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The Population of Native Pig Projection: A Case Study of Moo Lat Native Pig in Nongphue and Nongseng Villages, KaysonPhomvihane City, Savannakhet Province, Laos

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Abstract

The model for Moo Lat native pig production under the natural raising system (free-range) was developed to evaluate the productivity of Moo Lat native pig in Laos. Modeling was done with the use of software, structural thinking, and a real system (Survey Data) with Animation (STELLA) Research Version 9.0.2 for the window. The model used started breeding at 9 gilts/sows, and in the real system was conducted interviewed 27 respondents from two villages, such as Nongphue and Nongseng. The predicted population of Native pig from the model in the period of two years, from 9 sows as initial, and then in two years, is 55.07 sows were farrowed at the final, and the total number of pigs at weaning is 385.40 piglets, a total of finishing pig 177.39, and total sold 141.91 heads and replacement 35.48 heads. The results from the respondents have interviewed the first mating of gilts is at the age of 8.31±0.97 months old, and the

first mating of boars is at the age of 7.65±0.95 months old. As regards the timeline of the sow's pregnancy period observed that the Moo Lat native pig was at 115.44±2.97 days. The respondents observed that their sows' first farrowing was at the age of 12.02±0.89 months old. On litter size of Moo Lat sows provided 7.85±1.30 piglets. The average birth weight of the native pigs in the study sites is 0.78±0.07 kg. The average body weight of the piglets after weaning is 7.96±0.62 kg, and the average percent mortality of piglets is 9.81 ±1.93. This model is not sensitive to the mortality rates of piglets when compared with ±15% of pigs' mortality rate, but it is important for pig production. After the sensitivity test was conducted, a management intervention, P-value > 0.05, and the model used was also validated when compared between the assumption and the real system of the number of piglets.

Keywords: Moo Lat Native Pig, Model Used, Real System, Valid, Sensitive

1. Introduction

Livestock raising is important socio-economically and culturally. It is a source of livelihood, and it provides food and nutrition. Next to chicken, pork is the second most consumed meat, with an estimated 12 kg per capita per year, while total meat consumption per capita per year is 55 kg (Department of Livestock and Fisheries (DLF), 2015) [3].

In June 2019, Swine Fever (ASF) was first reported in Laos, saw 170 ASF outbreaks reported in 18 provinces, and more than 40,000 pigs were culled or died because of the disease. After the ASF outbreak and then continued to the Covid-19 pandemic, the prices of meat in the market are increasing because of the ASF outbreak and the Covid-19 pandemic <https://www.rfa.org/english/news/laos/laos-pork-shortage.html>. Additionally, evaluate the reproductive cycle system of the Moo Lat native pig. Native pig production has many categories of problems identified, including slow growth and low productivity, disease outbreaks, high mortality of piglets, production marketing instability, and insufficient funds to expand pig production (Keonouchanh and Dengkhounxay, 2017) [4]. Pig production is the most significant part of smallholder livestock management in the Lao PDR. Farmers raise pigs using three main rearing systems, namely: free scavenging, confinement in a small area with a simple shelter provided, and penning. The traditional pig management practice is based on free-range grazing of harvested or fallow lands. Women traditionally manage pigs. They spend time and labor each day collecting and preparing feed for their pigs. Pigs are directly provided mixed feeds (rice bran, broken rice, crushed maize and soya, dried and crushed

cassava, dried acacia leaves, and others), kitchen waste or left-over food (Phengsavanh *et al.*, 2011) [9].

Native pig meat is most popular to consume when compared with commercial pork. However, the price of native meat is high, but there is not enough for consumers. The researcher to analyze the reproductive cycle system of Mo Lat native pig from respondents in Nongphue and Nongseng villages, to predict the population of Moo Lat native pig and also to predict the number of piglets between the model used and real-system in two years, and to evaluate the percent-change of mortality in the prediction value, with $\pm 15\%$ change in the value driving variable of mortality rate.

2. Methodology

This study was conducted data interviewing respondents for actual data, especially in the reproductive cycle system of Moo Lat native pig from two villages, such as Nongphue village and Nongseng village, KaysonePhomvihane City, Savannakhet Province, Laos. For modeling was done with the use of software structural thinking.

A. Construction of the Predicted Native Pig Population

This model for Moo Lat native pig production under a natural raising system (free-range) was developed to evaluate the productivity of Moo Lat native pigs in Laos. The modeling was done with the use of software, structural thinking, and a real system (Survey Data) with Animation (STELLA) Research Version 9.0.2 for the window.

