MINISTRY OF EDUCATION AND TRAINNING

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

NATIONAL INSTITUTE OF ANIMAL SCIENCE

NGUYEN THI HONG NHUNG

PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF LANDRACE, YORKSHIRE PIGS WITH G+ GENETIC RESOURCES FROM FRANCE

MAJOR: ANIMAL PRODUCTION

CODE NUMBER: 9.62. 01.05

SUMMARY OF PHD THESIS

HANOI, 2020

PhD thesis was conducted at: **National Institute of Animal Science**

Supervisor: Associate Professor, Doctor Do Duc Luc
Doctor Pham Doan Lan

Reviewer 1: Associate Professor, Doctor. Nguyen Van Duc
Reviewer 2: Associate Professor, Doctor. Tran Van Phung
Reviewer 3: Associate Professor, Doctor. Phan Xuan Hao

The PhD theses will be defended at PhD Dissertation Committee of National Institute of Animal Science on …. h … day …. Month …. , 2020.

This PhD can be found in

- National Library of Vietnam
- Library of National Institute of Animal Science

LIST OF PUBLICATIONS INCLUDEED AS PART OF THE PHD THESIS

1. Nguyen Thi Hong Nhung, Pham Duy Pham, Trinh Hong Son, Pham Doan Lan and Do Duc Luc (2020). Growth performance and carcass performance of Landrace and Yorkshire pigs from French genetic resources. Journal of Animal Science and Technology, No. 111:13-22.

2. Nguyen Thi Hong Nhung, Pham Duy Pham, Trinh Hong Son, Pham Doan Lan and Do Duc Luc (2020). Sperm quality traits of Landrace and Yorshire from French genetic resource. Journal of Animal Husbandry Sciences and Technics, No. 257: 31-36.

3. Thi Hong Nhung Nguyen, Duy Pham Pham, Hong Son Trinh, Doan Lan Pham and Duc Luc Do (2020). Reproductive Performance of Landrace and Yorkshire Sows from French Genetic Resource in Three Different Generations at Thuy Phuong Pig Research and Development Center. Journal of Science and Development, Vol. 18(10): 854-861.

INTRODUCTION

1.1. Rationale

Importation of breeding animals with the elite performance from other countries in the world plays an important role in improvement of genetic progress and performance of livestock breeding population in Vietnam. The statistics from of the General Department of Customs show that in the first 6 months of 2020, a total of 11,441 breeding pigs were imported in whole country. An increase of 32.6 times over the same period in 2019, including Landrace (61.2%) and Yorkshire (36.5%) accounted 97.7% of imported exotic breeding pigs (Department of Livestock Production, 2020). Genplus (GEN+) is a French company in genetic research to improve performance and quality of elite breeding pigs in the world.

In 2015, Thuy Phuong Pig Research Centre imported 45 Landrace pigs (40 gilts and 5 young boars) and 45 Yorkshire pigs (40 gilts and 5 young boars) from above mentioned breeding company. The initial results showed that the pigs have a high performance (Trinh Hong Son et al., 2017b). Genetic parameters of production traits from this pigs were mentioned in the study of Trinh Hong Son et al. (2017a) and Trinh Hong Son and Le Van Sang (2018). Landrace and Yorkshire pigs with G+ genetic resources from France has been used in breeding program in combination with other pigs imported from other countries to create a new purebred pig lines to make a advantages of each breed with different origins (Trinh Hong Son and et al., 2019a; Trinh Hong Son et al., 2019b).

Landrace and Yorkshire pigs with G+ genetic resources from France has been using to multiple and to create a nuclear population over generations in Vietnam under the livestock conditions of Thuy Phuong Pig Research Centre. Therefore, the study entitled Productive and reproductive performance of Landrace, Yorkshire pigs with G+ genetic resources from France is necessary.

1.2. Objective of the thesis

- Estimate effects of several factors on semen quality, productive and reproductive performance of Landrace and Yorkshire pigs with G+ genetic resources from France in Vietnam in the livestock conditions at Thuy Phuong Pig Research Centre - National Institute of Animal Science.

- Evaluate productive performance of Landrace and Yorkshire gilts and young boars with G+ genetic resources from France.

- Evaluate semen quality traits of Landrace and Yorkshire boars with G+ genetic resources from France.

- Evaluate reproductive performance of Landrace and Yorkshire sows with G+ genetic resources from France.

1.3. Scientific and practical implications of the thesis

- The thesis provides further technical information on semen quality, productive and reproductive performance of Landrace and Yorkshire pigs with G+ genetic resources from France for breeding program to improve performance and quality of nuclear population.

- Evaluate adaptation and genetic potential of two breeds of Landrace and Yorkshire pigs with G+ genetic resources from France, in order to guideline the breeders to make an orientation on their strategies for exploitation and development of new genetic resources.

1.4. The novelty of thesis

- This is a systematic research on productive, reproductive performance and semen quality traits of Landrace, Yorkshire pigs with G+ genetic resources from French raised in Vietnam under the livestock condition at Thuy Phuong Pig Research Centre - National Institute of Animal Science.

- Effects of several factors on semen quality, productive and reproductive performance of Landrace, Yorkshire pigs with G+ genetic resource from France have been analysed and evaluated.

- The results of research on the semen quality, productive and reproductive performance of Landrace, Yorkshire pigs with G+ genetic source from France are guidelines for the orientation of exploitation and development for this new genetic resource, contributing to improving performance and quality of the nuclear population in the breeding system in our country.

Chapter II

SUBJECTS, CONTENTS AND METHODS

2.1. Research subjects

2.1.1. Productive performance of Landrace (L) and Yorkshire (Y) young boars and gilts

The study was conducted over 4 generations, including initial generation (5 males and 40 females per each breed); the generations 1, 2 and 3 (120 males and 240 females per generation for one breed). The initial generation came from France; generations 1, 2 and 3 were born in Vietnam.

