ORIGINAL ARTICLE

PRODUCTIVITY AND TECHNICAL EFFICIENCY OF SMALLHOLD HOG FARMING FROM THE 3RD DISTRICT OF PAMPANGA, THE PHILIPPINES

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ABSTRACT

This study aimed to determine and identify the productivity and technical efficiency of smallhold hog farms in the 3rd District of Pampanga, the Philippines. This study also recommended specific production inputs and technical parameter/s that can demonstrate improvement in reproductive efficiency and using a sow productivity index equation. Maximum likelihood estimates (MLE) were used and analyzed through Stochastic Production Frontier Approach. All variables for pig production were estimated to different functional forms and were all transformed to their natural logarithm, squared terms, and interaction terms. The most influential input variables are in sows (0.401) and in piglets born alive (0.52), which can increase their level of productivity as demonstrated by a positive and significant influence at $p< 0.05$ and $p < 0.01$ level of significance in the production output, respectively. It was also revealed that variables in the inefficiency model were efficient indicators with a significant effect on technical efficiency and with the inclusion of 21-day litter weight, can generate a Sow Productivity Index (SPI) based on the stochastic production frontier estimation of the relevant reproduction efficiency parameters. The high level of mean technical efficiency at 92% demonstrated that only 8% is needed for improvement for technical-based reproductive efficiency parameters.

Keywords: *reproductive performance, productivity, technical efficiency, stochastic, maximum likelihood estimation.*

Philipp. J. Vet Med., 59(2): 174-184

INTRODUCTION

The swine industry of the Philippines is the second-largest economic activity in the agricultural sector next to rice production. Contributes to generating jobs and economic prospects seem guaranteed for the coming years for investors and stakeholders who aspire to engage in a career or venture in modern pig production and processing. Demand is growing, concerning increasing population and growing income (and tourism), and pork per capita consumption is presumed to rise in parallel. This growth is credited to the increase from the adoption of new technologies genetic improvement, feed quality, swine health, and equipment (Strak, 2017).

Hog production has been expanding in both smallhold and commercial farms. Smallhold farms represented 65% of the industry and commercial farms comprised 35% of the total hog inventory (Swine Situation Report, January-December 2020 | Philippine Statistics Authority, 2020). In Central Luzon, Pampanga was reported consistently to be the third top in hog production among the provinces in Region III for the past ten (10) years from 2010 to 2019 (Swine Situation

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Report, October-December 2019|Philippine Statistics Authority, 2020, January).

Smallhold (tending less than 10 heads of adult and 20 young heads) hog raising is still predominant in the Philippines and their source of income and economic discretions depend deeply on the swine industry (Mugera and Featherstone, 2008). About 35% of the entire breeding herd was on commercial farms. The total breeding herd improved by 2.6% in 2016 and 5.3% in 2015. The significant regions for hog production are Central Luzon and Calabarzon which together, a tally for practically two-thirds of all commercial pig production (PSA, 2016; Strak, 2017). Swine breeding herd management is the key factor in hog raising to produce an excellent litter size. There are technical parameters to evaluate the reproductive performance of the sow such as litter index or farrowing index, piglets born alive, piglets weaned per litter, piglets weaned per sow per year, pigs produced per sow per year, and non-productive days.

Record keeping also plays a vital role in breeding management. A good, actual, and accurate system of record-keeping enables the hog raisers to determine the healthy and abnormal reproductive performance of the farm. It also provides a consistent basis for decision-making and applying appropriate judgment for sows and farm improvements. Data or information recorded must be interpreted to a logical technical figure and these are analyzed and evaluated to determine any weaknesses or failures in the operation of the farm. The main objective of this study was to determine and identify the productivity and technical efficiency of smallhold hog farms and recommend specific production inputs and technical parameter/s that can demonstrate improvement in reproductive efficiency and a sow productivity index equation in the 3rd District of Pampanga (Arayat, Mexico, Sta.Ana, Bacolor, and City of San Fernando).

MATERIALS AND METHODS

Study area, and data collection

The domain of the survey study was carried out on the 3rd District of Pampanga (Figure 1). Thirty (30) smallhold hog raisers, rearing five (5) to ten (10) gilts/sows were identified and selected by their corresponding Livestock Inspectors and Municipal Agriculturists who sold piglets/finishers knowledgeable on the details of swine raising, material inputs, labor, and expenses incurred and the disposition of produce will be served as samples of the survey. The survey was conducted from December 2019 to March 2020. Data collection was carried out through personal (face-to-face) interviews of the sample farmers in sample barangays using a structured questionnaire and a consent notification was obtained prior to the interview. The design and methodology of the present study were approved by the Central Luzon State University Research Advisory Committee.