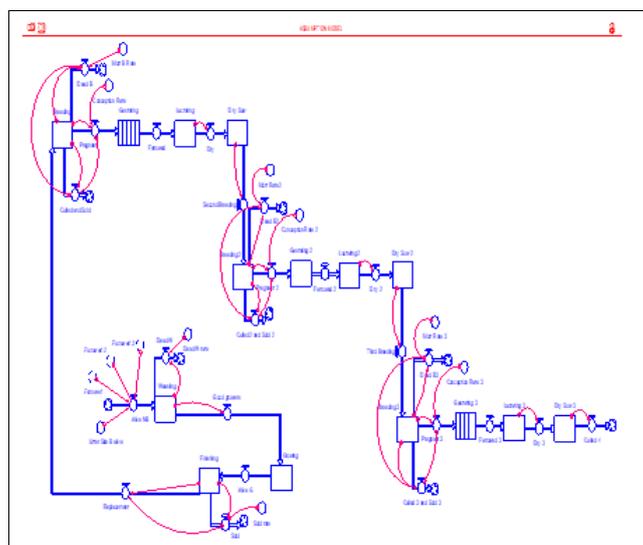
1. Structure of the Model

First, a deterministic model was initially developed to identify the different sectors that would influence productivity in Moo Lat native pigs. They are three-factors in this model such as predicting the population of Moo Lat native pig herd showing the population of Moo Lat native pig as sow/gilt, farrowed, weaning, growing, and finishing in the two years of period and predicted number of piglets if the Litter size change variable as model validation and also mortality rate of pigs is the most important as called sensitivity in the model used. Additionally, evaluate the reproductive cycle system of the Moo Lat native pig. Native

pig production has many categories of problems identified including slow growth and low productivity, disease outbreaks, and high mortality of piglets, production marketing instability, and insufficient funds to expand pig production (Keonouchanh and Dengkhounxay, 2017) [4]. Education in proper pig management and improved rearing conditions including appropriate feeding, provision of water, housing as well as raising awareness of disease prevention and vaccination, could improve this situation drastically (Phengsavanh *et al.*, 2011) [9]. The common health problems of pigs in Laos are Classical Swine Fever (CSF), Foot and Mouth Disease (FMD), and Porcine Reproductive and Respiratory Syndrome (PRRS) (Khounsy, 2011) [6].

2. A Sow of Native pig as a system

The different sectors of these components and their relationship are shown in Fig 1. A sow is set in a breeding state variable under the same management, so a sow usually starts when bought gilt or reared as a gilt replacement from their selected offspring. The gilt was observed as a standard of sow, such as breed, weight, age, and ready heat to mate of first gilts and breeding techniques as mating them at second heat. Gilts and sows were mated and controlled in order to confirm the pregnancy. They are moved to gestation variable for 114 days (3 months, 3 weeks, 3 days). If conception of the sow has failed, they will remain for re-mating in the next Oestrus, but it is not more than one time of re-mated. Otherwise, it is culled or sold, and pregnant animals are moved to the farrowing state variable. After farrowing, sows remain until lactating and then the dry period to receive a new batch of sows in the breeding state variable for restarting a new productive cycle. This study is a re-mating of the sow after only two reproductive cycles (the total reproductive cycle of the sow is three cycles). Litters size born alive of piglet were ghost from farrowed of each reproductive cycle to alive new born as source of weaning variable for a month and then good grower removed to growing state for 5 months, after that alive from growing moved to finishing variable for a months, finally fishing of native pig were sold and also selected good performance of gilt for replacement of sow.



