สมรรถภาพระบบสืบพันธุ์ในสุกรสาวทดแทนสามกลุ่มพันธุ์ในเกษตรกรผู้เลี้ยงสุกรแบบหลังบ้านของประเทศไทย

นางสาวศราวณี ขันมณี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาวิทยาการสืบพันธุ์สัตว์ ภาควิชาสูติศาสตร์-เธนุเวชวิทยาและวิทยาการสืบพันธุ์
คณะสัตวแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2557

Reproductive Performances of Three Group Breeders of Replacement Gilts for Backyard Pig Farms in Thailand

Miss Sarawanee Khunmanee

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Theriogenology
Department of Obstetrics Gynaecology and Reproduction
Faculty of Veterinary Science
Chulalongkorn University
Academic Year 2014

Thesis Title	Reproductive Performances of Three Group Breeders of Replacement Gilts for Backyard Pig Farms in Thailand
By	Miss Sarawanee Khunmanee
Field of Study	Theriogenology
Thesis Advisor	Professor Mongkol Techakumphu, D.V.M., Doctorate de 3e cycle
Thesis Co-Advisor	Nutthee Am-in, D.V.M., M.Sc., Ph.D.

Accepted by the Faculty of Veterinary Science, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

....Dean of the Faculty of Veterinary Science

(Professor Roongroje Thanawongnuwech, D.V.M., M.Sc., Ph.D.)

THESIS COMMITTEE

....Chairman

(Associate Professor Kaywalee Chatdarong, D.V.M., M.Sc., Ph.D.)

....Thesis Advisor

(Professor Mongkol Techakumphu, D.V.M., Doctorate de 3e cycle)

....Thesis Co-Advisor

(Nutthee Am-in, D.V.M., M.Sc., Ph.D.)

....Examiner

(Nalinee Imboonta, Ph.D.)

....External Examiner

(Associate Professor Kampon Kaeoket, D.V.M., M.Sc., Ph.D.)

ศราวณี ขันมณี : สมรรถภาพระบบสืบพันธุ์ในสุกรสาวทดแทนสามกลุ่มพันธุ์ในเกษตรกรผู้เลี้ยงสุกรแบบหลังบ้านของประเทศไทย (Reproductive Performances of Three Group Breeders of Replacement Gilts for Backyard Pig Farms in Thailand) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. น.สพ. ดร. มงคล เตชะกำพุ, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: อ. น.สพ. ดร. นัทธี อ่ำอินทร์, 41 หน้า.

การเลี้ยงสุกรในพื้นที่ชนบท ส่วนใหญ่เป็นการเลี้ยงแบบหลังบ้านซึ่งเป็นอาชีพเสริมสำหรับเกษตรกร เนื่องจากต้นทุนในการผลิตต่ำ จึงนำสุกรขุนเพศเมียมาใช้เป็นแม่พันธุ์สุกรทดแทน ทำให้ได้ผลผลิตต่ำ จากปัญหาดังกล่าวจึงนำมาซึ่งการศึกษาวิจัยในครั้งนี้ โดยแบ่งกลุ่มสุกรสาวทดแทนตามกลุ่มพันธุ์ทั้งหมด 3 กลุ่มพันธุ์ ดังนี้ กลุ่มที่ 1 (Gr1: สุกรสาว 2 สายพันธุ์; เกิดจากพ่อสุกรพันธุ์ผสม (แลนด์เรซ (L) x ยอร์กเชอร์ (Y): LY 50/50) และแม่สุกรพันธุ์ผสม (แลนด์เรซ (L) x ยอร์กเชอร์ (Y): LY 50/50)), กลุ่มที่ 2 (Gr2: สุกรสาว 2 สายพันธุ์; เกิดจากพ่อสุกรพันธุ์แท้ (ยอร์กเชอร์) และ แม่สุกรพันธุ์แท้ (แลนด์เรซ)) และกลุ่มที่ 3 (Gr3: สุกรสาวไฮบริด; (แลนด์เรซ x ยอร์กเชอร์ x ดูร็อก: 25/25/50)) กลุ่มละ 30 ตัว พบว่าสุกรสาวในทั้งสามกลุ่มเริ่มแสดงอาการเป็นสัดที่อายุประมาณ 229.94±15.77 วัน อายุที่ได้รับการผสมครั้งแรก 253.84±15.62 วัน และอายุเข้าคลอดครั้งแรกเท่ากับ 368±15.57 วัน น้ำหนักเมื่อได้รับการผสมคือ 121.06±9.16 กิโลกรัม ความหนาไขมันสันหลัง ณ เป็นสัดครั้งแรกและเมื่อรับการผสมประมาณ 13 มิลลิเมตร และ 18 มิลลิเมตร ตามลำดับ ไม่มีความแตกต่างนัยสำคัญทางสถิติ ($P>0.05$) จำนวนลูกแรกเกิดทั้งหมดต่อครอก จำนวนลูกมีชีวิตทั้งหมดต่อครอก และน้ำหนักลูกเฉลี่ยแรกเกิดในกลุ่มที่ 2 มากที่สุดเท่ากับ 12.73±3.13, 11.63±2.79 (ตัวต่อครอก) และ 1.56±1.22 กิโลกรัม ตามลำดับ ซึ่งจำนวนลูกแรกเกิดทั้งหมดต่อครอก จำนวนลูกมีชีวิตทั้งหมดต่อครอกมีความแตกต่างกันทางสถิติ ($P<0.05$) ในทั้ง 3 กลุ่ม น้ำหนักลูกเฉลี่ยแรกเกิดไม่มีความแตกต่างกันทางสถิติในกลุ่มที่ 1 และ 2 น้ำหนักลูกเฉลี่ยหย่านมในกลุ่มที่ 1 สูงที่สุดเท่ากับ 6.83±0.93 กิโลกรัม ซึ่งมีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($P<0.05$) การตายก่อนหย่านมในกลุ่มที่ 1 น้อยที่สุดเท่ากับ 2.90% มีความต่างกันอย่างมีนัยสำคัญทางสถิติ ระหว่างกลุ่มที่ 1 และ 2 ผลการตรวจสถานะสุขภาพฝูงสุกรสาวทดแทนพบว่าตรวจพบไข่พยาธิ 3 ชนิดในตัวอย่างอุจจาระสุกรสาวทดแทนคือพยาธิสตรองกาย (Strongyle) พยาธิไส้เดือน (*Ascaris suum*) และพยาธิแส้ม้า (*Trichuris suis*) ผลการตรวจตัวอย่างซีรั่มเพื่อหาภูมิคุ้มกันต่อ PRRS และ PPV พบว่าทุกตัวอย่างให้ผลลบต่อการตรวจหาภูมิคุ้มกันต่อ PRRS และทุกตัวอย่างพบระดับภูมิคุ้มกันต่อ PPV ค่าเฉลี่ยระดับฮอร์โมนโปรเจสเตอโรนในตัวอย่างอุจจาระสุกรสาวทดแทนวันที่ 1 มีค่าต่ำที่สุดและสูงที่สุดในวันที่ 12 หลังสุกรยืนนิ่งรับการผสม โดยสรุปจากผลการศึกษาสุกรสาวทดแทน 2 สายพันธุ์มีสมรรถภาพระบบสืบพันธุ์หรือให้ผลผลิตดีกว่าสุกรขุนเพศเมียที่นำมาเป็นสุกรสาวทดแทน รูปแบบการทดแทนสุกรสาวที่เหมาะสมได้พัฒนาประสบความสำเร็จ ทำให้ได้ผลผลิตที่ดีมีคุณภาพสำหรับการเลี้ยงสุกรแบบหลังบ้าน

ภาควิชา สูติศาสตร์-เธนุเวชวิทยาและวิทยาการสืบพันธุ์	ลายมือชื่อนิสิต ....
	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....
สาขาวิชา วิทยาการสืบพันธุ์สัตว์	ลายมือชื่อ อ.ที่ปรึกษาร่วม ....
ปีการศึกษา 2557	

5675322431 : MAJOR THERIOGENOLOGY
KEYWORDS: BACKYARD PIG FARM, REPLACEMENT GILT, REPRODUCTIVE PERFORMANCE

SARAWANEE KHUNMANEE: Reproductive Performances of Three Group Breeders of Replacement Gilts for Backyard Pig Farms in Thailand. ADVISOR: PROF. MONGKOL TECHAKUMPHU, D.V.M., Doctorate de 3e cycle, CO-ADVISOR: NUTTHEE AM-IN, D.V.M., M.Sc., Ph.D., 41 pp.

Most of pig production in countryside of Thailand is backyard farm. Almost all of farmers manage it as the second source of their income. As a result, the production costs are quite low. The production in each farm has been emanated from insufficient costs to cover all management. Especially, an essential basis of reproductive management; for instance, almost all of owners have been using female fatteners as replacement gilts. Both factors contribute to low litter size. Therefore, all of the problems are conduced to this study. The replacement gilts were classified by mating strategies and were divided into 3 groups: group 1 (Gr1: 30 crossbred gilts; produced by crossbred boar (Landrace (L) x Yorkshire (Y): LY 50/50) and crossbred sow (LY 50/50)), group 2 (Gr2: 30 crossbred gilts; produced by purebred boar (Yorkshire) and purebred sow (Landrace)) and group 3 (Gr3: 30 hybrid gilts; (Landrace x Yorkshire x Duroc: 25/25/50)). The average age at first observed estrus of replacement gilts in all 3 groups was 229.94±15.77 days of age and the gilts were mated at age 253.84±15.62 days of age. An average age at first farrowing was 368±15.57 days of age. There was not different between each group. Body weight at first service was 121.06±9.16 kg. In addition, backfat thickness at first observed estrus and at first service was approximately 13 and 18 mm respectively, in all groups. There was no significant difference (P>0.05) in all traits. TB, BA and mean birth weight of piglets in group 2 was the highest mean that equaled 12.73±3.13, 11.63±2.79 (piglets/litter) and 1.56±1.22 kg, respectively. There were significantly different between each of three groups (P<0.05) in average numbers of piglets in both total and alive sections. There was no significant difference (P>0.05) in average birth weight between group 1 and 2. According to the results of this observation, mean of weaning weight of piglets in group 1 was the highest (6.83±0.93 kg). There was significant difference (P<0.05) between group 1 and the other two groups. Percentage of pre-weaning mortality in group 1 was the lowest (2.90%). There was significantly different (P<0.05) of this amount between group 1 and group 2. The result of health condition screening of replacement found that three kinds of parasite eggs were found in feces samples including Strongyle, *Ascaris suum* and *Trichuris suis*. The results of serum antibodies to PRRS and PPV were reported that all serum samples were negative for PRRSV antibody; PPV antibody present in all serum samples. The average of feces P4 metabolite concentration on day 1 was the lowest and the highest on day 12 after standing heat. In conclusion, overall results suggested that the crossbred (LY) provides a higher reproductive performance than fattener female breeder. The appropriate model of gilt replacement can be successfully developed in order to produce the good production in backyard farm.