Figure 1. Map of the Third District of Pampanga

All type of breeds of sows (Landrace, Large white, Duroc, Peitrain), having farrowed more than twice or at least have two (2) parities were considered in the study. Each type of breed has its own desirable and undesirable characteristics trait.

Data Processing

Editing and coding of survey returns were done upon submission of the accomplished forms. After the data encoding, data cleaning (all data were formatted and transformed to natural logarithm, squared term, and interaction term) was done using the MS Excel program. The output of the data cleaning was the final set of raw data files that will be used for the generation of data tables.

Stochastic Frontier Model

The estimation of the model involves estimating the parameters of the frontier function and estimating inefficiency. There are various methods of estimation depending on the distributional assumptions for the error components. The choice of distributional assumptions on the components of the error term is central to the maximum likelihood estimation approach of the stochastic frontier model. After these distributional assumptions are imposed, the log-likelihood function of the model is derived and numerical maximization procedures are used to obtain the maximum likelihood estimates of the model parameters. Consequently, the maximum likelihood estimate of an unknown parameter is defined to be the value of the parameter that maximizes the probability (or likelihood) of randomly drawing a particular sample of observations.

The method of parameter estimation used in the study was maximum likelihood estimation (MLE) where the smallhold hog raisers were assumed to be technically inefficient. All variables were estimated and assessed through different functional forms, Linear (Battese and Coelli, 1993), Cobb Douglas (Coelli and Battese, 1995), and Transcendental logarithmic (Translog) (Battese and Coelli, 1993; Coelli and Battese, 1995; Aigner *et al.,* 1977). All data variables which were transformed to the natural logarithm, squared terms and interaction terms were estimated, its stochastic production frontier using MLE, and run for all functional forms (without the technical inefficiency variables). Maximum likelihood estimation was re-run for the best functional form (with technical inefficiency variables).

Data analysis

All data gathered was analyzed namely the production function, technical efficiency, and inefficiencies, using Stochastic Production Frontier Approach by Stata 12 software (Battese and Coelli, 1993; Coelli and Battese, 1995; Aigner *et al.,* 1977). The stochastic frontier approach has found wide acceptance within the agricultural economics literature and industrial settings because of its consistency with theory, versatility, and relative ease of estimation. Estimation of the productive farm efficiency presented insights into the effectiveness of hog production among small-scale producers and their capacity for hog raising productivity and improving resource use (Mugera and Featherstone, 2008).

This study was carried out following two steps, wherein the first step includes the specification and estimation of the stochastic frontier production function and the prediction of the technical inefficiency. The second step comprises the specification of a regression model for the predicted technical inefficiency effects, which contradicts the assumption of identically distributed inefficiency effects in the stochastic frontier (Battese and Coelli, 1995).

The stochastic frontier production function for panel data can be written as:

$$Y_{it} = \exp\left(X_{it}\beta + V_{it} - U_{it} \right) \qquad (1)$$

where Y_{it} = denotes the output for the i-th industry in the t-th time period;

X_{it} = denotes the $(1\times k)$ vector whose values are functions of inputs for the i-th industry in the t-th time period;

β = is a $(1\times k)$ vector of unknown parameters to be estimated;

V_{it} s = are the error components of random disturbances, distributed iid $N(0,s_n^2)$ and independent from U_{it} s;

U_{it} s = are non-negative random variables associated with the technical inefficiency of production; and

"ln" = refers to the natural logarithm

Equation (1) specifies the stochastic frontier production function in terms of the original production values. However, the technical inefficiency effects, the U_{it} s, are assumed to be a function of a set of explanatory variables, the z_{it} s, and an unknown vector of coefficients, d.