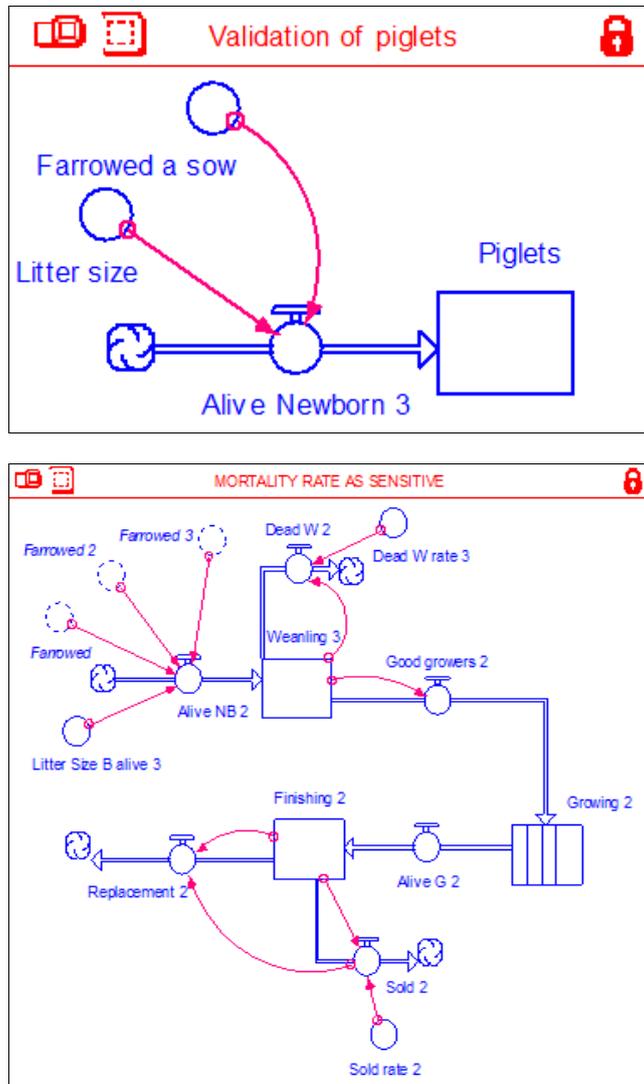


Fig 1: Components of the model assumption and their three factors

B. The modeling of Pig production

1. Related to the Modeling process

The modeling process can be described in different stages, as shown in Fig 2. First of all, selecting a proper sow to breed her, as a real system, is the entity to be presented. A natural description of what is observed can lead to formulating an empirical herd model, more or less complex, depending on the number of variables considered. Observations can come from experiments performed under a co-controlled situation or from statistics obtained from a record-keeping data bank or literature. The empiric herd

model can be used to establish or study empiric relationships among variables, which can be used after a successful validation in prediction-making about system evolution. Prediction can be addressed to solve practical problems, for on-farm decision support, to just to gain knowledge in hypothetical situations or system behavior, for research or educational purposes. An effort to generalize the model to situations other than observed implies a more conceptual work on the empirical herd model. As a result, a more detailed mathematical herd model can be formulated.

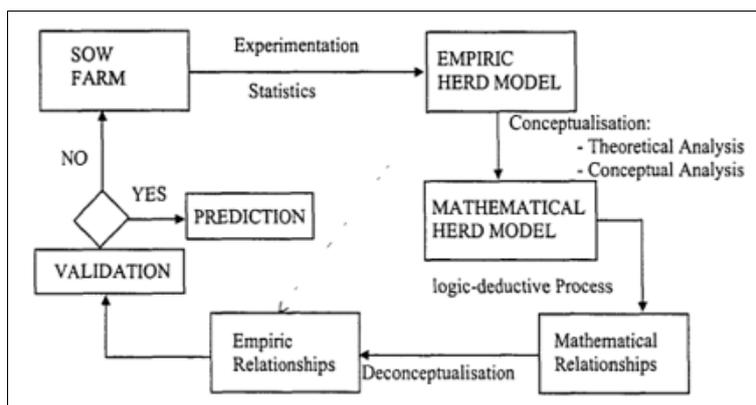


Fig 2: The modeling process (adapted from Rios, 1995)

2. Qualitative specification of the deterministic model

This assumption of the model, based on the reproductive cycle performance of the Moo Lat native pig of the Lao native pig, was specific in the components of the different sectors of the deterministic model (Table 1). The predicted model used in the period of two years, from 9 sows initially to 55.07 sows farrowed at the final, and the total of pigs at weaning is 385.40 piglets, a total of finishing pigs 177.39, and a total sold 141.91 heads and replacement 35.48 heads. Farmers raise pigs using three main rearing systems, namely: free scavenging, confinement in a small area with a simple shelter provided, and penning. The traditional pig management practice is based on free-range grazing of harvested or fallow lands. Women traditionally manage pigs. They spend time and labor each day collecting and preparing feed for their pigs. Pigs are directly provided mixed feeds (rice bran, broken rice, crushed maize and soya, dried and crushed cassava, dried acacia leaves, and others), kitchen waste or left-over food (Phengsavanh *et al.*, 2011) [9].