Department:	Obstetrics Gynaecology and Reproduction	Student's Signature	....
		Advisor's Signature	....
Field of Study:	Theriogenology	Co-Advisor's Signature	....
Academic Year:	2014		

ACKNOWLEDGEMENTS

The studies were carried out at the Department of Obstetrics, Gynaecology and Reproduction, Faculty of Veterinary Science, Chulalongkorn University, Bangkok, in co-operation with The School of Agricultural Resource, Nan Province, Thailand.

There are many persons who dedicated their time supporting my studies.

I would like to express my sincere gratitude to the following people:

Prof. Dr. Mongkol Techakumphu, Dr. Nutthee Am-in, Prof. Dr. Annop Kunavongkrit, Assoc. Prof. Dr. Wichai Tantasuparuk, who gave me the opportunity to be their student and encouraged me to be an active researcher, not only the knowledge and skills that they gave me, but the vision of a researcher that I absorbed from them was also one of the most important things that I have earned.

Mr. Kajohn Nitiwararuk, Dr. Winai Kaewlamun, Dr. Somtat Yangsuk, Dr. Paweena Diloksumpan, Dr. Nitira Anakkul, Ms. Junpen Suwimonteerabutr, Dr. Narong Tiptanavattana, Dr. Nicole Mehl, Dr. Wanlaya Tipkantha, Dr. Nae Tanpradit, Dr. Kanchanarur Mungkong, Dr. Panthipa Borikappakul, Mr. Chokchai Rachasombat and Mr. Chainarong Punkong for helping me to achieve this experiment. Furthermore, I would like to thank staff at School of Agricultural Resources, all staffs at OGR (CU, Thailand) without them, my work cannot be accomplished.

Finally, I would like to thank my family for their supports. They are the most important part of my life and my accomplishment. Without their guidance and help, this achievement would not have been happened.

CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AI	artificial insemination
BA	number of piglets born alive per litter
BF	backfat thickness
bw	body weight
°C	Celsius degree
cm	centimeter
CU	Chulalongkorn University
EIA	enzyme immunoassay
ELISA	enzyme linked immunosorbent assays
FCR	feed conversion rate
Gr	group
g	gram
HI	haemagglutination inhibition
hr	hour
IGF-I	insulin-like growth factor-I
IVM	ivermectin
kg	kilogram
L	Landrace
LH	luteinizing hormone
LY	Landrace x Yorkshire
M	mole
MMA	metritis, mastitis and agalactia
m	meters
ml	milliliter
mm	millimeter
NaCl	sodium chloride
nmol	nanomole
OFZ	oxfendazole
PCV2	porcine circovirus type2
PPV	porcine parvovirus
PRRS	porcine reproductive and respiratory syndrome
PRRSV	porcine reproductive and respiratory syndrome virus

P4	progesterone
PZQ	praziqualtel
SD	standard deviation
SMEDI	Stillbirth, Mummification, Embryonic Death and Infertility
TB	total number of piglets born per litter
THI	temperature humidity index
Y	Yorkshire
μg	microgram

CHAPTER I

INTRODUCTION

Importance and Rationale

As pig production in rural areas has not been conducting as in commercial farm, however, the key of success of production is started from good breeder. A low quality of gilts were practically replaced, hence makes a subsequent the low and variable production. As my observation, I found that almost all farmers use female fatteners (hybrid) as replacement gilts. The main reason comes from a lack of breeder available in rural.

In Thailand, as in the other countries in the South East Asia, crop and livestock farming are the main income and well integrated in rural area. However, the lack of stable income, and an insufficiency of reserve, causes low production of crop because of a high investment. Then, the farmers usually raise poultry, cattle and pigs as secondary income (Vongporom et al., 2013). Pig farming is popular, in rural area due to easy to manage, and can feed with agricultural wastes as vegetable mixed with rice brand or banana trunk and leaf. In some areas, exotic breed as Landrace (L) or Yorkshire (Y) or crossbred (landrace x Yorkshire: LY) were found, but their reproductive performance and growth are poor and incomparable with those in intensive farms.

Since 2004, the promotion of organic pig production under the cooperation projects between Chulalongkorn University and the Office of the Non-formal and Informal Education at Nan province was established in order to improve the pig production in rural area, at Nan province (Techakumphu et al., 2007a). The artificial insemination (AI) was firstly introduced to the backyard farms, by providing a good quality of semen from free-disease boar for artificial insemination. The production was significantly improved and fatteners can be sold with a better price. Later on the farmers were educated to perform AI by themselves with their own breeders by local transport shipment of semen directly to farmers.

The success of AI implementation was shown, by two master degree dissertations. The first work delivered by Am-in and colleagues (Am-in et al., 2010) entitled “The comparison of artificial insemination with natural mating on small holder farms in Thailand; the effects of boar stimulation and distance of semen delivery on sow reproductive performance”. They also found that transporting boar semen to other locations within 1 hour (h) did not effect on reproductive indexes by Am-in (Am-in, 2005). However the presence of boar during insemination could improve its production as well. The second work was done by Visalvethaya and collaborators in, 2011 (Visalvethaya et al., 2011) who set up a practice model for artificial insemination by backyard pig farmers in the same area. It is noted that heat detection, farmer’s responsibility and logistic model of semen delivery play major role on the success of AI in backyard farms. However, both studies did not focus on the reproductive performances of replacement breeders which is one of the major factor concerned production. An improvement of replacement breeder system will then be necessary to get a higher production, hence meaning a higher income for farmers in rural areas.

Our objective is to develop the appropriate model of breeder replacement in backyard pig farm in order to increase the farm production and can be distributed regional wide. The replacement gilts from the two breeding systems were then compared with the existing practices in rural. The reproductive performances included age at first observed estrus, age at first service, age at first farrowing, body weight at first service, total number of piglets born per litter (TB), number of piglets born alive per litter (BA), mean birth weight of piglets, mean weaning weight of piglets and percentage of pre-weaning mortality were recorded.

From all of the data above, main problem of pig production in backyard pig farms emanated from insufficient replacement gilts and using female fatteners as replacement gilts. Both factors contribute to litter size that is lower than those of commercial farms which use crossbred gilts. Therefore, all of the problems and factors are conduced to this study.

CHAPTER II
LITERATURE REVIEW

Pig production in backyard pig farms

Generally for backyard pig farms, both male and female piglets were raise together after weaning until their body weight reach 30 kilogram (kg). Afterwards, all piglets were separated by sex. Male were fed to be fattener; female with a good characteristics; body weight, normal external genital tract and normal growth will be used to be replacement gilt. The female, will be used at 6 months; then, farmer will let them inseminated afterward.

Since 2004, Chulalongkorn University cooperating with Nan provincial livestock department started to implement artificial insemination to solve an insufficient breeding boar and providing knowledge of pig management among farmers. This project formed a new model of translational research called “Service research” which foster the farrowing rate and litter size better than natural mating (Techakumphu et al., 2007b; Am-in et al., 2010). In 2010, there was a research about the developed artificial insemination model for backyard farmers and the trained farmers are able to inseminate their own sows by themselves. Efficacy of Artificial insemination by pig farmers is as successful as trained AI man which better than natural mating in Nan (Visalvethaya et al., 2011). Reproductive performances of artificial insemination sows by farmers showed non-return rate, farrowing rate, TB and BA were 84%, 69.2%, 11.5±2.8 and 10.7±2.8, respectively (Am-in et al., 2010; Visalvethaya et al., 2011). The model was already implemented and distributed to other areas of Nan province, including other part of Thailand. Recently in 2010, the program of enhancing production using Nan Model, were exported to the Laos People's Democratic Republic by cooperating with the National University of Laos.

In the present, an insufficiency of replacement gilt is one of the main problems of pig production in rural areas. Because the farmers do not have enough budget to buy a good genetically replacement gilt from commercial farm, they still use their own female fattener to be replacement breeder. No study was done to evaluated the reproductive performance of these female.

Genetic

Usually, heterosis effect significantly affects both several reproductive traits in pigs and litter size. Normally, the feed consumption, the lactation capacity (production and period) and number of piglet born in purebred sows seem lower than crossbred sows. The litter size of purebred sows possessed 0.16 piglets lower than crossbred's. However, the number of stillborn piglets of pure breed sows increased by 0.09 piglets when compared with the crossbred breeding (Lukač, 2013).

To produce heterosis, there are several breeds of swine that have usually used for breeding such as Duroc, Landrace, and Yorkshire. Duroc is mostly use to be a paternal line because this breed possesses several outstanding characteristics including better in growth rate, intramuscular fat content, high meat quality and low backfat. While Landrace is mostly use to be a maternal line because of its high litter size at weaning, high litter weight of piglets and low backfat. The same as Yorkshire is most likely used to be a maternal line because its high litters size, high litter weight of piglets, and high growth performance (Lammers et al., 2007).