For the Production Function

The empirical version of the stochastic frontier model (1) will be expressed with the decomposed errors:

InYi = ß1InX1 + ß2InX2 + ß3InX3 + ß4InX4 + ß5InX5 + ß1InX6 + ß2InX7 + ß2InX8 + ß2InX9 + ß2InX10 + ß2InX11 + ß2InX12 - ß3InX13 - ß3InX14

Where:
Yi .... Pigs produced per farm (Yield), heads;
X1 .... capital cost (pesos);
X2 .... hired labor;
X3 .... total cost of medication;
X4 .... number of replacement gilts, heads;
X5 .... number of sows (active sows – farrowed, gestating, lactating, dry), heads;
X6 .... number of boars (junior and senior), heads;
X7 .... quantity of feeds (commercial), kg;
X8 .... quantity of feeds (home-mixed), kg;
X9 .... quantity of feeds (commercial/HM + swill) *
X10 .... average number of piglets born alive
X11 .... litter size at weaning
X12 .... number of parity (at least 2 parities)
X13 .... number of stillborn
X14 .... number of mummified
Legend: * - dummy variables
Commercial/HM + swill – 1, without swill – 0 (otherwise)

For Technical Efficiency

Technical efficiency is the ability to utilize the existing technology in producing the highest level of output at a given level of input usage. The technical inefficiency effect, U_{it} s, in the stochastic frontier model (1). All input and output variables were transformed to their corresponding log values. Given equation (1) and the distributional assumption on the inefficiency component (*ui*) of the composed error term (Battese and Coelli, 1995), the inefficiency model could be specified as in equation (2),

$$U_{it} = z_{it} d + W_{it} \qquad (2)$$

Where:
U_{it} = being a non-negative truncation of the N (Z_{it}d,s^2) – distribution.
= independent and identically distributed non-truncations (at zero) of N(Z_{it}d,s^2) distribution;
Z_{it} = (1xm) vector of farm specific inefficiency variables;
d = (mx1) vector of unknown coefficients of farm specific inefficiency variables; and
W_{it} = is defined by the truncation of the normal distribution with zero mean and variance,s^2
= truncation of N(0,s^2)

The inefficiency model as:
Ui = δ0 + δ1D1 + δ2D2 + δ3D3 + δ4D4 + δ5D5 + δ6D6 + δ7D7 + δ8D8 + δ9D9 + δ10D10 + δ11D11 + δ11D12 + δ11D13 + δ11D14 + δ11D15

Where:
Ui ....Inefficiency model;
Farm-specific characteristics
D1 ....age at breeding (months);
D2 ....weight at breeding (kg);
D3 ....breeding method (dummy variable)
D4 ....heat detection (dummy variable)
D5 .... weaning age (days);
D6 .... post-weaning estrus (days);
Socio-demographic/economic characteristics
D7 .... gender;
D8 .... educational level (years);
D9 .... farming experience (years);
D10 .... attendance in seminars/training (hours);
D11 .... number of times visited by the technician;

Legend: a dummy variable
Breeding method: 1 – AI
0 – otherwise
Heat detection: (practicing method of heat detection: haunch pressure test, riding at the back at least 1 minute)
1 – Yes
0 – No
Record keeping: 1 – Yes
0 – No

In this study, distributional assumptions on the inefficiency component of the error term are made and results are cross-checked and tested.

RESULTS AND DISCUSSION

Socio-demographic/economic Characteristics of Respondents

The socio-demographic/economic characteristics of the smallhold hog raisers in the study area are presented in Table 1. It is evident from the table that 73% of the hog raisers were male showing a higher percentage than females at 27%. These findings align with those of (Umeh *et al.*, 2015; Aminu and Akhigbe-Ahonkhai, 2017) which suggested that sex may increase technical efficiency as male producers, who are more vigorous to procure and administer production inputs, are the majority of hog farmers in the study area. While females were prone to physical injury and would be added responsibility in terms of time and physical ability.

Table 1. Percentage distribution of the socio-demographic/economic characteristics of respondents

Variables	Frequency	Percentage
Gender		
Male	22	73.0
Female	8	27.0
Educational years		
< 6	2	7.0
7 – 10	15	50.0
11 – 14	11	37.0
> 15	2	7.0
Farming experience (years)		
< 10	23	77.0
11 – 20	4	13.0
21 – 30	2	7.0
> 30	1	3.0
Training hours		
16	18	60.0
120	10	33.0
400	1	3.0
4380	1	3.0

Source: Field Survey, 2019-2020

The average number of years spent in education of 11. 38 years implies that hog farmers were educated and this will help to utilize underlying opportunities in swine production and may also adopt improved technologies. This is verified by the outcome of (Adetunji and Adeyemo, 2012; Aminu and Akhigbe-Ahonkhai, 2017) who reported a mean school year spent 13 years and time of schooling of 14.8 years in their study, respectively. The distribution of the respondents by hog rearing experience discloses that 77% of the sampled respondents had between one (1) and 10 years of hog raising experience, 13% had between 11 and 20 years while 7% and 3% had between 21 and 30 years and more than 30 years of experience, respectively. The mean hog raising experience in the study was 9.5 years which suggests that respondents had substantial years of pig production experience in this study.