The majority of native pig-raising systems are free-range, and most of them do not practice proper pig management. Breeding is natural mating because many raising farmers have no boar in their house, so they send their sows/gilts to mate in their village. According to Lormaisim *et al.* (2019) [7], found that farmer (27%) has their own boar, while most of them (73%) do not have a boar, so most of them hire and choose boars for their sows, as most of them do not own a boar.

Table 1: Assumption of reproductive cycle performance of Moo Lat native pig (Predicted in two years of Population) by using the qualified model in two years

Parameters	Reproductive cycle system of model used
Gilt/Sow initial (head)	9
Total Replacement (head)	35.48
Conception rate (%)	95
Gestation period (Months)	4
Total Farrowed (head)	55.07
Litter size (head)	7
Total Weaning (head)	385.40
Growing period (Months)	5
Total Growing (head)	346.7
Total Finishing (head)	177.39
Total Sold Finishing (head)	141.91
Mortality (Breeding phase) %	3%
Mortality (Piglet)%	7%
Total Culled and sold (Breeding phase) (head)	1.15
Culled (Sow Breeders) (head)	7.72

3. Sensitivity Analysis

The sensitivity test of this model is the mortality rates of piglets when compared with ±15% of piglets' mortality rate, and this model is validated when comparing the assumption and the real system of the number of piglets. This study has been done on relationships among parameters. Based on the respondents, this model was sensitive to changes in mortalities and the number of piglets. Native pig data was tested by running the simulation using reproductive data, and native pig farmers were interviewed to think for two years of the reproductive cycle system.

4. Samples of respondents

First, all households raising native pigs in two villages were pooled together (a total of 30 houses of farmers), and then, the number of respondents from the two villages was computed:

$$n = \frac{N}{1 + Ne^2}$$

Using Slovin's formula. According to Tejada and Punzalan (2012), Slovin's formula calculates the sample size (n) in a given population size (N), and a margin of error (e) as follows:

Where;

n = Sample

N = Total number of households with native pigs in the two villages

e = Margin of error set at 0.05 or 95% confidence level as follows:

$$\text{Sample size in the village} = \frac{\text{total number of households in each village with native pigs}}{N} \times n$$

The villages and/or households included in the sample should meet the following criteria: must have at least three gilts/sows of native pigs per household;

Table 2: Total number of households and sample from the randomly selected villages

City	Villages	Total Number of Households	Samples
KaysonPhomvihane	Nongphue	14	13
	Nongseng	16	14
Total		30	27

5. The model uses

After the sensitivity test and then will test a management intervention using the model as control and confinement with vaccinated pigs as the management intervention group (data from seven farmers who have confined their pigs in their farm). It is excluded in the two villages (Nongphue and Nongseng) because those two villages were not confined to their pigs.

6. Data analysis

Computation of assumptions was used STELLA version 9.0.2, and other data were subjected to Excel 2010 for statistical description and T-Test.

3. Results and Discussion

3.1 Analysis of the reproductive cycle system of the Moo Lat native pig

The reproductive cycle system of the Mo Lat native pig in Laos, data for the reproduction performances (First mating of gilt and boar, pregnant period, first farrowed of gilt, litter size, birth weight, weaning weight of piglets, and mortality rates of piglets). Table 3 shows the pig Reproduction performance in the selected villages under study. The results from the respondents who have interviewed the first mating of gilts are at the age of 8.31±0.97 months, and the first

mating of boar is at the age of 7.65±0.95 months. As regards the timeline of the sow’s pregnancy period observed that the Moo Lat native pig was at 115.44±2.97 days. The respondents observed that their sows’ first farrowing was at the age of 12.02±0.89 months. On litter size of Moo Lat native pig sows provided 7.85±1.30 piglets. The average birth weight of the Moo Lat native pigs in the study sites is 0.78±0.07 kg. The average body weight of the piglets after weaning is 7.96±0.62 kg, and the average percent mortality of piglets is 9.81 ±1.93.