2.1.2. Reproductive performance of Landrace and Yorkshire pigs

2.1.2.1. Quantity and quality of semen in boars L and Y

The study was conducted over 4 generations, including 5 boars per each breed over 4 seasons for the initial generation; 40 boars per each generation for one breed from the next generations (1, 2 and 3). From the generation 1 to 3, in each generation 10 boars per each breed were in each season.

2.1.2.1. Reproductive performance of L and Y sows

The study was conducted over 3 generations, including 40 sows per each breed for the initial generation, 60 sows per each breed for the generation 1 and 2.

2.2. Location and time of study

2.2.1. Research location

The Ky Son nuclear pig breeding research and development station belongs to Thuy Phuong Pig Research Centre - National Institute of Animal Science.

2.2.2. Research time

- From September 2015 to June 2017, the data was collected from the database of the Centre;

- From July 2017 to April 2020, the data was collected directly from the experiment.

2.3. Research content

2.3.1. Productive performance of L and Y young boars and gilts

- Factors affecting productive performance of L and Y pigs. Evaluate productive performance by breed (L and Y), generation (initial, 1, 2 and 3), gender (young boars and gilts) and season (spring, summer, autumn and winter).

- Factors affecting productive performance of L pigs. Evaluate productive performance of L pigs by generation (initial, 1, 2 and 3), gender (young boars and gilts) and season (spring, summer, autumn and winter).

- Factors affecting productive performance of Y pigs. Evaluate productive performance of Y pigs by generation (initial, 1, 2 and 3), gender (young boars and gilts) and season (spring, summer, autumn and winter).

2.3.2. Reproductive performance of L and Y pigs

2.3.2.1. Sperm quantity and quality of L and Y boars

- Factors affecting the sperm quantity and quality of L and Y

boars. Evaluate sperm quantity and quality of boars by breed (L and Y), generation (initial, 1, 2 and 3) and season (spring, summer, autumn and winter).

- Factors affecting the sperm quantity and quality of L boars. Evaluate sperm quantity and quality of L boars by generation (initial, 1, 2 and 3) and season (spring, summer, autumn and winter).

- Factors affecting the sperm quantity and quality of Y boars. Evaluate sperm quantity and quality of Y boars by generation (initial, 1, 2 and 3) and season (spring, summer, autumn and winter).

2.3.2.2. Reproductive performance of L and Y sows

- Factors affecting reproductive performance of L and Y sows. Evaluate reproductive performance of sows by breed (L and Y), generation (initial, 1 and 2), litter (1, 2, 3, 4, 5 and 6) and season (spring, summer, autumn and winter).

- Factors affecting reproductive performance of L sows. Evaluate reproductive performance of L sows by generation (initial, 1 and 2), litter (1, 2, 3, 4, 5 and 6) and season (spring, summer, autumn and winter).

- Factors affecting reproductive performance of Y sows. Evaluate reproductive performance of Y sows by generation (initial, 1 and 2), litter (1, 2, 3, 4, 5 and 6) and season (spring, summer, autumn and winter).

2.4. Research Methods

2.4.1. Productive performance of L and Y young boars and gilts

- Productive performance was tested individually for young boars and by groups for gilts. The animals was evaluated at the beginning at the age of 74.08 ± 1.19 days with the weight of 30.17 ± 1.06 kg; and in the end at the age of 152.44 ± 3.32 days with the weight of

100.70 ± 1.25 kg.

- Backfat thickness and depth of *longissimus dorsal* were measured at the end of the testing period using Agroscan AL ultrasound with ALAL 350 probe (ECM, France) at the base of the last rib, 6.5 cm above the spine on each living individual following the method described in the study by Youssao et al. (2002). Backfat thickness and depth of *longissimus dorsal* were used to estimate lean meat percentage using a regression equation recommended by the Belgian Ministry of Agriculture in 1999. $Y = 59.902386 - 1.060750\ X_1 + 0.229324\ X_2$; where: Y is the estimated lean percentage (%); X_1: backfat thickness, including leather (mm); X_2: depth of *longissimus dorsal* (mm).

- Intramuscular fat was measured by Exago ultrasound with L3130B probe (ECM, France) at the 10th rib position, 6.5 cm from the spine line on each living animal in the same time while weighting the final bodyweight. The percentage of intramuscular was estimated on Biosoft Toolbox II for Swine software.

* *Data analysis*

The effect of fixed factors (breed, generation, season and sex) on the productive traits was analyzed according to the statistical model (1): $y_{ijklm} = \mu + G_i + TH_j + MV_k + TB_l + \varepsilon_{ijklm}$. Where: y_{ijklm} = productive traits; μ = overall mean; G_i = effect of breed i (Landrace and Yorkshire); TH_j = effect of generation j (initial generation, 1, 2 and 3); MV_k = effect of season k (spring, summer, autumn and winter); TB_l = effect of gender l (male and female) and ε_{ijklm} = residual error.

The days of old at beginning and at finishing of the experiment were added into the model as covariance corresponding to the beginning and finishing times. Interaction between factors was not

statistically significant, therefore the interaction was not mentioned in the final statistical model. For the feed conversion ratio, the gender was not added in the model due to only boars were presented.

For each breed (L or Y), the effect of fixed factors (generation, season and sex) was analyzed according to the statistical model (2): $y_{ijkl} = \mu + TH_i + MV_j + TB_k + \varepsilon_{ijkl}$. Where: y_{ijkl} = productive traits; μ = overall mean; TH_i = effect of generation i (initial, 1, 2 and 3); MV_j = effect of season j (spring, summer, autumn and winter); TB_k = effect of gender k (male and female) and ε_{ijkl} = random error.

The productive performance through each generation for male and female pigs of each breed (L or Y) was analyzed according to the statistical model (3): $y_{ijk} = \mu + TH_i + MV_j + \varepsilon_{ijk}$. Where: y_{ijk} = productive traits; μ = overall mean; TH_i = effect of generation i (initial, 1, 2 and 3); MV_j = effect of season j (spring, summer, autumn and winter) and ε_{ijk} = random error.