The study also reveals that the majority (60 %) of the respondents attended training for 16 hours, 33% for 120 hours while 3% attended for 400 hours, and 4380 hours of training respectively. This indicates that smallhold hog raisers received training from some private institutions (feed companies) and government agencies involved and knowledgeable in swine production. The implication of this is that trained hog raisers will be more equipped with skills and techniques and perform well in swine production.

Breeding management practices

The breeding management practices of smallhold hog raisers in this study are presented in Table 2. It is displayed that 47% of the respondents breed their sows at the age of eight months, 30% at nine months old, and 17% at seven months of age while 7% were bred at 10 months old. These results indicate that hog raisers breed their sows at the recommended age which is eight months old. Patterson *et al.* (2010) suggested that the age of gilts at first-mating is still an important factor in farm data analysis of piglets born alive (PBA) and lifetime performance in commercial herds. Iida *et al.* (2015) stated that the importance of gilt age at first mating is that

Table 2. Percentage distribution of the breeding practices of smallhold hog raisers.

Breeding Practices	Frequency	Percentage
Breeding age (months)		
7	5	17.0
8	14	47.0
9	9	30.0
10	2	7.0
Breeding Practices	**Frequency**	**Percentage**
Breeding weight (kgs.)		
40	1	3.0
110	12	40.0
140	16	53.0
200	1	3.0
Breeding method		
Natural	8	27.0
Artificial insemination	22	73.0
Heat detection[1]		
No	17	57.0
Yes	13	43.0
Weaning age (days)		
28	1	3.0
30	14	47.0
35	10	33.0
45	5	17.0
Post-weaning estrus (days)		
3	3	10.0
7	21	70.0
30	5	17.0
60	1	3.0
No. of times visited by a technician		
< 1	18	60.0
2 – 3	5	17.0
4 – 7	5	17.0
> 8	2	7.0

Source: Field Survey, 2019-2020
N=30 respondents
[1]Heat detection (practicing haunch pressure test or riding at the back test)

sows first mated at a high age of 278 days or elder, had lower lifetime performance than those mated at an earlier age. The study also reveals that 53% of the respondent hog raisers breed their gilts at a weight of 140 kilograms, 40% were at 110 kilograms bodyweight while 3% both at 40 kilograms and 200 kilograms body weight, respectively. This result is following Roongsitthichai *et al.* (2013) which recommends that the farmers were to mate their gilts at the second or further observed estrus, along with, at least, 130 kg of body weight.

The table also shows that 73% of hog raisers used artificial insemination (AI) as a breeding method and 27% used natural mating. The table also illustrates results that indicate a disagreeable number of breeding practices of smallhold hog raisers namely, 57% were not exercising thorough heat detection or heat detection method such as riding at the back test and haunch pressure test for at least one minute and were just depending on the physical sign of heat (reddening and swelling of the vulva) that may lead to poor productivity while 43% were practicing heat detection. Koketsu *et al.* (2017) stated that returned females tend to have estrus behavior that is different from non-returned females. These behavioral differences include having short estrus duration or weak estrus signs, both of which are hard to detect when determining the appropriate timing of inseminations. Any such occurrence increases the non-productive days of female pigs and decreases their productivity. Belstra *et al.* (2007) recommended that thorough and methodical heat checks can decrease herd non-productive days and increase reproductive efficiency. Detection of estrus is relatively simple however, all the individuals involved must know the signs of approaching estrus so that errors can be avoided.

The breakdown of the weaning age distribution which showed the highest percentage (47%) was 30 days, 33% was at 35 days weaning age, 17% belongs to the traditional weaning age of 45 days, and 3% for early weaning age which is 28 days. On post-weaning estrus, the majority of the respondents (70%) breed their sows at seven days after weaning, 17% were between eight and 30 days after weaning, 10% were at three days after weaning and 3% was 60 days after weaning. The study also shows that a greater part of the respondents or 60% received technical assistance or were not even assisted by a technician, 17% were visited and assisted by a technician between two and seven times, and 7% were regularly assisted by a technician.