Reproductive performances

Age at first observed estrus

Generally, the highest pig productions are explicit in the first three parity, especially in the female that shows sign of first estrus between 181 to 200 days of age (Tummaruk et al., 2007). Furthermore, temperature is another significant factor. In the cold season, interval from entry to first observed estrus of gilts is shorter than interval in other seasons. In addition, during 30 days before entering to the gilt pool, gilts that exposed to high temperature, a high temperature humidity index (THI) and/or short photo period show sign of first estrus later than gilts that exposed to low temperature, a low THI and/or a long photo period (Tummaruk, 2012).

Age at first service

Mean of age at first service in pigs is about 236.2±17.5 days of age (Tummaruk et al., 2009). Photo period is the main factor that affects age at first service. During 91 to 150 days of age, age at first service increases by 0.96-3.05 days for every hour when photo period is decreased. Therefore, gilts should expose to light about 15 h during puberty attainment (Iida and Koketsu, 2013). In addition, age at first service that is delayed by 10 days affects litter size which would be increased about 0.1 piglets per litter in primiparous sows. Then litter size will decreased in parities 4 and 5 (Tummaruk et al., 2001).

Body weight at first service

Body weight (BW) that is appropriate for mating is 139.1±6.0 kg (Tummaruk et al., 2009). BW of gilts at entering into the breeding unit affects TB. In case that BW of gilts is more than 150 kg, they will deliver a large TB in the second parity. TB of gilts with this body weight is higher than TB of gilts with BW between 136 to 140 kg during mating (Roongsitthichai et al., 2013).

Age at first farrowing

Age at first farrowing and farrowing rate of gilts is 352.2±19.6 days and 84.8%, respectively (Tummaruk et al., 2009). Result from previous study has shown that first farrowing at 356 days of age is the best reproductive results (Le Cozler et al., 1998).

Backfat thickness (BF)

Backfat is source of hormones including leptin, insulin-like growth factor-I (IGF-I) and progesterone (P4) that involve with puberty achievement.The BF of replacement gilt between 13.1 and 15.0 millimeter (mm) at first observed estrus and 18.0 to 23.0 mm at the first service had the highest mean of litter size in the first three parity in gilts (Tummaruk et al., 2007; Roongsitthichai and Tummaruk, 2014). High BF gilts at service had more litter size than low BF gilts. Piglets born from low BF gilts have lower growth rate and mean weaning weight of piglets than piglets from high BF gilts (Roongsitthichai and Tummaruk, 2014).

Litter size

In commercial farms, the reproductive data of pig production consist of TB (10.4±2.4), BA (9.9±2.2), mean birth weight of piglets (1.63±0.01), number of weaned piglets per litter (9.0±1.8) and mean weaning weight of piglets (4.14±0.1) (Akdag et al., 2009; Tummaruk et al., 2009; Kilbride et al., 2012).

Insemination

We should inseminate “immediately” after estrus detection. Farrowing rate after following this protocol is 8.3 to 8.4% higher than another protocol that inseminated at 6 to 12 and 24 h. Feeding is another factor that affects pig born alive. The number of pig born alive increases when gilt was restricted feeding after insemination. In addition, the amounts of pig born alive are 0.17 (in first inseminate group) and 0.23 (in re-inseminate group) that higher than from gilt that was not restricted feeding (Kaneko and Koketsu, 2012).

Factors effect on reproductive performances

Typically, the first litter is smaller than any other parity. Furthermore, litter size increases to maximum between third and fifth litter. In this case, there are many factors that affect reproductive performances. Husbandry and feeding are also important; if pig is fed with good quality and proper amount during the first 48 to 72 h after breeding it can reduce embryonic lost. It is recommended the female should be bred at the second time of estrus, hence increase litter size by 0.7 pigs per litter. Semen quality for insemination play important factors influences the reproductive performance. A poor semen quality affected by high temperature of environment, old age and over-usage frequency of boar. High ambient temperature about 30 Celsius degree (°C) reduce boar fertility and subsequent frequency litter size. Moreover, it was reported that high temperature and humidity (record at the herd level) at previous weaning/mating or at farrowing had negative effects on litter size, but negative influences were not significant (Suriyasomboon et al., 2006). A change environment after recent mating and sow movement would decrease embryonic lost. Time at first service is associated with age of gilts at the time of entering into the gilts pool. Observed estrus of gilts with an older age at the time of entering into the gilts pool are rather older in comparison with younger gilts. Therefore, these affect time at first service to be late. Moreover, there are many factors including season, outdoor climate, and photo period which affect age at first observed estrus. Gilts standing heat in the hot and rainy season are older than the gilts in the cool seasons. According to this effect, we should be entering gilt into the pool during hot season because interval from entry to first observed estrus is short. Temperature and humidity were involve age at first service, gilts that exposed to low temperature; a low THI; and/or a long photo period in the 30 days before entering into the gilt pool are younger at first observed estrus than gilts that exposed to high temperature; a high THI; and/or a short photo period (Tummaruk, 2012).

Furthermore, growth rate is one of the indicators for reproductive performance. Gilts with a high growth rate up to 100 kg body weight have larger litter size (all parity 1 to 5), shorter weaning to first service interval (all parity 1 to 5) and higher farrowing rate (parity 2 and 5) than gilts with a low growth rate (Tummaruk et al., 2001).

Reproductive failure

The reproductive failure has a tremendous effect on production, the repeat breeding, abortion, low litter size from weak neonates, stillbirth, mummification, embryonic and fetal death, and infertility. This increase the non-productive day in farm. The reproductive failure comes from noninfectious and infectious causes.

Noninfectious causes

There are many factors that affect this problem. Management consists of number of services, mating quality, timing of mating, type of service, and feeding. In the summer-autumn period, restricted feeding after mating should practice. This is an important rule to maintain conception rate at the early pregnancy in gilts and sows. Luteinizing hormone (LH) secretion exerts a progesterone-mediated detrimental effect on the capability of embryos to produce adequate embryonic signaling. This is the reason that leads to a seasonal disruption of pregnancy and a return to estrus within 25 to 30 days after mating (Peltoniemi et al., 2000). Moreover mycotoxin; parity; temperature and stress (Einarsson et al., 2008); and boar factors that consist of age, genetics, individual differences, temperature, and number of services affect regular return to estrus.

Infectious causes

There were infectious causes of reproductive failure including Porcine parvovirus (PPV), Porcine Reproductive and Respiratory Syndrome (PRRS), Leptospirosis, Pseudorabies, Porcine circovirus type2 (PCV2), Brucellosis, Japanese B Encephalitis Virus Infection and Classical Swine Fever etc.

Gilts can be infected PPV in every stage of gestation, although fetuses are infected and death at different stages of pregnancy. Almost all females are naturally infected before their second pregnancy, and immunity is long-life. Fetal dead with varying sizes, including mummified fetuses, along with stillborn and healthy pigs born to first parity gilts are remarkable of porcine parvovirus. Most PRRS strains do not cross the placenta until after 90 days of gestation. Usually, most abortions are found in the late stage of gestation that are composed of fresh and autolysis dead pigs, weak infected pigs, and healthy uninfected pigs that are often develop respiratory disease within a few days of birth. In July 2012, PRRS outbreak occurred in Wiang Sa district of Nan province (Songmeunggan, 2012) that causes economic losses through its and effects on reproduction.

Gastrointestinal parasites in pig

Parasitic infections are problem in tropical area that depend on several factors including immune system, route of infection and environment (Roepstorff and Nansen, 1994). The previous study, 57.9% indicated more than one kind of parasite infection. High prevalence rates of parasite infection were found in poor hygiene and dirty solid floor and were not different in deworming and non-deworming groups (Nantavisai et al., 2008). Low Feed Conversion Ratio (FCR) and low of growth rate were observed in infected pigs (Weng et al., 2005).

Progesterone analyses in fecal

Concentration of P4 in feces can use to indicate luteal function of ovaries in gilts. At prepubetal period, the level of P4 in feces is lower than 1.5 nanomole/milliliter (nmol/ml). Afterwards, metabolite of P4 in feces is continually increased in high level (>20 nmol/ml) between day 7 to 16 after standing heat. Finally, the level of metabolite of P4 in feces is highest on day 13 after standing heat (Tummaruk et al., 2003).

Objective of the study

To develop the appropriate model of gilt replacements in backyard farms and compare the reproductive performance of three breeds of replacement gilts for backyard pig farms in Thailand

Hypothesis of the study

1. Farmers are able to produce replacement gilts by themselves that have appropriate quality for their community
2. The crossbred provides a high reproductive performance than fattener female breeder
3. These strategies enhance litter size in backyard pig farms

Expected outcomes

Farmers are able to produce replacement gilts that have appropriate quality for their backyard pig production and the litter size from these gilts increased.

CHAPTER III
MATERIALS AND METHODS

This study focuses on pig production in rural areas that most of them were raised in backyard. Each farm consisted of 2 to 5 sows per farm. The animals were fed with 0.2 kg of rice bran mixed with 1.5-2.0 kg of commercial feed per meal. They are sometimes given fermented food, vegetables and fruits as supplementary. Basic form housings are made of wood and other materials that are found around the area. The overall dimension of individual housing for gilt is 2.5 meters (m) in length and 2 m in width. The dimension of pen inside housing is 1.8 m in length and 0.8 m in width. The dimension of group housing that contain up to 5 to 10 growing pigs are 6 m in length and 3 m in width. Most housing are divided into two zones that consisted of dry zone (cement) and wet zone (excavate into ground for 0.5 to 0.6 m in depth and fill materials for bedding consisted of husk, water bio-fermentation, lime and salt). When the production cycle was finished, waste from wet zone can be used as fertilizer which is the way to decrease greenhouse effect and waste from agriculture (Figure 2 and 3).