2.4.2. Reproductive performance of L and Y pigs

2.4.2.1. Sperm quantity and quality of L and Y boars

- The cage size was 2.5m x 2.5m for each boar.

- Sperm concentration (C) was determined by using concentration machine (SDM5 of Minitube, Germany) and expressed in million/ml.

* *Data analysis*

The effect of fixed factors (breed, generation, season) on sperm quality indicators was analyzed according to the statistical model (6): $Y_{ijkl} = \mu + G_i + TH_j + MV_k + \varepsilon_{ijkl}$ In which : Y_{ijkl} = sperm quality criteria; μ = overall mean; G_i = effect of breed i: (L and Y); TH_j = effect of generation j: (initial, 1, 2 and 3); MV_k = effect of season k (spring, summer, autumn and winter) and ε_{ijkl} = error random.

For each breed (L or Y), the effect of fixed factors (generation, season) on sperm quality was analyzed according to the statistical model (7): $Y_{ijk} = \mu + TH_i + MV_j + \varepsilon_{ijk}$ In which: Y_{ijk} = sperm quality

criteria; μ = overall mean; TH_i = effect of generation i: (derived generation, 1, 2 and 3); MV_j = effect of season k (spring, summer, autumn and winter) and ε_{ijk} = random error.

2.4.2.2. Reproductive performance of L and Y sows

- From September 2015 to June 2017, the data was collected from the database of the Centre;

- From July 2017 to April 2020, the data was collected directly from the experiment.

** Data analysis*

Effect of fixed factors (breed, generation, season and litter) on reproductive performance was analyzed according to the statistical model (4): $Y_{ijklm} = \mu + G_i + TH_j + MV_k + L_l + \varepsilon_{ijklm}$ Where: Y_{ijklm} = reproductive traits; μ = overall; G_i = effect of breed i (L and Y); TH_j = effect of generation j (initial, 1, 2 and 3); MV_k = effect of season k (spring, summer, autumn and winter); L_l = effect of litter l (1, 2, 3, 4, 5 and 6) and ε_{ijklm} = random error.

For each breed (L or Y), the effect of the fixed factors (generation, season and litter) was analyzed according to the statistical model (5): $y_{ijkl} = m + TH_i + MV_j + L_k + \varepsilon_{ijkl}$ Where: y_{ijkl} = reproductive traits; m = overall mean; TH_i = effect of generation i (initial, 1, 2 and 3); MV_j = effect of season j (spring, summer, autumn and winter); L_k = effect of litter k (1, 2, 3, 4, 5 and 6) and ε_{ijkl} = random error.

For age at the first mating and age at the first farrowing, there are only season and generation were presented in the model. For the interval between parities, season was ignored from the model.

The statistical parameters were: sample size (n), least-squares mean (LSM), standard error (SE), coefficient of determination (R^2) and the significantly difference according to the p-value (P). The pairwise comparison between LSMs was used Tukey test. Data were analyzed using SAS 9.1 (2002) software.

Chapter III
RESULTS AND DISCUSSION

3.1. Productive performance of Landrace and Yorkshire gilts and boars with French genetic resources

3.1.1. Productive performance of Landrace (L) and Yorkshire (Y) gilts and boars

Effect of breed, generation, season, and gender on productive performance of L and Y pigs are presented in Table 3.1.

Table 3.1. Factors affecting productive performance Landrace and Yorkshire gilts and young boars

Indicators	Breed	Generation	Season	Gender	R^2 (%)
Body weight at initial (kg)	0.4935	<0.0001	0.0156	0.0080	27.29
Body weight at finishing (kg)	0.0006	<0.0001	<0.0001	<0.0001	10.47
Average daily gain (gr)	<0.0001	<0.0001	<0.0001	<0.0001	80.75
Back fat thickness (mm)	<0.0001	<0.0001	<0.0001	<0.0001	79.62
Depth of *longissimus* dorsal (mm)	0.3370	<0.0001	<0.0001	<0.0001	37.01
Lean meat percentage (%)	<0.0001	<0.0001	<0.0001	<0.0001	83.81
Intramuscular fat (%)	0.2255	0.0167	0.1525	<0.0001	9.49
Feed conversion ratio (kg)	0.1137	<0.0001	<0.0001	-	14.36

Breed, generation, season, and gender affected average daily gain (ADG) and lean meat percentage (LMP) of L and Y gilts and young boars with G+ genetic resource from France ($P<0.001$). Breed and season did not affect intramuscular fat (IMF) ($P>0.05$), however there was a difference between male and female ($P<0.0001$). Some traits such as ADG, backfat thickness (BFT) and LMP had a high coefficient of determination (R^2), respectively 80.75, 79.62 and 83.81%. R^2 ranged from 9.49% for IMF to 83.81% for LMP (Table 3.1).

Productive performance of L and Y pigs with G+ genetic resource from France is presented in Table 3.2. The results showed that ADG of Y was higher than L pig but LMP was lower.

ADG of L in this study was lower than that of French-origin L pig raised in Denmark (931 gr/ day) Danbred (2006). ADG of L in the

current study was higher than reported ADG of L (798.1 gr/ day) raised in Thailand (Thivakorn Sirichokchatchawan, 2015); L pigs in Vietnam 551.40 gr/ day (Phung Thi Van et al., 2001), 646 gr/day (Phan Xuan Hao, 2002) and 710.56 g/day (Pham Thi Kim Dung, 2005).