Results of the stochastic frontier model

The maximum likelihood estimates of the parameters of the stochastic frontier production function (SFPF) and inefficiency model given by the two-equation system (1) and (2) were simultaneously obtained using Stochastic Production Frontier Analysis and are reported in Table 3. All variables in this study were all estimated and analyzed using the different functional forms (Battese and Coelli, 1993; Coelli and Battese, 1995; Aigner *et al.,* 1977), Linear (Battese and Coelli, 1993), Cobb Douglas (Coelli and Battese, 1995), and Transcendental logarithmic (Translog) (Battese and Coelli, 1993; Coelli and Battese, 1995; Aigner *et al.,* 1977). All data variables were transformed to the natural logarithm, squared terms and interaction terms, transcendental logarithmic (Translog) Stochastic Production Function (half-normal distribution model) which is estimated with inefficiency effects that fits the data better than the other functional forms.

Estimation of Parameter of the Production Factors

The parameters and related statistical test results obtained from the stochastic frontier production function analysis are presented in Table 3. For pig production using maximum likelihood estimates (MLE), all the coefficients in the model have the expected a priori signs and are mainly significant. The variables at 0.05 and 0.01 level of significance were the ln capital (X_1), ln gilt (X_2), ln boar (X_3), ln commercial/home-mixed + swill (X_4), ln medication cost $(X_1)^2$, ln sow $(X_2)^2$, ln home-mixed feeds $(X_3)^2$, ln piglets born alive $(X_4)^2$ and ln sows X ln hired labor. All these variables have positive effects on pig production except ln capital and ln boar having negative signs, which means that all these positive and significant variables will increase the output of the enterprise; a unit increase in amount spend on additional prolific and genetically improved gilt, could potentially give an increase on the production.

The additional input of either commercial or home-mixed feeds + swill can also elevate the output through alternative use of concentrates and could also lessen the feed cost. The squared term variables, (ln medication cost^2) must also be administered twice, meaning the biologics requirement of pigs was not yet over-utilized and it also shows the fact that indeed, some hog raisers had limited the use of vaccines and other medication needed by the sows. The (ln home mixed feeds^2) intake should be doubled, meaning,

Table 3. Maximum likelihood estimates for the parameters of the stochastic frontier production for pig production

Production variable	Coefficient	z - value
Constant	3.028919	623.41*
Ln capital	-.0190553	-113.09*
Ln gilt	.000029	52.22*
Ln boar	-.0000267	-25.67*
Ln commercial/HM + swill	.0000433	27.06*
0.5 x ln medication cost^2	.0037859	30.81*
0.5 x ln sows^2	.4013432	1189.82*
0.5 x ln home mixed feeds^2	.000056	49.55*
0.5 x ln piglets born alive^2	.51647	1207.67*
Ln sows x ln hired labor	.0000126	17.33*
Inefficiency Model		
Constant	-41.61768	-3.60
Breeding age	2.309268	3.13*
Breeding weight	-.0193505	-0.53
Breeding method	1.745416	1.56
Weaning age	.2909868	3.10*
Post-weaning estrus	.0468895	2.15*
Gender	-4.635761	-3.35*
Educational level (years)	1.105158	5.01*
Farming experience	.1151191	2.24*
Training attended (hrs.)	.0012856	3.08*
Variance parameter		
lnsig2v	-38.91477	
Sigma_v	3.55e-09	
Log-likelihood function	55.671972	

Note: P>|z| value *significant at 5% level

home-mixed feeds are more significant than commercial, and through self-formulation, it might give the appropriate nutritional requirements at a minimal cost. The squared term variables (ln sows^2) and (ln piglets born alive^2), also indicates that the hog raisers must double the number of population of highly prolific, and genetically superior sows to multiply the production of piglets born alive that gives highest contribution in increasing production output.

Lastly, the variables ln sows x ln hired labor interaction, which was also significant, shows the fact that the synergetic relationship of farmworker and farm animals will definitely yield an increase in the total value of the output. It also implies that the animal caretaker must strictly implement good animal husbandry practices particularly in breeding management. On the other hand, the variable ln capital shows a negative effect on the production, which reveals that too much monetary investment, even if it displays significance in the production, may lead to overutilization of inputs. Another variable that shows significant but presents negative signs to the production is ln boar, which implies that increasing the number of boars would lessen the productivity, since most of the raisers preferred the artificial insemination method.

The present study shows that the older the gilt, the more it becomes technically inefficient. Moreover, the younger the age of gilt, there is more increase in the level of technical efficiency. The result displayed in Table 3 for the variable weaning age which is significant and gained positive sign, implies the increase in technical inefficiency. This result was different with the findings of Vega *et al*., (2012) who concluded that farms practicing early weaning (21-24 days) had better reproductive performance and pigs weaned and produced/sow/year, meaning early weaning will increase the level of technical efficiency. Likewise, late weaning would result in unappealing reproductive performance and also increase the level of inefficiency.