Study areas

The study area is Nan province, one of the Northern Province of Thailand, situated in between 18.317869 North latitude and 100.392094 East longitude. Nan province consists of 15 districts (Muang, Mae Charim, Ban Luang, Na Noi, Tha Wang Pha, Pua, Wiang Sa, Thung Chang, Chiang Klang, Na Muen, Bo Kluea, Song Khwae, Phu Phiang, Chaloem Phra Kiat and Sunti Suk). The farms located in 5 districts, having been the network of Chulalongkorn University AI center for either AI service or veterinary service were selected including Muang, Pau, Tha Wang Pha, Wiang Sa and Sunti Suk (Figure 1).

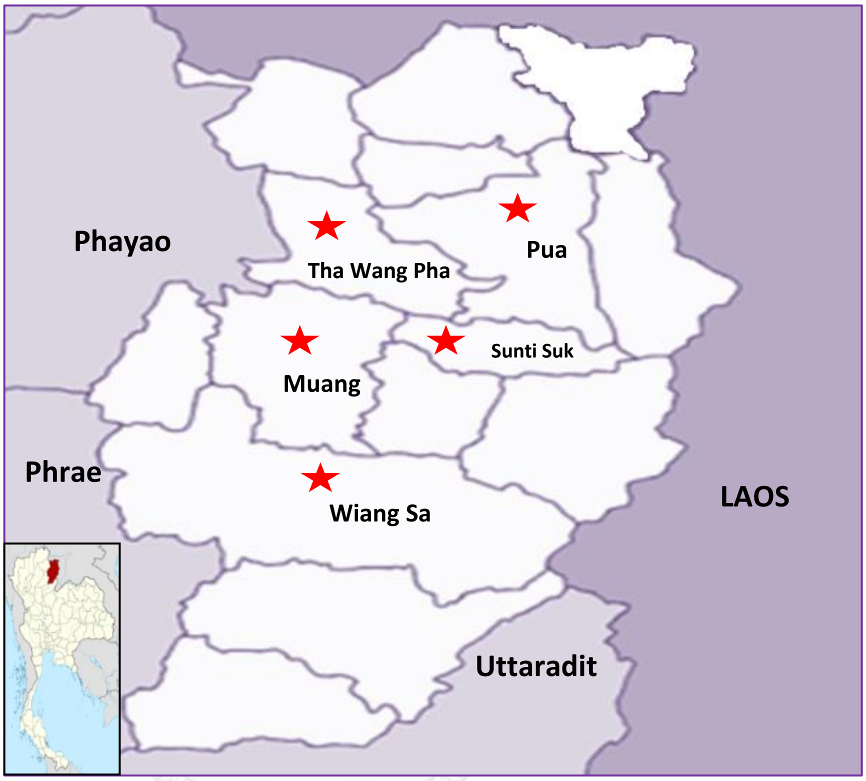

Figure 1 The studied area in Nan province

Replacement gilts

A total of 90 healthy replacement gilts selected randomly from 77 backyard farms were used and were classified by mating strategies as 3 groups:

- Group 1 (Gr1: crossbred gilts; produced by crossbred boar (Landrace (L) x Yorkshire (Y): LY 50/50) and crossbred sow (Landrace (L) x Yorkshire (Y): LY 50/50))
- Group 2 (Gr2: crossbred gilts; produced by purebred boar (Yorkshire) and purebred sow (Landrace))
- Group 3 (Gr3: hybrid gilts; (Landrace x Yorkshire x Duroc: 25/25/50)).

Each group consisted of 30 animals. Gilts from group 1 and 2 were produced by CU AI center.

At least one estrus cycle was recorded before mating allowance. Housing, feeding and other managements were under the traditional conditions as backyard system. Data of replacement gilts including gilt’s identities, date of birth, age at first observed estrus, age at first service, age at first farrowing, BF (at first observed estrus and at first service) and body weight at first service were noted.

Figure 2 The traditional housing of backyard farms at Nan province

Figure 3 Bedding consisted of husk, water bio-fermentation, lime and salt

Figure 4 Measuring the chest girth with a tape measure for approximate weight

Boars

All experimental gilts were artificially inseminated with semen produced under a standard protocol from two mature Duroc boars belonging to the Chulalongkorn University AI center. These boars are regularly checked for PPRS and under veterinary observation. The semen was prepared as the standard of the Department of Obstetrics Gynaecology and Reproduction, Faculty of Veterinary Science, Chulalongkorn Univeristy. A final sperm concentration of $3x10^9$ sperms per 80 ml dose.

General management

About 1.5 to 2.0 kg commercial feed mixed with 0.2 kg of rice bran were fed once a day. Some farmers gave fermented feed, vegetables and fruits as supplementary. Their average age at entering gilt pool is 180 days of age. The dimension of individual housing for replacement gilt is 2.5 m in length and 2 m in width. The dimension of pen inside housing is 1.8 m in length and 0.8 m in width. This housing is used for entire process such as insemination, gestation, and farrowing as shown in figure 2 and 3.

Blood collection

Blood samples were collected for PRRS and PPV analysis. Blood sampling (n=7) from all group, (n=2) from boars were used in this study and (n=1) from gilt in CU AI center only one time before the study begin.

Feces collection and deworm

Swine fecal samples were collected from the rectum. Approximately 10 grams (g) of fecal were used for worm infection. These feces were kept at -20°C until investigation. Numbers of swine population that were used for fecal collection consisted of 3 gilts from each group. Fecal samples for hormonal analyses were collected at 6 months of age and were repeated every 7 day interval until the gilts show signs of first estrus. After that, fecal sample was collected again at the day of first observed estrus and at day 7, 13 and 19 after observed estrus. Feces collected about 9.00-11.00 p.m. of every time. Finally, fecal samples were collected at 3 months after deworm.

For dewormimg, ivermectin (IVM) at concentration of 300 microgram (μg) per kilogram body weight was subcutaneously given once at first service.

The experimental scope was presented in Figure 5.

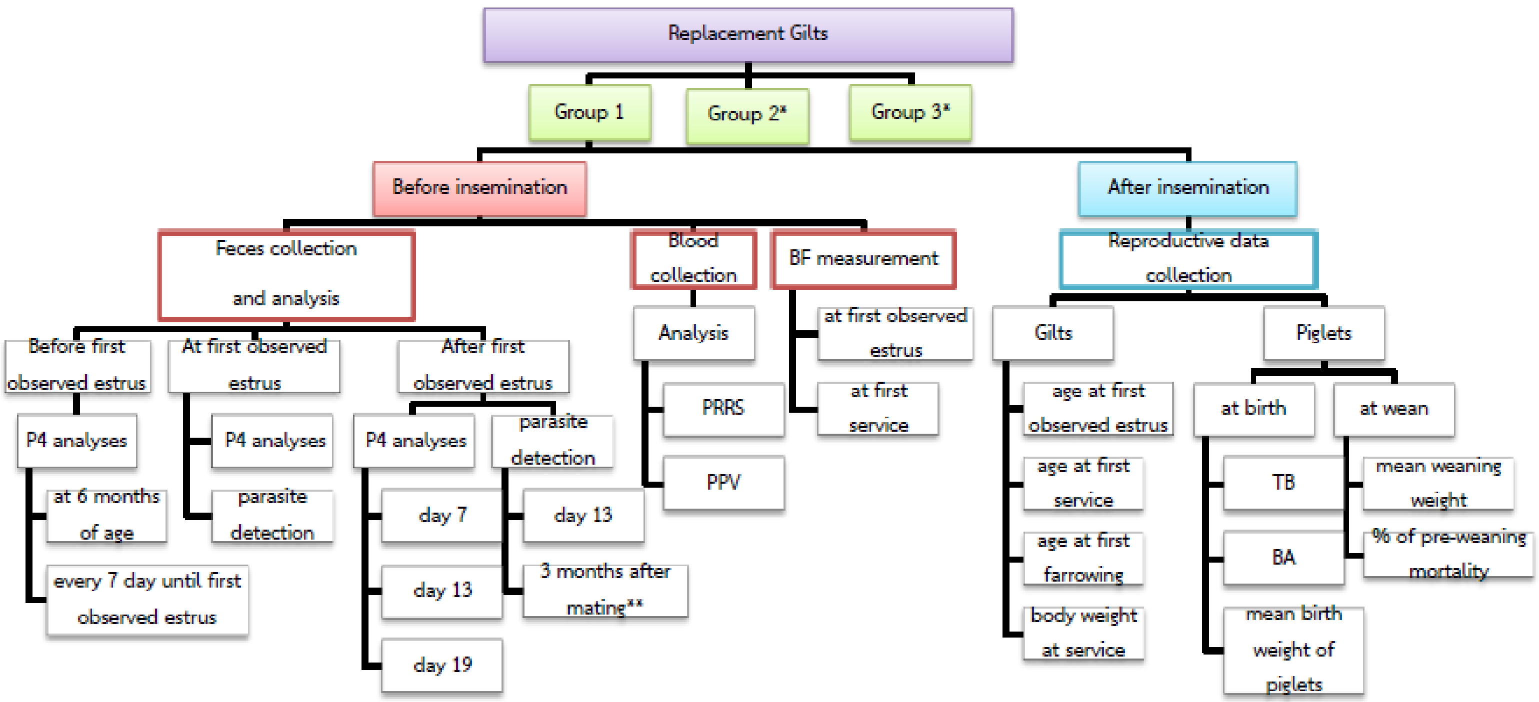

Figure 5 Scope and detail of experiment

* Samples are administered by the same process as Group (Gr) 1

** During time of gestation period

Health status determination replacement gilts

The health status of local breeders was identified by scoring of parasitic infection and; PRRS and PPV immunological status.

Parasite detection for feces samples

For investigation process, the technique for parasite detection was floatation technique. Two grams of gilt feces samples were added to 15 ml of sugar solution. The mixture is then homogenized by shaking the 50 ml tubes. Then strain mixture through a tea strainer into waxed-paper cup. The strained contents are transfer to 15 ml conical centrifuge tube and centrifuge for 5 minutes. The tube was removed to place in rest tube rack, add sugar solution to tube until a slight meniscus forms above the top of tube. Cover slip was placed on the top for 5 minutes, and then cover slip was removed to slide for parasite detection (Pittman et al., 2010).