Table 3: Reproduction performances of boar and sow under study

Parameters	Reproductive performance		
	Nong phue Village n=13	Nong seng Village n= 14	Overall n=27
	Mean ± SD	Mean ± SD	Mean ± SD
Gilt’s first mating (months)	8.19 ± 0.95	8.43±0.98	8.31±0.97
Boar start at first service (months)	7.77 ±0.91	7.54± 0.97	7.65±0.95
Pregnancy period (days)	115.92±3.29	115.00 ±2.56	115.44±2.97
First farrowing (months)	11.81±0.82	12.21 ±0.90	12.02±0.89
Piglets/litter size (head)	7.92 ±1.07	7.79 ±1.47	7.85±1.30
Birth weight (kg)	0.77 ±0.08	0.78 ±0.06	0.78±0.07
Weaning weight of pigs (kg)	8.02 ±0.54	7.91 ±0.68	7.96±0.62
Mortality of piglets (%)	9.15 ±1.17	10.43±2.26	9.81 ±1.93

Similarly, with the report of Keonouchanh *et al.* (2011) [5] that the age of the first estrus is between 189-586 days with 39 kg of body weight. The weight of mature sows is about 47-61 kg, and the youngest age of first farrowing is around 1 year. Usually weaning period is 60 to 90 days, with an average of 9.5 kg of the piglet's weaning weight. Mature males of this type also have a lower body weight (25 kg) than females, and the maximum body weight of boars can reach 30 to 50 kg.

3.2 Predicted value of Litter size between the model used and the real system

A sow or gilt mating of model thinking in a free-range raising system with local feeding and confinement with vaccinated with a real-system production system, was used with a basic time to predict the value of piglets of a sow in two two-year periods. The result of the T-test to predict the number of piglets in two years of a sow between models used data and real system data is shown in Table 4. In this study, there are 27 replications in both model data and real system data. Model data came from the deterministic model, as the litter size of the pig is 7 pigs in a sow, and then the deterministic model changed to the Stochastic model to get each of the replications of the model used data, then using a T-test to analyze descriptive statistics between the model used data and the real system data. Finally, the data is validated between the model-used data and the real system data. Data change from a deterministic to a stochastic model. The hypothesis of this study is as Ho: The predicted value from the model and data from the real systems are the same. Ha: The predicted value from the model and the data

from the real system are NOT the same, and Decision Rate: If the P-value is less than 0.05, reject Ho and accept Ha. Otherwise, accept Ho.

Table 4: Test whether the predicted values from the model are the same as the actual data from the real system in a period of two years

Description Statistic	Model used	Real -system
Mean of piglets/sow/2years	22.85	25.91
SD	4.19	4.19
Observations	27	27
P-Value	0.220	

So, the result found that the P-value>0.05, which is accepted as Ho, a confirmed hypothesis. It means that the predicted value from the model and the date from the real system are the same, and this model is Valid. In terms of the rule in selecting of sow or gilt for the breeder, one of the most important of selected criteria is litter size of a sow, because it can result in an increased number of piglets, as known as an increased population of a pig’s herd if high litter size of a sow. However, it depends on the raiser of pig production which proper practices in management especially manage at birth to weaning not more than one month would be good, and then the sow can become dry sow, and Oestrus then receives a new batch of sows in gestation and also proper pig management to improve rearing conditions including appropriate feeding, provision of water, housing as well as raising awareness of disease prevention, and vaccinated could improve this situation drastically. Keonouchanh *et al.* (2011) [5] found that the sow of a pig depends on management systems, sows have 1.5 to 1.8 litters per year and 7 to 8 piglets per litter. However, Raisers of pig need to consider good sow such as those that give birth between 13 and14 piglets per litter or the average 10 piglets per litter in one year; those that can provide 2.4 litters and the period of pig pregnant used time is about 114 days (3 months, 3 weeks and 3 days) per litter, weaned piglets at 2 to 4 weeks and weight for delivery to slaughter about 100 kg in 6 months. Boars have to be taken care of and kept in individual pens. The majority of pigs for delivery to the slaughterhouse are about 90 to 110 kg of live weight at an age between 20 and 24 weeks (Compassion in World Farming, 2013) [1].

3.3 Mortality rate from weaning to finishing of the Moo Lat native pig

The predicted fishing population of Moo Lat native pig at two years of two years is compared between the mortality of the baseline model and the decrease/increase of these mortality ±15% in Table 5. The result from the baseline mortality rate is 7% and the predicted number of pigs is 177 heads/two years. If farmers' proper management especially confines their pigs, provides vaccination, and often clears the pig pen, the mortality rate will decrease by about (-15%) of the baseline mortality rate, and predicted that the number of pigs will increase by 179 heads/two years (%change from baseline = 1.08%). In contrast, if the farmer is not practicing management, the mortality rate will increase by about 15% of the baseline mortality rate, and the predicted number of pigs will decrease to 175 heads/two years (%change from baseline = -1.35%).