Table 3.2. Productive performance of Landrace and Yorkshire gilts and young boars

Indicators	Landrace			Yorkshire		
	n	LSM	SE	n	LSM	SE
Body weight at initial (kg)	1125	30.26	0.04	1125	30.28	0.04
Body weight at finishing (kg)	1125	100.28[b]	0.06	1125	100.46[a]	0.05
Average daily gain (gr)	1125	891.28[b]	0.70	1125	896.36[a]	0.62
Back fat thickness (mm)	1125	12.22[b]	0.03	1125	12.35[a]	0.03
Depth of *longissimus* dorsal (mm)	1125	57.86	0.03	1125	57.89	0.03
Lean meat percentage (%)	1125	60.20[a]	0.03	1125	60.07[b]	0.03
Intramuscular fat (%)	255	2.765	0.012	255	2.782	0.012
Feed conversion ratio (kg)	365	2.557	0.006	365	2.565	0.006

Note: Within rows, LSM values followed by different letters are significantly different (P<0.05)

In this study, ADG of Y pig was higher than which was published by Phan Xuan Hao (2007) with ADG of Y pig of 664.87 gr/day. Nguyen Van Duc et al. (2010) reported that ADG of Y pig was 675.60 gr/day. Zhang et al. (2011) announced that, ADG of Y fattening pigs 100 kg was 803.60 gr/ day. Doan Phuong Thuy et al. (2016) confirmed that ADG was 794.78 gr/day.

The productive performance over 4 generations was calculated for both breeds and as well as for gilts and young boars separately. These results are shown in Tables 3.7, 3.10, 3.11, 3.13, 3.16 and 3.17.

Table 3.7. Productive performance of Landrace gilts and young boars by generation

Indicators	Initial			Generation 1			Generation 2			Generation 3		
	n	LSM	SE	n	LSM	SE	n	LSM	SE	n	LSM	SE
Bodyweight at the start of the test (kg)	45	30.65^{a}	0.16	360	30.20^{b}	0.05	360	30.13^{b}	0.05	360	30.25^{ab}	0.05
Bodyweight at the end of experiment (kg)	45	99.13^{c}	0.28	360	100.29^{b}	0.07	360	101.05^{a}	0.08	360	101.27^{a}	0.09
Daily weight gain (gr/day)	45	840.82^{d}	3.55	360	889.20^{c}	0.90	360	912.12^{b}	0.99	360	918.92^{a}	1.20
Back fat thickness (mm)	45	12.67^{a}	0.12	360	12.62^{a}	0.04	360	11.98^{b}	0.04	360	11.70^{c}	0.04
Loin muscle thickness (mm)	45	56.70^{c}	0.13	360	57.76^{b}	0.04	360	58.46^{a}	0.04	360	58.59^{a}	0.04
Lean percentage (%)	45	59.47^{c}	0.12	360	59.76^{c}	0.04	360	60.59^{b}	0.04	360	60.93^{a}	0.04
Intramuscular fat percentage (%)	15	2.712	0.046	80	2.768	0.018	80	2.792	0.018	80	2.798	0.018
Food conversion ratio (kg)	5	2.620^{a}	0.035	120	2.552^{ab}	0.007	120	2.525^{bc}	0.007	120	2.527^{c}	0.007

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.10. Productive performance of Landrace gilts by generation

Indicators	Initial			Generation 1			Generation 2			Generation 3		
	n	LSM	SE	n	LSM	SE	n	LSM	SE	n	LSM	SE
Bodyweight at the start of the test (kg)	40	30.63^{a}	0.18	240	30.27^{ab}	0.07	240	30.11^{b}	0.07	240	30.20^{ab}	0.07
Bodyweight at the end of experiment (kg)	40	98.84^{c}	0.39	240	100.15^{b}	0.11	240	101.21^{a}	0.09	240	101.34^{a}	0.12
Daily weight gain (gr/day)	40	815.19^{d}	4.67	240	866.57^{c}	1.28	240	895.07^{b}	1.11	240	901.69^{a}	1.39
Back fat thickness (mm)	40	14.18^{a}	0.14	240	14.14^{a}	0.05	240	13.48^{b}	0.05	240	13.21^{c}	0.05
Loin muscle thickness (mm)	40	56.28^{d}	0.15	240	57.28^{c}	0.06	240	57.96^{b}	0.06	240	58.15^{a}	0.06
Lean percentage (%)	40	57.77^{a}	0.15	240	58.03^{a}	0.06	240	58.89^{b}	0.06	240	59.23^{c}	0.06
Intramuscular fat percentage (%)	10	2.758	0.063	40	2.811	0.028	40	2.840	0.028	40	2.846	0.028

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.11. Productive performance of Landrace boars by generation

	Initial			Generation 1			Generation 2			Generation 3		
Variable	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**
Bodyweight at the start of the test (kg)	5	30.76^{a}	0.37	120	30.01^{b}	0.08	120	30.12^{ab}	0.08	120	30.31^{a}	0.08
Bodyweight at the end of experiment (kg)	5	99.33^{c}	0.48	120	100.27^{b}	0.11	120	100.45^{b}	0.09	120	100.89^{a}	0.10
Daily weight gain (gr/day)	5	867.95^{d}	7.25	120	918.38^{c}	1.60	120	932.50^{b}	1.32	120	940.82^{a}	1.47
Back fat thickness (mm)	5	11.10^{a}	0.26	120	11.08^{a}	0.05	120	10.50^{b}	0.05	120	10.19^{c}	0.05
Loin muscle thickness (mm)	5	56.98^{c}	0.35	120	58.26^{b}	0.07	120	58.97^{a}	0.07	120	59.00^{a}	0.07
Lean percentage (%)	5	61.19^{c}	0.25	120	61.51^{c}	0.05	120	62.29^{b}	0.05	120	62.63^{a}	0.05
Intramuscular fat percentage (%)	5	2.665	0.073	40	2.724	0.024	40	2.743	0.024	40	2.749	0.024

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.13. Productive performance of Yorkshire gilts and young boars by generation