Hormonal analyses of fecal samples

The levels of progesterone in feces were determined by Enzyme immunoassay (EIA). One gram of gilt feces was suspended in 10 ml 0.01 mole (M) phosphate buffer with 0.15 M sodium chloride (NaCl) (pH 7.0). The sample was shake for 12 h at 25 °C, and then centrifuged at 2700 x g for 15 minutes. The supernatant was collected and either frozen (-20°C) or immediately used in the assay (Figure 6 and 7).

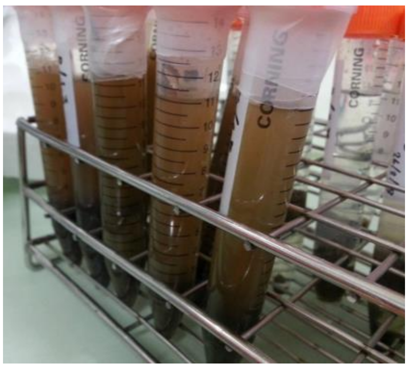

Figure 6 One gram of gilt feces was suspended in 10 ml 0.01 mole M phosphate buffer with 0.15 M NaCl (pH 7.0)

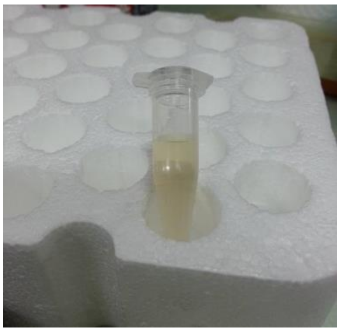

Figure 7 The supernatant fluid of feces samples

Backfat thickness measurement

BF measure at the first observe estrus and at first service, was done at the last rib about 6-8 centimeter (cm) from the mid line, on left and right side of gilt (Figure 8). A-mode ultrasonography for the BF measurement is used for this process (Tummaruk et al., 2007).

Figure 8 BF measurement

Estrus detection and insemination

Heat detection was performed by back pressure test, vulva symptoms (swollen, reddening and mucus discharge) and other combined behaviors (grunts, growls, loss of appetite and standing heat). AI was managed by farmers and no boars are presented in any of the farms. All of them were inseminated twice per estrus period with boar semen from AI center for mating gilts. AI is conducted immediately (Kaneko and Koketsu, 2012) after estrus detection and are repeated at 12 h later with the same boar semen (Figure 9 and 10).

Figure 9 Heat detection was performed by farmers

Figure 10 Artificial insemination was managed by farmers

Pregnancy detection

After 18 to 24 days of serving, return of estrus was observed. Non return estrus gilts were assumed as pregnancy. Pregnancy was performed by ultrasound real-time B-mode scanning at 30 days after service.

Reproductive data, including age at first observed estrus, age at first service, body weight at service, age at first farrowing, TB, BA, mean birth weight of piglets, mean weaning weight of piglets and % of pre-weaning mortality were followed up and recorded.

Statistical analysis

Reproductive performances (age at first observed estrus, age at first service, body weight at service, age at first farrowing, total born per litter, born alive per litter, mean body weight at birth, mean body weight at wean and % of pre-weaning mortality) and backfat thickness are present as mean±standard deviation (SD) analyzed by using the ANOVA, $P < 0.05$ was set as level of significance.

The data for PRRS, PPV and parasite detection; show as positive and negative was analyzed using the Chi-square test.

CHAPTER IV
RESULTS

The study was focused on backyard farm at Nan province using 90 replacement gilts divided in 3 groups as mentioned in materials and methods. The animals in group 1 and 2 were allocated randomly to farmers while the group 3 was produced by normal replacement. The comparative performances of each reproductive criterion were shown in Table 1 and 2.

General

Age at first observed estrus, age at first service, age at first farrowing, pregnancy rate and farrowing rate

The average of age at first observed estrus in replacement gilts in all 3 groups was in average of 229.94±15.77 days of age (range 208-271 days) and the gilts were mated at the average age 253.84±15.62 days of age (P>0.05). For an average age at first farrowing was 368±15.57 days of age and no difference among the three groups. Pregnancy rate and farrowing rate was 100% in all traits (Table 1).

Body weight and backfat thickness

The estimated body weight at the first service was 121.06±9.16 kg (range 100-145 kg). In addition, backfat thickness was about 13.0 mm at first observed estrus and 18.0 mm at first service in all groups (Table 1). There was no significant difference (P>0.05) between group in all traits.

Table 1 Comparison of age at first observed estrus, age at first service, age at first farrowing, body weight at service and backfat thickness of replacement gilts (n=90)

Parameter	**Group (mean±SD)**			
	Gr1	**Gr2**	**Gr3**	**All**
Age at first observed estrus (days)	231.53±16.36	226.43±13.69	231.87±16.98	229.94±15.77
Age at first service (days)	252.8±16.24	251.57±13.61	257.17±16.77	253.84±15.62
Age at first farrowing (days)	367.13±16.14	365.83±13.58	366.48±16.86	368±15.57
Body weight at service (kg)	121.67±12.48	122±4.47	121.83±8.84	121.06±9.16
BF at first observed estrus (mm)	13.23±1.85	13.37±2.37	13.23±1.43	13.28±1.91
BF at first service (mm)	18.23±1.84	18.4±2.37	18.23±1.42	18.29±1.91

Reproductive performances

Litter size at birth

The average of TB was 10.97±2.49, 12.73±3.13 and 9.37±2.50 (piglets/litter) in group 1, 2 and 3 respectively (Table 2). On average, BA was 10.2±2.41, 11.63±2.79 and 7.87±1.59 (piglets/litter) in group 1, 2 and 3 respectively (Table 2). These average numbers of piglets in both total and alive sections of gilts in group 2 were higher than group 1 and group3 respectively. In addition, there were significantly different between each of three groups (P<0.05).

Mean birth weight of piglets and mean weaning weight of piglets

An average mean birth weight of newborn piglets was 1.54±0.18, 1.57±0.22 and 1.46±0.13 kg in group 1, 2 and 3, respectively (Table 2). For mean of weaning weight of piglets, mean in group 1 was 6.92±0.98 kg and was significantly higher than group 2 and 3 (5.62±1.42 and 5.93±0.68 respectively) (Table 2). This quantity was higher than group 2 and 3, there was significant difference (P<0.05) between group 1 and the other two groups.

Pre-weaning mortality

The percentage of pre-weaning mortality in group 2 and 3 were higher than group 1 shown in Table 2. In addition, there was significantly different of this amount between group 1 and group 2; 2 and 3 (P<0.05). There was no significant difference between group 1 and 3 (P>0.05).

Table 2 Comparison of total number of piglets born per litter (TB), number of piglets born alive per litter (BA), mean birth weight of piglets, mean weaning weight of piglets and pre-weaning mortality in each group (n=30 per group)

Parameter	Group (mean±SD)		
	1	**2**	**3**
TB (piglets/litter)	10.97 ± 2.49^{b}	12.73 ± 3.13^{a}	9.37 ± 2.50^{c}
BA (piglets/litter)	10.2 ± 2.41^{b}	11.63 ± 2.79^{a}	7.87 ± 1.59^{c}
Mean birth weight of piglets (kg)	1.54 ± 0.18^{a}	1.57 ± 0.22^{a}	1.46 ± 0.13^{b}
Mean weaning weight of piglets (kg)	6.92 ± 0.98^{a}	5.62 ± 1.42^{b}	5.93 ± 0.68^{b}
Number of weaned piglets per litter (piglets/litter)	9.87 ± 2.29^{a}	9.67 ± 3.23^{a}	7.57 ± 1.65^{b}
Pre-weaning mortality (%)	2.90^{b}	15.37^{a}	3.61^{b}

$^{a, b, c}$ within row differs $p < 0.05$

Health condition of replacement

Parasite detection

The health status of replacement gilts were identified by parasite infection examination and PRRS and PPV immunological status. It is found that parasite eggs could be detected in every section of were 33.33% (1 of 3 gilts), 66.67% (2 of 3 gilts) and 66.67% (2 of 3 gilts) in group 1, 2 and 3 respectively. Three kinds of parasite eggs were found in feces samples including Strongyle, *Ascaris suum* and *Trichuris suis* (Figure 11 and 12). Parasite infection was declined to 61.54-82.76% 2 weeks after deworming and the animals were reinfected after 3 months of observation.

PRRS and PPV analyses for serum samples

In this study, serum sampling from gilts and boars were randomly collected and then analyzed by enzyme linked immunosorbent assays (ELISA) for Porcine reproductive and respiratory syndrome virus (PRRSV) antibody detection. All serum samples were negative for PRRSV antibody (Table 3). Analysis of all serum samples by Haemagglutination inhibition test (HI test), the HI titer of PPV were demonstrated in Table 4. For PRRS and PPV immunological status, it was found that all gilts were free from PRRS infection. While the low titer of PPV was found in all gilts compared to AI boar and gilt from CU AI center (Table 4).

Table 3 Result of serum antibodies to porcine reproductive and respiratory syndrome virus (PRRSV) by ELISA in replacement gilts and boars (n=10)

No.	S/P	Result
1	0.006	Negative
2	0.000	Negative
3	0.002	Negative
4	0.000	Negative
5	0.050	Negative
6	0.006	Negative
7	0.000	Negative
8	0.036	Negative
9	0.034	Negative
10	0.018	Negative

Positive control (OD) = 0.570

Negative control (OD) = 0.073

Serum sampling from gilts and boars were analyzed by ELISA (ELISA-IDEXXLotHK495) for Porcine reproductive and respiratory syndrome virus (PRRSV) antibody detection.