So, this model is "not sensitive" to that variable, but the death rate of weaning to finishing of Moo Lat native pig is

still an important component of this model because mortality affects to pig population. Farmers should be very careful in the assumed value for that variable. It should be based on a reliable source.

Data from the National Animal Health Monitoring System (NAHMS), 2001 [2]. Indicate that the average number of pigs born per sow is 10.9, of which 10.0 are born alive, and only 8.9 can survive until weaning. This results in an 11% pre-weaning mortality rate. In comparison, NAHMS data from 1990 and 1995, respectively, indicate that the number of pigs born alive was 9.9 and 9.5, with 8.4 and 8.6 piglets weaned per litter. So, although we saw a decrease in pre-weaning mortality between 1990 and 1995, we show a slight increase from 9% to 11% between 1995 and 2000. Because average litter size has slowly increased, we have been able to realize a slow increase in the number weaned from 1990, 1995, and 2000; resulting in 8.4, 8.6, and currently, 8.9 pigs weaned per litter.

Table 5: Mortality rate from weaning to finishing of Moo Lat native pig in the period of two years

Mortality rate	Value	Predicted Fishing Pop at 2 years	% change from baseline	Sensitivity Level
Baseline	0.070	177		
+15%	0.081	175	-1.35%	15% up - sensitive
-15%	0.060	179	1.08%	<15% - not that sensitive

3.4 Model use

After the sensitivity test and then test a management intervention using the model as the control group and confinement with vaccinated pigs as the management intervention group (data from seven farmers who have confined their pigs in their farm). It is excluded in the two villages (Nongphue and Nongseng) because those two villages were not confined to their pigs. The population of pigs from model thinking in a free-range raising system with local feeding and confinement with vaccinated group as a real-system production system was used with a basic time to predict the population of pigs based on the mortality rate in two two-year periods. The T-test to predict the number of pigs in two years between the control group and management intervention group data is shown in Table 6. There are seven replications in both the model data (control group) and the management intervention group. Model data (control group) from the Stochastic model, as the mortality rate of the pig is 7% and data of the management intervention group is 5%. This data from seven respondents who have confinement with vaccinated their pigs and then run both groups multiple times for the replications, after that using the T-test to analyze descriptive statistics between the control group and management intervention group. The hypothesis of this study is as Ho: The predicted value from the control group and data from the management intervention group. Ha: The predicted value from the model and the data from the management intervention group are NOT the same, and Decision Rate: If the P-value is less than 0.05, reject Ho and accept Ha. Otherwise, accept Ho.

Table 6: Test whether the predicted values from the model use the mortality rate in a period of two years

Description Statistic	Control group	Confinement with vaccinated group
Mean	142.97	125.52
SD	19.97	12.49
Observations	7.00	7.00
P-Value	0.11	

The result shows a P-value > 0.05, which is accepted as Ho as a confirmed hypothesis. The predicted value between the control group and the management intervention group is the same, which means this model is useful. The mortality of pigs is important to the pig population because it can affect the increase/decrease in the population of pigs. If a low mortality rate, as is known as the increased population of pigs' herds. However, the mortality rate of pigs depends on the raiser of pigs. With proper practices in management, especially confinement of their pigs to improve growth performance and reduce waste from manure, including appropriate feeding, provision of water, housing, as well as raising awareness of disease prevention and vaccination, could improve this situation. To decrease these losses, raisers of pigs should use good sow management and provide effective early piglet care. Pre-weaning mortality is a significant cause of economic loss in the swine sector. While we often see an increase in Pre-weaning mortality with larger litter sizes, it can be reduced or prevented these losses with proper management. Many factors contribute to pig mortality, which include crushing, low viability, and starvation, and others. Control of piglets begins with good herd management prior to, during, and after farrowing (Prairie Swine Health Services, 2020) [8].

4. Conclusions and Recommendations

The model can be used to determine the population of pig production performance from gilt or sow until growing-finishing in the period of the predicted two years. This model determined the mortality rates of piglets when compared with ±15% of piglets' mortality rate, and then the model is not sensitive, but the model is still useful, and this model is also validated when compared between the assumption and the real system of the number of piglets. Reproductive cycle system of the two villages (Nongphue and Nongseng) most of the farmers do not have their boar, so they just provide their sow or gilt mating as a natural around their village and this study also observed first mating of gilt is older than first mating of boar and in Nongphue village found that pregnant period, litter size at birth, weaning weight of piglets slightly more than Nongseng village, but in mortality rates, birth weight and First farrowing of their piglets Nongseng village is high than Nongphue village.

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