	Initial			Generation 1			Generation 2			Generation 3		
Variable	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**	**n**	**LSM**	**SE**
Bodyweight at the start of the test (kg)	45	30.45^{a}	0.13	360	29.98^{b}	0.04	360	30.14^{ab}	0.04	360	30.35^{a}	0.04
Bodyweight at the end of experiment (kg)	45	98.23^{d}	0.29	360	100.23^{c}	0.07	360	101.11^{b}	0.07	360	101.53^{a}	0.10
Daily weight gain (gr/day)	45	844.41^{d}	3.56	360	899.46^{c}	0.85	360	917.94^{b}	0.89	360	926.82^{a}	1.26
Back fat thickness (mm)	45	12.71^{a}	0.13	360	12.69^{a}	0.04	360	12.16^{b}	0.04	360	11.78^{c}	0.04
Loin muscle thickness (mm)	45	56.64^{c}	0.15	360	57.73^{b}	0.05	360	58.53^{a}	0.05	360	58.60^{a}	0.05
Lean percentage (%)	45	59.41^{c}	0.12	360	59.68^{c}	0.04	360	60.42^{b}	0.04	360	60.84^{a}	0.04
Intramuscular fat percentage (%)	15	2.707	0.045	80	2.783	0.018	80	2.814	0.018	80	2.816	0.018
Food conversion ratio (kg)	5	2.638^{a}	0.024	120	2.557^{b}	0.005	120	2.535^{c}	0.005	120	2.534^{c}	0.005

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.16. Productive performance of Yorkshire gilts by generation

Variable	Initial			Generation 1			Generation 2			Generation 3		
	n	LSM	SE	n	LSM	SE	n	LSM	SE	n	LSM	SE
Bodyweight at the start of the test (kg)	40	30.36[a]	0.14	240	30.01[b]	0.05	240	30.09[ab]	0.05	240	30.34[a]	0.05
Bodyweight at the end of experiment (kg)	40	97.73[d]	0.43	240	100.07[c]	0.11	240	101.12[b]	0.09	240	101.70[a]	0.14
Daily weight gain (gr/day)	40	815.99[d]	5.07	240	876.43[c]	1.31	240	897.89[b]	1.03	240	909.60[a]	1.62
Back fat thickness (mm)	40	14.28[a]	0.15	240	14.24[a]	0.06	240	13.77[b]	0.06	240	13.34[c]	0.06
Loin muscle thickness (mm)	40	56.20 [c]	0.16	240	57.38[b]	0.06	240	58.09[a]	0.06	240	58.17[a]	0.06
Lean percentage (%)	40	57.64[d]	0.14	240	57.95[c]	0.05	240	58.61[b]	0.05	240	59.09[a]	0.05
Intramuscular fat percentage (%)	10	2.733	0.057	40	2.822	0.026	40	2.859	0.026	40	2.860	0.026

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.17. Productive performance of Yorkshire boars by generation

Variable	Initial			Generation 1			Generation 2			Generation 3		
	n	LSM	SE	n	LSM	SE	n	LSM	SE	n	LSM	SE
Bodyweight at the start of the test (kg)	5	30.96[a]	0.34	120	29.87[c]	0.07	120	30.19[b]	0.07	120	30.29[ab]	0.07
Bodyweight at the end of experiment (kg)	5	98.83[d]	0.40	120	99.92[c]	0.09	120	100.63[b]	0.07	120	100.91[a]	0.08
Daily weight gain (gr/day)	5	880.91[d]	5.91	120	927.26[c]	1.34	120	942.52[b]	1.09	120	948.59[a]	1.23
Back fat thickness (mm)	5	11.25[a]	0.27	120	11.15[a]	0.05	120	10.52[b]	0.05	120	10.24[c]	0.05
Loin muscle thickness (mm)	5	57.201[c]	0.357	120	58.031[b]	0.071	120	59.006[a]	0.071	120	59.055[a]	0.071
Lean percentage (%)	5	61.087[c]	0.265	120	61.379[c]	0.053	120	62.277[b]	0.053	120	62.586[a]	0.053
Intramuscular fat percentage (%)	5	2.692	0.077	40	2.744	0.026	40	2.769	0.026	40	2.773	0.026

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

The results in all tables showed that ADG and LMP tended to improve over generations and these values were highest in generation 3. IMF did not differ between generations (P> 0.05). However, FCR tended to decrease over generations.

For both L and Y pigs, ADG and LMP of males were higher than those of females. However IMF of males was lower than that of females.

The study results showed that L and Y gilts and young boars with G + genetic resources from France had adapted to the farming conditions at Thuy Phuong Pig Research Center.

3.2. Reproductive performance of L and Y pigs with French genetic resources

3.2.1. Sperm quantity and quality of L and Y boars with French genetic resources

Breed, generation and season have a significant difference (P <0.0001) on all traits of sperm quantity and quality of L and Y pigs. The coefficient of determination (R^2) is the highest in sperm motility (57.80%) and the lowest in sperm volume (29.09%).

Table 3.18 Factors affecting sperm quantity and quality of Landrace and Yorkshire boars

Variable	Breeds	Generation	Season	R^2 (%)
Ejaculate volume (ml)	<0.0001	<0.0001	<0.0001	29.09
Sperm motility (%)	<0.0001	<0.0001	<0.0001	57.80
Sperm concentration (millions/ml)	<0.0001	<0.0001	<0.0001	31.39
Total number of sperm (billions/time)	<0.0001	<0.0001	<0.0001	43.27
Abnormal sperm (%)	<0.0001	<0.0001	<0.0001	51.38

Results of current research tended to be similar to those published by national and international authors. Specifically, Knecht et al. (2014) showed that, breed affects all traits of semen quantity and

quality, while season affects ejaculate volume and sperm concentration; Kunowska-Slosarz and Makowska (2011) showed that breed and season affect ejaculate volume, sperm concentration and sperm survival rate; Wierzbicki et al. (2010) when studied on Polish L and LW pigs showed that breed affects all parameters of semen quantity and quality, while season only affected sperm concentration; Hong Son et al. (2013) when studying the sperm quantity and quality of VCN03 synthesized boars, showed that, age, generation, season and year had a significant effect (P <0.001) on most of the traits of sperm quantity and quality; Trinh Van Than et al. (2010) also reported that season, breed and method of husbandry had a significant effect on the sperm quantity and quality (P<0.001).

The traits for sperm quantity and quality L and Y boars are presented in Table 3.19.