Table 4 Serological results of gilts and boars sera from Nan province tested by Haemagglutination inhibition test (HI test) (n=10)

No.	Titer	No.	Titer
1	16	6	32
2	32	7	≥ 4096
3	≤ 4	8	≥ 4096
4	32	9	512
5	8	10	≥ 4096

Sample No.1 to 6 and 9 were collected from gilt in backyard farms

No. 7 and 8 were collected from boars

No.10 was collected from gilt in CU AI center

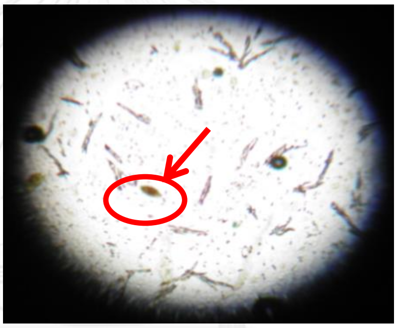

Figure 11 *Trichuris suis* eggs found in feces sample of replacement gilt

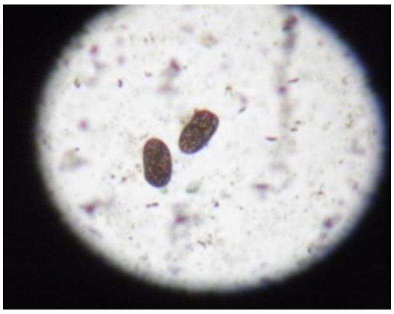

Figure 12 Strongyle eggs in feces sample of replacement gilt under light microscope

Hormonal analyses for feces samples

Feces P4 metabolite concentration on day 1, 7, 12 and 19 of estrus cycle were demonstrated in Table 6. Level of feces P4 metabolite increased about day 7 of estrus cycle and day 19 after standing heat was decrease (Table 5).

Table 5 Level of feces progesterone metabolite at different days of estrus cycle in replacement gilts (n=7)

Day of estrus	Feces progesterone (nmol/L)	
	Range	mean±SD
1	34.698-54.444	40.310±6.848
7	39.152-182.331	101.483±51.532
12	77.455-419.328	247.838±122.804
19	41.892-104.541	76.230±23.596

CHAPTER V
DISCUSSION

The study reported the first time of the comparative performance of replacement gilts in rural area in Thailand. The ultimate goal of this study was to develop the model of breeder production for self-replacement of farmers'.

At first, crossbred gilts (LY) were produced by two mating systems. The first, one by using 50% LY boars X 50% LY sows to produce crossbred (LY) gilts as indicated group 1 in our study, and while the second one come from purebred boar (Y) mated with purebred sows (L) to produced LY gilts assigned as group 2. The performances of reproduction from these two gilts were compared with traditional replaced gilts which are fattener gilts.

Our study showed that

In this study, the sign of estrus of replacement breeder presented at 229.94±15.77 days of age. This does not differ among the groups, means genetic background do not influence on puberty. The age at puberty is older than that reported by using commercial gilts which is about 202.6±17.7 days of age. Then, the late puberty seems evident in backyard farm production. The feed quality and a good reproductive management may help to solve the problem.

As found that the age of farrowing was about 1 year or at 368±15.57 days of age. On calculation, age at first mating should be about 250 days after diminish from the pregnancy period. This come to the fact that non-productive day from puberty to mating is about 30 days. It means that the farmers succeeded to follow the estrus cycle and are able to be inseminated at the second estrus as not differ.

It is reported that age at first observed estrus or age at first ovulation is under genetic control, has heritability of 0.3 (Rydhmer et al., 1994; Bidanel et al., 1996). The data above implied that gene controlling age of puberty not express in backyard pig farms which was corresponded to our study that no difference was found of age of puberty all three groups. Body weight at first service and backfat thickness in each group was not difference.

The health condition may be one of the factors affected on delay puberty. The result of parasitic investigation indicated that all replacement gilts were infected with at least 3 kinds of intestinal parasite including Strongyle, *Ascaris suum* and *Trichuris suis*. Parasite eggs were found in all groups of replacement gilt. However the parasitic infections in each group decreased in 2 weeks after deworming and then become reinfected in 3 months after deworming. This because the breeder expose to soil and bedding all time, consequently. In this study, only one anthelmintic was used to deworm pig; therefore, effectiveness against parasites of drug might not inclusive. In order to improve deworming program, appropriate duration for repeated deworming should further study, which should be before 3 months after the first deworming. In addition, feces collection for parasite eggs detection should perform regularly. A combination of at least two types of anthelmintic is recommended such as ivermectin and praziqualtel (PZQ) (Tang et al., 2012) or IVM and oxfendazole (OFZ) (Mkupasi et al., 2013). According to the different efficacy of each drug, parallel using of anthelmintic would be more effective for controlling the parasites.

The S/P Ratio from ELISA test indicated that all sampling were negative for PRRS. This result implied that this population had never been exposure to PRRSV before entering to the farm. These farms are PRRS free herd that are good for having good production. Furthermore, the most backyard pig farms did not perform PRRS vaccination program; as a result, PRRSV antibodies were not found. Another possible reason of negative result is that if swine had become infected with PRRS less than 14 days, PRRSV antibody would not have found in immune system. In order to maintain PRRS free herd, a routine blood testing should be performed including a good quarantine of new breeder (Mengeling et al., 2000). On the other hand, PPV antibody presented in all serum samples. However, it is found that a low titer was found in all gilts, while in AI boars immunized with PPV vaccine having a high titer. Immunization with PPV to prevent the Stillbirth, Mummification, Embryonic Death and Infertility (SMEDI), should be then, performed by vaccination or by acclimatization with sows in farm. Previous study suggested that receiving two doses of vaccine had titers higher than receiving one dose of vaccine (Paul and Mengeling, 1986). Then, to improve the health status of replacement breeder, a regular deworming, preventing from PRRS infection and a vaccination against PPV should be explored.

The previous study found that on average, fecal P4 metabolite was lowest on day 1 and highest on day 13. The level P4 metabolite in feces increased around day 7 after standing heat and remained in high level (>20 nmol/kg) until days 16 after standing heat (Tummaruk et al., 2003). The result above support this study, the average of feces P4 metabolite concentration on day 1 was the lowest (34.698 to 54.444 nmol/L) and the highest (77.455 to 419.328 nmol/L) on day 12 after standing heat that indicate luteal function of ovaries in gilts are normal..

Reproductive performances of female can be measured by litter size, BA, mean birth weight of piglets, number of piglets weaned, age at puberty, weaning to estrus interval and farrowing interval (Rothschild, 1996). Litter size is the first choice as selection objection and the criterion to improve reproductive trait (McLaren and Bovey, 1992). Litter size at birth and BA has been viewed as the most important reproductive traits, the heritability were estimates 0.10 or lower (Rothschild, 1996). The reproductive traits have heritability about (5 to 30%), while carcass traits have heritability about (40 to 60%). Yorkshire and Landrace are known for maternal traits because this breed has several excellent characteristics including litter size at weaned, litter weight of piglets, growth rate and backfat; and Duroc is known for carcass or terminal traits because this breed better in growth rate, intramuscular fat, meat quality and backfat (Lammers et al., 2007). In this study, replacement gilts in group 3 were hybrid gilts (Landrace x Yorkshire x Duroc: 25/25/50) that had passed on carcass traits. Gilts in group 1 (produced by crossbred boar (Landrace (L) x Yorkshire (Y): LY 50/50) and crossbred sow (Landrace (L) x Yorkshire (Y): LY 50/50) and group 2 (produced by purebred boar (Yorkshire) and purebred sow (Landrace)) were crossbred gilts that had passed on reproductive traits. The result above support this study, gilts from group 1 and 2 were appropriate for replacement gilt and group 3 are produced to be fattener. Besides, there were reproductive traits including mean birth weight of piglets, mean weaning weight of piglets and pre-weaning mortality. Heritabilities were estimated to be in mean birth weight of piglets, mean weaning weight of piglets and pre-weaning mortality was 0.4, 0.3 and 0.04 respectively (Kerr and Cameron, 1995; Rydhmer, 2000). Therefore, there are passed on reproductive traits to replacement gilts in group 1 and 2 more than group 3. According to the results of this study, mean birth weight of piglets in group 2 was the highest and mean weaning weight of piglets in group 1 was the highest turned out as the estimated theory. Because number of piglet born alive in group 2 more than group 1 therefore mean weaning weight of piglets in group 1 was higher. But there are important remarkable for percentage of pre-weaning mortality in group 2 was the highest. These losses occurred because four gilts in group 2 were unhealthy and were prone to infect of metritis, mastitis and agalactia (MMA) infection after parturition. This infection was the cause of low milk production; therefore, piglets may then be starved and become death due to insufficient feeding. Moreover, backyard pig farms are open system that may be introducing diseases. The farmers' lack of experience and management in pure breed gilts, then MMA was occurred in these animals easier than crossbred gilts. This may lead to interpret that providing purebred breeder to backyard farmer is not suitable to have a good production. The previous study found that when selection for larger litters at birth has been successful it has led to higher piglet mortality (Brandt and Grandjot, 1998).

In conclusion, overall results suggested that the crossbred (LY) from group 1 provides a higher reproductive performance than fattener female breeder. In addition, model of gilt replacement same as group 1 is simpler than group 2 because management of crossbred not complicate and easier than purebred. These strategies enhance litter size in backyard pig farms. The appropriate model of gilt replacement can be successfully developed in order to produce the good production in backyard farm.

Future prospect; because replacement gilts that used in this study were differences in weight. In order to eliminate confounding factor that effect on the result, therefore should select gilts be similar in weight and body condition score. Besides should check herd health status including detection of eggs parasite in feces and screening of antibodies against PRRS and PPV before the study begin.

REFERENCES

Akdag F, Arslan S and Demir H 2009. The effect of Parity and Litter Size on Birth Weight and the Effect of Birth Weight Variations on Weaning Weight and Pre-Weaning Survival in Piglet. J Anim Vet Adv. 8(11): 2133-2138.

