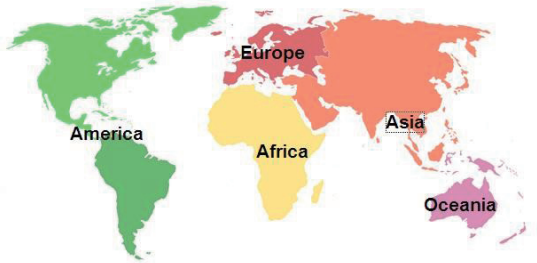
Hal-1843 gene for stress (AB), ESR gene for prolificacy (MN) and 16,613bp mtDNA for maternal origin, especially on D-loop region (1,175bp) of 29 SNPs and UTRn (tacacgtgcg 10bp)$_{17-27}$ in various breeds of pigs.

CRC+ESR+18SNP+UTR+11SNP

mtDNA D-Loop

A0021-02 Lanyu	AAMNcaattgctcgtttctcag24tgctcgaaacc
T0596-01 Taoyuan	AAMMcaattgcttgttttccag24tgctcgaaact
L0074-10 Landrace	AAMNttgccattcaccctccaa27tgcttaaaatt
Y0150-03 Yorkshire	AAMNcaattgcctgttttccag25tccccgaaacc
D0167-05 Duroc	AANNttgccattcaccctccaa26tgcttaaaatc

Conclusion & Vision



- Marker-assisted selection rests on a wide base of pedigree registration.
- Growth Performance Test & Quality Pork Evaluation of progeny pigs is served as genetic evaluation of breeding stocks in Taiwan.
- Taiwan www.angrin.tlri.gov.tw web-networking system is for pig breeders to view the profile of economic traits of breeding stocks on-line.