Table 3.19. Sperm quantity and quality of L and Y boars

Variable	L (n=3640)		Y (n=3640)	
	LSM	**SE**	**LSM**	**SE**
Ejaculate volume (ml)	266.49[a]	0.58	263.24[b]	0.58
Sperm motility (%)	85.01[a]	0.08	84.23[b]	0.08
Sperm concentration (millions/ml)	278.33[a]	0.46	274.30[b]	0.46
Total number of sperm (billions/time)	65.04[a]	0.24	62.60[b]	0.24
Abnormal sperm (%)	7.27[b]	0.02	7.60[a]	0.02

Sperm quantity and quality traits of L boar were better than those of Y boar (P<0.05). The traits for the quantity and sperm quality of pigs L and Y both met TCVN 9111: 2011.

The sperm quantity and quality of both L and Y boars tended to improve gradually over generations and reach the best at generation 3, the results are shown in tables 3.23 and 3.26.

Table 3.23. Sperm quantity and quality of Landrace boars by generation

Variable	Initial (n=520)		Generation 1 (n=1040)		Generation 2 (n=1040)		Generation 3 (n=1040)	
	LSM	**SE**	**LSM**	**SE**	**LSM**	**SE**	**LSM**	**SE**
Ejaculate volume (ml)	230.24[c]	1.54	271.67[b]	1.09	280.69[a]	1.09	282.87[a]	1.09
Sperm motility (%)	80.25[d]	0.19	85.47[c]	0.13	86.68[b]	0.13	88.00[a]	0.13
Sperm concentration (millions/ml)	261.93[c]	1.20	280.89[b]	0.85	285.05[a]	0.85	285.2[a]	0.85
Total number of sperm (billions/time)	50.55[c]	0.64	67.07[b]	0.45	70.60[a]	0.45	71.96[a]	0.45
Abnormal sperm (%)	9.31[a]	0.06	7.05[b]	0.04	6.46[c]	0.04	6.16[d]	0.04

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

Table 3.26. Sperm quantity and quality of Yorkshire boars by generation

Variable	Initial (n=520)		Generation (n=1040)		Generation (n=1040)		Generation (n=1040)	
	LSM	**SE**	**LSM**	**SE**	**LSM**	**SE**	**LSM**	**SE**
Ejaculate volume (ml)	228.72[d]	1.46	269.99[c]	1.03	275.11[b]	1.04	279.68[a]	1.04
Sperm motility (%)	78.02[d]	0.20	84.63[c]	0.14	86.29[b]	0.14	87.64[a]	0.14
Sperm concentration (millions/ml)	258.53[c]	1.20	276.00[b]	0.85	280.14[a]	0.85	282.85[a]	0.85
Total number of sperm (billions/time)	47.77[d]	0.61	64.70[c]	0.43	67.53[b]	0.43	70.40[a]	0.43
Abnormal sperm (%)	10.04[a]	0.06	7.36[b]	0.05	6.64[c]	0.05	6.44[d]	0.05

Note: Within rows, LSM values followed by different letters within an effect are significantly different (P <0.05)

3.2.2. Reproductive performance of L and Y sows with G+ genetic resources from France

Effect of several factors on reproductive performance of sows L and Y is presented in Table 3.28

Table 3.28. Effects of several factors on reproductive performance of Landrace and Yorkshire sows

Variable	Breed	Generation	Season	Parity	R^2 (%)
Age at first service	0.3271	0.0005	-	-	4.95
Age at first farrowing	0.2775	0.0003	-	-	5.28
Number born alive/ litter	<0.0001	0.0002	0.2839	<0.0001	14.21
Litter weight at birth	<0.0001	0.0051	0.4598	<0.0001	15.69
Individual bodyweight at birth	<0.0001	0.0001	0.4919	0.0548	3.01
Number to weaning/ litter	<0.0001	<0.0001	0.7927	<0.0001	25.95
Litter weight at weaning	<0.0001	<0.0001	0.5100	<0.0001	28.93
Individual bodyweight at weaning	0.0585	0.6083	0.8494	0.1644	1.35
Day of pregnancy after weaning	0.0036	0.8786	<0.0001	<0.0001	11.88
Duration of cycle (day)	0.0101	0.6740	-	<0.0001	6.77

For L and Y pigs, breed, generation and litter significantly affected total number of pigs per litter and litter weight at birth and at weaning; however, the season did not affect these traits. Reproductive performance of L and Y sows is presented in Table 3.29. The results in table 3.29 showed that Y sows had better reproductive performance than L sows.

This result showed that L and Y sows have similar maturity age (Table 3.29). Y sow had higher weight/litter and number of pigs/litter at the time of birth and weaning than L sow but had a shorter post-weaning mating time and shorter farrowing interval. Number of born alive per litter of Y pig was higher than L, therefore individual bodyweight at birth of Y pig was lower ($P<0.0001$). However, the individual bodyweight at weaning did not differ between these two breeds. Trinh Hong Son et al. (2019d) concluded that there was no difference in reproductive performance between L and Y sows.

Number born alive per litter of L sow was in agreement with results of Le Van Sang et al. (2019) but higher than the study of Le Dinh Phung et al. (2011) and Doan Phuong Thuy et al. (2015). The

number born alive per litter of Y sow was higher than the announcement of Tummaruk et al. (2004), Doan Phuong Thuy et al. (2015), Wähner and Brüssow (2009), Nguyen Van Duc et al. (2010), Nguyen Ngoc Thanh Yen et al. (2018) and Trinh Hong Son et al. (2020).