Am-in N 2005. Sow reproductive performance before and after implementation of AI service in small holder farms. Chulalongkorn University.

Am-in N, Tantasuparuk W and Techakumphu M 2010. Comparison of artificial insemination with natural mating on smallholder farms in Thailand, and the effects of boar stimulation and distance of semen delivery on sow reproductive performance. Trop Anim Health Prod. 42(5): 921-924.

Bidanel JP, Gruand J and Legault C 1996. Genetic variability of age and weight at puberty, ovulation rate and embryo survival in gilts and relations with production traits. Genetics, Selection, Evolution : GSE. 28(1): 103-115.

Brandt H and Grandjot G 1998. Genetic and environmental effects of male fertility of AI-boars. The 6th World Congress of Genetics Applied to Livestock Production Publications, Armidale, Australia: 527-530.

Einarsson S, Brandt Y, Lundeheim N and Madej A 2008. Stress and its influence on reproduction in pigs: a review. Acta Vet Scand. 50: 48.

Iida R and Koketsu Y 2013. Delayed age of gilts at first mating associated with photoperiod and number of hot days in humid subtropical areas. Anim Reprod Sci. 139(1-4): 115-120.

Kaneko M and Koketsu Y 2012. Gilt development and mating in commercial swine herds with varying reproductive performance. Theriogenology. 77(5): 840-846.

Kerr JC and Cameron ND 1995. Reproductive performance of pigs selected for components of efficient lean growth. Anim Sci. 60(02): 281-290.

Kilbride AL, Mendl M, Statham P, Held S, Harris M, Cooper S and Green LE 2012. A cohort study of preweaning piglet mortality and farrowing accommodation on 112 commercial pig farms in England. Prev Vet Med. 104(3-4): 281-291.

Lammers PJ, Stender DR and Honeyman MS 2007. Crossbreeding and Hybrid Vigor. IPIC NPP. 410: 1-4.

Le Cozler Y, Dagorn J, Lindberg JE, Aumaître A and Dourmad JY 1998. Effect of age at first farrowing and herd management on long-term productivity of sows. Livest Prod Sci. 53(2): 135-142.

Lukač D 2013. Reproductive traits in relation to crossbreeding in pigs. Afr J Agric Res. 8(19): 2166-2171.

McLaren DG and Bovey M 1992. Genetic influences on reproductive performance. Vet Clin North Am Food Anim Pract. 8(3): 435-459.

Mengeling WL, Lager KM and Vorwald AC 2000. The effect of porcine parvovirus and porcine reproductive and respiratory syndrome virus on porcine reproductive performance. Anim Reprod Sci. 60-61: 199-210.

Mkupasi EM, Ngowi HA, Sikasunge CS, Leifsson PS and Johansen MV 2013. Efficacy of ivermectin and oxfendazole against Taenia solium cysticercosis and other parasitoses in naturally infected pigs. Acta Trop. 128(1): 48-53.

Nantavisai P, Jairak W, Chongcheau W, Muangyai M and Techakumphu M 2008. Prevalence of Swine Intestinal Parasites in Small Farm in Nan Chulalongkorn University.

Paul PS and Mengeling WL 1986. Vaccination of swine with an inactivated porcine parvovirus vaccine in the presence of passive immunity. J Am Vet Med Assoc. 188(4): 410-413.

Peltoniemi OA, Tast A and Love RJ 2000. Factors effecting reproduction in the pig: seasonal effects and restricted feeding of the pregnant gilt and sow. Anim Reprod Sci. 60-61: 173-184.

Pittman JS, Shepherd G, Thacker BJ and Gil HM 2010. Modified technique for collecting and processing fecal material for diagnosing intestinal parasites in swine. J Swine Health Prod. 18(5): 249-252.

Roepstorff A and Nansen P 1994. Epidemiology and control of helminth infections in pigs under intensive and non-intensive production systems. Vet Parasitol. 54(1-3): 69-85.

Roongsitthichai A, Cheuchuchart P, Chatwijitkul S, Chantarothai O and Tummaruk P 2013. Influence of age at first estrus, body weight, and average daily gain of replacement gilts on their subsequent reproductive performance as sows. Livest Sci. 151(2–3): 238-245.

Roongsitthichai A and Tummaruk P 2014. Importance of Backfat Thickness to Reproductive Performance in Female Pigs. Thai J Vet Med. 44(2): 171-178.

Rothschild MF 1996. Genetics and reproduction in the pig. Anim Reprod Sci. 42(1–4): 143-151.

Rydhmer L 2000. Genetics of sow reproduction, including puberty, oestrus, pregnancy, farrowing and lactation. Livest Prod Sci. 66: 1-12.

Rydhmer L, Eliasson-Selling L, Johansson K, Stern S and Andersson K 1994. A genetic study of estrus symptoms at puberty and their relationship to growth and leanness in gilts. J Anim Sci. 72(8): 1964-1970.

Songmeunggan P. 2012. Prevent and Control of PRRS in Swine. Pages 40-41. The economic new in Nan. http://www.nan.go.th/cgdnan/doc_eco/32.doc.

Suriyasomboon A, Lundeheim N, Kunavongkrit A and Einarsson S 2006. Effect of temperature and humidity on reproductive performance of crossbred sows in Thailand. Theriogenology. 65(3): 606-628.

Tang S, Chen L, Guo Z, Hu X, He J, Wang G, Zhao T and Xiao X 2012. Pharmacokinetics of a new ivermectin/praziquantel oil suspension after intramuscular administration in pigs. Vet Parasitol. 185(2-4): 229-235.

Techakumphu M, Tantasuparuk W and Polyotha C 2007a. Project of organic pigs farming in rural villages Chulalongkorn University. http://www.csr.chula.ac.th/sufficiency_economy/.

Techakumphu M, Tantasuparuk W, Suwimonteerabutr J, Am-in N, Manopak S and Tanu N 2007b. Establishment of artificial insemination center and related researches. Cooperation Between Chulalongkorn University and Rajamangala University of Technology Lanna Nan. Thailand.

Tummaruk P 2012. Effects of season, outdoor climate and photo period on age at first observed estrus in Landrace x Yorkshire crossbred gilts in Thailand. Livest Sci. 144(1–2): 163-172.

Tummaruk P, Cheuchuchart P, Chatvijitkul S and Chantarothai O 2009. Influence of age at puberty of gilts on their reproductive performances as sows. Chulalongkorn University.

Tummaruk P, Lundeheim N, Einarsson S and Dalin AM 2001. Effect of birth litter size, birth parity number, growth rate, backfat thickness and age at first mating of gilts on their reproductive performance as sows. Anim Reprod Sci. 66(3-4): 225-237.

Tummaruk P, Suwimonteerabutr J, Tantasuparuk W, Techakumphu M and Kunavongkrit A 2003. The use of fecal progesterone profile to determine ovarian function in gilts. The 11th International Symposium of the World Association of Veterinary Laboratory Diagnosticians and OIE Seminar on Biotechnology, Thailand:131.

Tummaruk P, Tantasuparuk W, Techakumphu M and Kunavongkrit A 2007. Age, body weight and backfat thickness at first observed oestrus in crossbred Landrace x Yorkshire gilts, seasonal variations and their influence on subsequence reproductive performance. Anim Reprod Sci. 99(1-2): 167-181.

Visalvethaya W, Tantasuparuk W and Techakumphu M 2011. The development of a model for artificial insemination by backyard pig farmers in Thailand. Trop Anim Health Prod. 43(4): 787-793.

Vongporom S, Sae-Chua M and Sadkratokg P 2013. Study on deep bed pig farming and the farmers' satisfaction toward knowledge transfer from Surin provincial livestock office. Page 25 P. http://www.dld.go.th/pvlo_sur/2556/.

Weng YB, Hu YJ, Li Y, Li BS, Lin RQ, Xie DH, Gasser RB and Zhu XQ 2005. Survey of intestinal parasites in pigs from intensive farms in Guangdong Province, People's Republic of China. Vet Parasitol. 127(3-4): 333-336.

APPENDIX

APPENDIX A

Table 6 The result of parasite detection in feces before and after deworming (n=3 per group)

No.	Group	Parasite eggs detection							Score*
		Before deworming			Score*	2 weeks after deworming	Score*	3 months after deworming	
		Trichuris suis	*Ascaris suum*	Strongyle					
1	1	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0
3	1	0	0	50	3	0//0//14	2	0//0//21	2
4	2	16	0	10	2	7//0//3	1	16//0//4	2
5	2	0	0	94	3	0//0//33	2	0//0//78	3
6	2	0	0	0	0	0	0	0	0
7	3	0	23	64	3	0//5//10	2	0//17//52	3
8	3	0	0	35	2	0//0//10	1	0//0//29	2
9	3	0	0	0	0	0	0	0	0

* score 0 eggs per cover slip = 0

1 to 10 eggs per cover slip = 1

11 to 49 eggs per cover slip = 2

≥ 50 eggs per cover slip = 3 (Pittman et al. (2010))

APPENDIX B

Table 7 Individual age at first observed estrus of 90 replacement gilts

Age at first observed estrus			
No	Group		
	1	2	3
1	221	216	231
2	211	251	210
3	216	236	221
4	231	231	251
5	246	216	216
6	211	221	211
7	216	231	256
8	241	216	231
9	251	236	241
10	231	216	216
11	216	225	208
12	221	216	271
13	231	215	241
14	216	221	216
15	236	251	221
16	216	216	226
17	216	210	241
18	221	225	211
19	241	211	251
20	221	216	219
21	251	231	236
22	216	221	241
23	236	241	266
24	248	218	251
25	240	246	241
26	261	221	216
27	216	216	231
28	251	236	221
29	271	221	226
30	246	266	238

APPENDIX C

Table 8 Individual age at first service of 90 replacement gilts

No	Age at first service		
	Group		
	1	2	3
1	250	241	256
2	232	276	235
3	237	261	246
4	252	256	276
5	267	241	241
6	232	246	236
7	237	256	281
8	262	241	256
9	272	261	266
10	252	241	241
11	237	250	233
12	242	241	296
13	252	240	266
14	237	246	241
15	257	276	246
16	237	241	251
17	237	235	266
18	242	250	236
19	262	236	276
20	242	245	244
21	272	256	261
22	237	246	266
23	257	266	291
24	269	243	276
25	261	271	266
26	282	246	250
27	237	241	256
28	272	261	246
29	292	246	251
30	267	291	263

APPENDIX D

Table 9 Individual age at first farrowing of 90 replacement gilts

No	Age at first farrowing		
	Group		
	1	2	3
1	356	355	370
2	346	390	349
3	351	375	360
4	366	370	390
5	381	355	355
6	346	360	350
7	351	370	395
8	376	355	370
9	386	375	380
10	366	355	355
11	351	364	347
12	356	355	410
13	366	360	380
14	355	360	355
15	371	390	362
16	360	355	365
17	351	349	380
18	356	370	350
19	376	350	390
20	356	355	358
21	386	370	375
22	351	360	380
23	371	380	405
24	383	357	390
25	380	385	380
26	396	360	358
27	351	355	370
28	386	375	360
29	406	360	365
30	381	405	377

APPENDIX E

Table 10 Individual BF at first observed estrus of 90 replacement gilts

No	BF at first observed estrus, Group (L/R side) 1		2		3	
1	8	10	13	13	15	16
2	10	10	8	9	12	11
3	15	14	14	14	13	13
4	13	13	7	8	12	12
5	15	14	14	15	11	11
6	10	11	11	12	15	14
7	12	13	20	21	10	12
8	17	15	15	15	14	13
9	16	16	13	14	16	15
10	13	13	10	12	12	13
11	12	12	12	12	15	14
12	11	11	14	13	13	14
13	15	14	13	15	14	14
14	10	12	15	14	12	13
15	14	13	14	14	12	13
16	16	15	12	13	13	14
17	12	13	12	13	14	13
18	15	14	13	14	11	13
19	13	14	14	13	16	15
20	14	15	11	13	15	15
21	15	15	16	15	12	11
22	15	14	15	15	12	13
23	13	14	15	14	14	14
24	12	11	12	13	13	13
25	12	13	13	13	14	15
26	14	14	16	15	11	12
27	13	13	17	15	15	15
28	16	15	14	14	13	13
29	11	13	10	12	12	12
30	14	14	13	13	14	13

APPENDIX F

Table 11 Individual BF at first service of 90 replacement gilts

BF at first service						
No	Group (L/R side)					
	1		2		1	
1	13	15	18	18	20	21
2	15	15	13	14	17	16
3	20	19	19	19	18	18
4	18	18	12	13	17	17
5	20	19	19	20	16	16
6	15	16	16	17	20	19
7	17	18	25	26	15	17
8	22	20	20	20	19	18
9	21	21	18	19	21	20
10	18	18	15	17	17	18
11	17	17	17	17	20	19
12	16	16	19	18	18	19
13	20	19	18	20	19	19
14	15	17	20	20	17	17
15	19	18	19	19	17	18
16	20	20	17	18	18	19
17	17	18	17	18	19	18
18	20	19	18	19	16	18
19	18	19	19	18	21	20
20	19	20	16	18	20	20
21	20	20	21	20	17	16
22	20	20	20	20	17	18
23	18	19	20	19	19	19
24	17	16	18	18	18	18
25	17	18	18	18	19	20
26	19	19	21	20	17	17
27	18	18	22	20	20	20
28	21	20	19	19	18	18
29	16	18	15	17	17	17
30	19	19	18	18	19	18

APPENDIX G

Table 12 Individual BW at service of 90 replacement gilts

No	BW at service		
	Group		
	1	2	3
1	140	125	120
2	130	120	120
3	130	120	125
4	120	120	120
5	140	125	125
6	120	120	130
7	100	110	110
8	100	120	115
9	145	130	120
10	145	120	120
11	120	125	120
12	120	120	125
13	120	120	130
14	120	125	120
15	110	120	120
16	100	125	120
17	100	125	120
18	120	125	125
19	120	120	110
20	120	110	130
21	120	125	135
22	120	125	120
23	120	125	125
24	125	130	120
25	110	120	130
26	120	120	110
27	140	120	100
28	130	120	120
29	120	125	100
30	125	125	100

VITA

SARAWANEE KHUNMANEE, D.V.M.

Date of birth: October 13th, 1983

Place of birth: Uttaradit

Education:

2003-2008 Faculty of Veterinary Science, Chulalongkorn University

1996-2001 Uttaradirdarunee School, Thailand

1988-1995 Anuban Uttaradit School, Thailand

Work experience:

2008-now Veterinary and research assistant at The School of Agricultural Resources, Chulalongkorn University

Publication

1. Anakkul N, Suwimonteerabutr J, Khunmanee S, Thanomsuksinchai N, Panyaboriban S, Tharasanit T and Techakumphu M 2012. Laparoscopic Artificial Insemination with frozen semen and Embryo Transfer with Early Embryonic Stage in Goat. RGJ Seminar Series LXXXVII: "From Life Science to One Health" 17 May 2012, Faculty of Vet. Science, Chulalongkorn University, Bangkok, Thailand.

2. Anakkul N, Suwimonteerabutr J, Panyaboriban S, Khunmanee S, Thanomsuksinchai N, Tharasanit T and Techakumphu 2012. Production of Black Skin Goat Using Embryo Transfer Technique. THE 1ST ASIA DAIRY GOAT CONFERENCE, 9 – 12 APRIL 2012, University Putra Malaysia, Kuala Lumpur, Malaysia.

3. Anakkul N, Suwimonteerabutr J, Khunmanee S, Diloksumpan P, Tharasanit T and Techakumphu M 2011. Unilateral and bilateral laparoscopic insemination of frozen goat semen, Peoceeding of the 10th Chulalongkorn University Veterinary Annual Conference, 21-22 April 2011, Faculty of Vet. Science, Chulalongkorn University, Bangkok, Thailand.

4. Anakkul N, Suwimonteerabutr J, Khunmanee S, Diloksumpan P, Virakul P, Tharasanit T and Techakumphu M. 2011. Artificial Insemination in Goat in Thailand from Bench to Industry. RGJ Seminar Series LXXX: "Innovations for Animal Health and

Production II", 20 April 2011, Faculty of Vet. Science, Chulalongkorn University, Bangkok, Thailand.

5. Anakkul N, Suwimonteerabutr J, Khunmanee S, Diloksumpan P, Virakul P, Tharasanit T and Techakumphu M 2011. Artificial Insemination in Goat in Thailand from Bench to Industry. RGJ-Ph.D. Congress XII, 1-3 April 2011, Jomtien Palm Beach Resort, Pattaya, Chonburi.

6. Anakkul N, Suwimonteerabutr J, Khunmanee S, Diloksumpan P, Promthep K and Techakumphu M 2010. Semen Quality from Consecutive Collection of Goat in Thailand, 13th Association of Institutions for Tropical Veterinary Medicine (AITVM) Conference, 23-25 August, 2010, Bangkok, Thailand.

7. Anakkul N, Khunmanee S, Diloksumpan P, Promthep K, Suwimonteerabutr J, Techakumphu M 2010. Cryopreservation of Goat Semen in Extenders Supplemented with Different Concentrations of Equex STM Paste, Peoceeding of the 9th Chulalongkorn University Veterinary Annual Conference, 1st April 2010, Faculty of Vet. Science, Chulalongkorn University , Bangkok, Thailand.

8. Khunmanee S, Am-in N, Techakumphu M 2014. Increase efficiency of artificial insemination in pigs with Post- Cervical Artificial Insemination : decrease period of insemination time and boar semen volume, The 2nd Symposium of the Thai Society for Animal Reproduction, 20-21 March, 2014, Bangkok, Thailand.

9. Khunmanee S, Am-in N, Techakumphu M 2015. Effectiveness Development of Replacement Gilt System for Backyard Pig Farms, The 14th Chulalongkorn University Veterinary Conference, 20-22 April, 2015, Bangkok, Thailand.

REFERENCES

APPENDIX

VITA

SARAWANEE KHUNMANEE, D.V.M.

Date of birth: October 13th, 1983

Place of birth: Uttaradit

Education:

2003-2008 Faculty of Veterinary Science, Chulalongkorn University

1996-2001 Uttaradirdarunee School, Thailand

1988-1995 Anuban Uttaradit School, Thailand

Work experience:

2008-now Veterinary and research assistant at The School of Agricultural

Resources, Chulalongkorn University

Publication

1. Nitira Anakkul, Junpen Suwimonteerabutr, Sarawanee Khunmanee, Nutthakarn Thanomsuksinchai, Saritvich Panyaboriban, Theerawat Tharasanit, and Mongkol Techakumphu. 2012. Laparoscopic Artificial Insemination with frozen semen and Embryo Transfer with Early Embryonic Stage in Goat. RGJ Seminar Series LXXXVII: "From Life Science to One Health". 17 May 2012, Faculty of Vet. Science, Chulalongkorn University, Bangkok, Thailand

2. N. Anakkul, J. Suwimonteerabutr, S. Panyaboriban, S. Khunmanee, N. Thanomsuksinchai , T. Tharasanit & M. Techakumphu. 2012. Production of Black Skin Goat Using Embryo Transfer Technique. THE 1ST ASIA DAIRY GOAT CONFERENCE, 9 – 12 APRIL 2012, University Putra Malaysia, Kuala Lumpur, Malaysia

3. N. Anakkul, J. Suwimonteerabutr, S. Khunmanee, P. Diloksumpan, T. Tharasanit, M. Techakumphu. 2011. Unilateral and bilateral laparoscopic