Table 3.29. Reproductive performance of L and Y sows

Variable	Landrace			Yorkshire		
	n	**LSM**	**SE**	**n**	**LSM**	**SE**
Age at first service (day)	160	241.52	1.37	160	243.41	1.37
Age at first farrowing (day)	159	356.66	1.37	160	358.75	1.37
Number born alive/ litter (piglet)	781	12.81^{b}	0.08	768	13.59^{a}	0.08
Litter weight at birth (kg)	781	19.62^{b}	0.10	768	20.39^{a}	0.10
Bodyweight at birth (kg)	781	1.54^{a}	0.01	768	1.52^{b}	0.01
Number to weaning/ litter (piglet)	781	11.37^{b}	0.05	768	12.01^{a}	0.05
Litter weight at weaning (kg)	781	74.43^{b}	0.37	768	79.06^{a}	0.36
Bodyweight at weaning (kg)	781	6.55	0.02	768	6.61	0.02
Mating day after weaning (day)	621	16.06^{a}	0.69	608	13.32^{b}	0.68
Duration of cycle (day)	621	153.63^{a}	0.71	608	151.14^{b}	0.70

Note: Within rows, LSM values followed by different letters are significantly different (P <0.05)

The litter weight at weaning of L sow was lower than that of Y sow (P<0.0001) but the difference in individual bodyweight at weaning was not statistically significant (P=0.0585). This finding was also higher than the results published by Nguyen Van Thang (2017) and Nguyen Ngoc Thanh Yen et al. (2018) on litter weight at weaning of L and Y. According to Nguyen Binh Truong et al. (2018), the litter weight at weaning of 28 days of age in L and Y sows was 79.1 and 70.9 kg, respectively.

The results in Tables 3.34 and 3.38 show that, reproductive performance of L, Y sows improved from initial generation to generation 2.

Table 3.34. Reproductive performance of Landrace sows by generation

Variable	Initial			Generation 1			Generation 2		
	n	LSM	SE	n	LSM	SE	n	LSM	SE
Age at first service (day)	40	246.83[a]	2.02	60	237.92[b]	1.65	60	239.65[b]	1.65
Age at first farrowing (day)	40	362.50[a]	1.98	59	352.75[b]	1.63	60	354.68[b]	1.62
Number born alive/ litter (piglet)	213	12.45[b]	0.14	299	12.83[a]	0.12	269	13.14[a]	0.13
Litter weight at birth (kg)	213	19.05[b]	0.17	299	19.67[a]	0.15	269	20.05[a]	0.16
Bodyweight at birth (kg)	213	1.54	0.01	299	1.55	0.01	269	1.54	0.01
Number to weaning/ litter (piglet)	213	10.75[c]	0.09	299	11.56[b]	0.08	269	11.89[a]	0.09
Litter weight at weaning (kg)	213	70.01[b]	0.72	299	75.70[a]	0.62	269	77.72[a]	0.69
Bodyweight at weaning (kg)	213	6.51	0.05	299	6.56	0.04	269	6.54	0.04
Mating day after weaning (day)	173	14.50	1.29	239	16.02	1.11	209	17.00	1.28
Duration of cycle (day)	173	152.51	1.35	239	153.62	1.16	209	154.14	1.33

Table 3.38. Reproductive productivity of Yorkshire sows by generation

Variable	Initial			Generation 1			Generation 2		
	n	LSM	SE	n	LSM	SE	n	LSM	SE
Age at first service (day)	40	249.75[a]	3.28	60	241.57[ab]	2.68	60	239.08[b]	2.68
Age at first farrowing (day)	40	364.85[a]	3.28	60	357.10[ab]	2.68	60	354.35[b]	2.68
Number born alive/ litter (piglet)	211	13.28	0.16	299	13.75	0.13	258	13.73	0.15
Litter weight at birth (kg)	211	20.37[a]	0.20	299	20.85[a]	0.17	258	19.97[b]	0.19
Bodyweight at birth (kg)	211	1.54[a]	0.01	299	1.53[a]	0.01	258	1.48[b]	0.01
Number to weaning/ litter (piglet)	211	11.40[b]	0.11	299	12.27[a]	0.09	258	12.33[a]	0.10
Litter weight at weaning (kg)	211	75.06[b]	0.62	299	80.97[a]	0.52	258	80.96[a]	0.59
Bodyweight at weaning (kg)	211	6.60	0.04	299	6.63	0.03	258	6.61	0.04
Mating day after weaning (day)	171	14.06	1.20	239	13.36	1.02	198	13.44	1.21
Duration of cycle (day)	171	151.82	1.24	239	151.28	1.05	198	150.71	1.22

In the initial generation, the age at the first service was high for L and Y sows, leading to increase the age at the first farrowing. These increasing might be due to the adaptation of the pigs from the initial generation from France.

The number of weaned pigs per litter and the litter weight at weaning of L and Y sows tended to improve over generations, lower at the initial generation and highest at the generation 2. It means that, L and Y sows from generations 1 and 2 born in Vietnam were adapted.

Reproductive performance of L and Y sows by litter is presented in Tables 3.36 and 3.40. The results showed that number born alive per litter, number of weaned pigs per litter, litter weight at birth and litter weight at weaning tended to increase from the first litter to the third litter; after that it tended to decrease. These values were higher from the second to the fourth litter ($P>0.05$) and highest at the third; lower at the first and the sixth.

This result is consistent with the results of Tran Thi Minh Hoang et al. (2008), Pham Thi Kim Dung and Tran Thi Minh Hoang (2009) on the L and Y sows; Doan Van Soan and Dang Vu Binh (2010) and Nguyen Van Thang and Vu Dinh Ton (2010) on F1 (L x Y) and F1 (Y x L) sows.

Dang Vu Binh et al. (2005) and Nguyen Van Thang (2017) showed that reproductive performance of L and Y sows tend to be the lowest in the first litter, increased gradually and reached the highest values at the fourth litter. Research results by Trinh Hong Son et al. (2019c) in pigs L and Y showed that, reproductive performance increased from the first litter to the fourth litter.

Duration of pregnancy after weaning between the first litter and the second litter. It might explain that at the moment of the first litter, sows are not yet physically complete, sow body weight loss during nursing period. And therefore recovery time for the sows required longer. It directly affected the time to return to heat after weaning and the rate of pregnant mating after weaning.

.

Table 3.36. Reproductive performance of Landrace sows by parity

Variable	Parity 1 (n=160)		Parity 2 (n=159)		Parity 3 (n=155)		Parity 4 (n=139)		Parity 5 (n=114)		Parity 6 (n=54)	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Number born alive/ litter (piglet)	11.81^{c}	0.23	13.28^{ab}	0.20	13.78^{a}	0.22	13.39^{ab}	0.20	12.65^{bc}	0.21	11.88^{c}	0.30
Litter weight at birth (kg)	18.00^{c}	0.27	20.27^{ab}	0.24	21.30^{a}	0.26	20.44^{ab}	0.24	19.57^{b}	0.26	17.94^{c}	0.36
Bodyweight at birth (kg)	1.54	0.01	1.54	0.01	1.55	0.01	1.54	0.01	1.56	0.01	1.52	0.02
Number to weaning/ litter (piglet)	10.57^{c}	0.15	11.60^{b}	0.13	12.42^{a}	0.14	11.82^{ab}	0.13	11.45^{b}	0.14	10.54^{c}	0.19
Litter weight at weaning (kg)	67.60^{c}	1.15	77.66^{ab}	1.02	80.72^{a}	1.11	78.64^{ab}	1.04	75.19^{b}	1.09	67.03^{c}	1.52
Bodyweight at weaning (kg)	6.43	0.08	6.71	0.07	6.50	0.07	6.66	0.07	6.58	0.07	6.36	0.10
Mating day after weaning (day)	-	-	25.53^{a}	1.68	11.71^{bc}	1.85	17.70^{b}	1.71	6.63^{c}	1.82	17.62^{b}	2.54
Duration of cycle (day)	-	-	162.02^{a}	1.41	152.46^{b}	1.43	149.94^{b}	1.50	150.31^{b}	1.66	152.41^{b}	2.46

Table 3.40. Reproductive performance of Yorkshire sows by parity

Variable	Parity 1 (n=160)		Parity 2 (n=159)		Parity 3 (n=155)		Parity 4 (n=139)		Parity 5 (n=114)		Parity 6 (n=54)	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Number born alive/ litter (piglet)	12.69^{c}	0.21	14.00^{ab}	0.20	14.80^{a}	0.21	14.10$_{ab}$	0.21	13.33^{bc}	0.22	12.60^{c}	0.28
Litter weight at birth (kg)	19.03^{c}	0.26	20.81^{ab}	0.25	21.69^{a}	0.26	21.37^{ab}	0.26	20.48^{b}	0.27	19.02^{c}	0.35
Bodyweight at birth (kg)	1.51^{ab}	0.01	1.50^{ab}	0.01	1.48^{b}	0.01	1.53^{ab}	0.01	1.55^{a}	0.01	1.53^{ab}	0.02
Number to weaning/ litter (piglet)	11.43^{c}	0.14	12.44^{b}	0.13	13.10^{a}	0.14	12.43^{b}	0.14	11.62^{c}	0.14	10.98^{c}	0.19
Litter weight at weaning (kg)	74.66^{cd}	0.81	81.98^{b}	0.78	86.79^{a}	0.83	81.67^{b}	0.83	77.06^{c}	0.85	71.82^{d}	1.11
Bodyweight at weaning (kg)	6.58	0.05	6.62	0.05	6.64	0.05	6.62	0.05	6.66	0.05	6.57	0.07
Mating day after weaning (day)	-	-	20.95^{a}	1.38	11.27^{b}	1.47	11.23^{b}	1.47	10.59^{b}	1.48	14.05^{b}	1.95
Duration of cycle (day)	-	-	158.19^{a}	1.33	148.77^{b}	1.37	148.44^{b}	1.43	149.66^{b}	1.46	151.29^{ab}	1.99

Chapter IV

CONCLUSION AND RECOMMENDATION

4.1. Conclusion

Breed, generation, season and sex affected ADG and LMP of Landrace and Yorkshire gilts and young boars with G+ genetic resources from France (P<0.001). Yorkshire pigs have a higher ADG than Landrace pigs but LMP is lower. Specifically, Landrace and Yorkshire had ADG during the testing period of 891.28 and 896.36 gr/day (P<0.05), LMP was 60.20 and 60.07 (P<0.05). ADG and LMP were improved over generations (P<0.05) and the highest in the generation 3.

The sperm quantity and quality of Landrace and Yorkshire boars with G+ genetic resources from France were meet the National Standard TCVN 9111- 2011. These treats have been improved over generations, achieving the best in the 3rd generation born in Vietnam. Landrace boars have higher sperm quantity and quality than Yorkshire boars. Breed, generation and season significantly affect all traits of sperm quantity and quality.

Yorkshire sows had better reproductive performance than Landrace sows. Specifically, the number of piglets born alive of Landrace and Yorkshire sows was 12.81 and 13.59 piglet per litter respectively (P<0.05), the number of weaned pigs was 11.37 and 12.01 pigs per litter, (P<0.05), the litter weight at weaning was 74.43 and 79.06 kg (P<0.05). Reproductive performance of Landrace and Yorkshire sows with G+ genetic resources from France tended to increase over generations and reach the highest level in the generation 2. Breed, generation and litter affect the number of piglets born alive per litter, number of weaned pigs per litter, litter weight at

birth and litter weight of weaning ($P<0.001$).

The results of this study on productive and reproductive performance of Landrace and Yorkshire pigs with G+ genetic resources from France showed that these two breeds have good adaptation in Vietnam under livestock conditions at the Thuy Phuong Pig Research Centre.

4.2. Recommendation

Using Landrace and Yorkshire boars with G+ genetic resources from France might improve ejaculate volume and sperm quality. The sows with G+ genetic resources from France with high reproductive performance might be used as a nuclear herd to improve pig production.

Using Landrace and Yorkshire pigs with G+ genetic resources from France with high productive and reproductive potentials to create the high performance pig lines with Vietnamese brand.

Landrace and Yorkshire pigs with G+ genetic resources from France are the basis for strategic direction of exploitation and development of this new genetic resource, contributing to improve the productivity and quality of nuclear herds in the pig breeding system in our country.