Educational years as shown in the table, displays a significant result and attained positive sign signifies that an increase of technical inefficiency would show disadvantage in the production. This result is not in agreement with the findings of Adetunji and Adeyemo (2012) reported that the higher the education status, the more likely farmers are to improve on the production and be more economically efficient. The results are also not in agreement with the output of Umeh *et al*. (2015), which suggests that farmers who are educated achieved higher levels of technical efficiency and effective utilization of inputs in pig production. The farming experience variable in Table 3 achieves a significant and positive result, which denotes that a maturing experience in pig farming would result in a rise in technical inefficiency. This was not in agreement with Aminu and Akhigbe-Ahonkhai (2017) which also reported that pig farmers with more years of farming experience will have more technical skills in management and thus, higher efficiency than younger pig farmers.

The negative signs obtained from the variables breeding weight, not significant at 0.05 level and gender, significant at 0.01 level, respectively affected technical inefficiency. An increase of a unit in breeding weight, though was not significant, the technical efficiency will increase by 0.0193. This implies that the increase in body weight increases reproductive performance. This was in agreement with Roongsitthichai *et al*. (2013) which recommends that the farmer must mate their gilts at the second or further observed estrus, along with, at least, 130 kg of body weight . It was also mentioned that the gilts with high body weight tended to have a higher number of total piglets born per litter than those with low body weight in the second parity.

Both socio-demographic/economic and farm-specific characteristics had a significant effect on the productivity however, it would become more efficient with the inclusion of adjusted litter weight at 21 days, an indication of sows milking ability, and litter size (Lipsey *et al*., 2006). This economic important trait should be part of the selection process that could offset the low litter size of piglets born alive to have an excellent average sow reproductive performance and thus, would improve the milking ability and prolificacy traits of sows. (Lofgren and Einstein, 1994) stated that the economic significance of traits such as number born alive, 21-d litter weight, and number of weaned piglets led to the selection and improvement in these traits. Furthermore, as the precision of selection programs was improved, the rate of genetic progress per generation increased.

Distribution of Respondents by Technical Efficiency

Table 4 shows the individual technical efficiencies of the sampled smallhold hog raisers obtained using the estimated stochastic frontier model. The projected technical efficiencies vary substantially among the hog raisers, ranging between 0.74 and 1. The table also shows that 20% of the respondents operated at a technical efficiency of less than 0.84, 23% worked within the technical efficiency at 0.96 – 0.99 while 30% of the hog raisers managed within the technical efficiency at 0.96 – 0.99. Twenty-seven percent (27%) of the hog raiser respondents were 100% technically efficient, which indicates that eight (8) hog raisers were the best performing farmers among the respondents. The mean technical efficiency of smallhold hog raisers in the 3rd district of Pampanga was predicted to be 0.92 and the minimum technical efficiency was 0.74 while the maximum technical efficiency was one. This result displayed a high level of technical efficiency among the swine farmers and implies that pig producers in this study were at about 92 percent of the potential production level. This outcome also suggests that the technical efficiency in swine production could be increased by 8% through better and proper use of available resources given the current state of technologies. This could be achieved through improved and enhanced socio-economic/demographic characteristics of farmers like gender (dominantly by male), higher education, more farming experience, increased hours of trainings, and farm-specific characteristics or breeding management practices such as younger breeding age, high breeding weight, strict and well-performed heat detection method or heat check, and well-implemented good

Table 4. Efficiency Distribution of small hold swine raisers by Technical Efficiency

Technical efficiency	Frequency	Percentage
< 0.84	6	20.0
0.85 - 0.95	9	30.0
0.96 - 0.99	7	23.0
1	8	27.0
Total	30	100.0
Mean efficiency	0.92	
Minimum efficiency	0.74	
Maximum efficiency	1	

animal husbandry practices in breeding management.

In conclusion, the present study was conducted to examine and measure the productivity and technical efficiency of pig production in the 3rd District of Pampanga. The stochastic frontier production function was estimated for the pig production input expenses as descriptive variables. Based on the value revealed, the productivity variable inputs and efficiency variables (socio-demographic/economic and farm-specific characteristics) were significant, it can be concluded that the pig production in the 3rd district was productive, profitable, and efficient however, there are still some of the smallhold hog raisers whose actual performance did not meet the Philippine Swine Production standards. Although, the mean efficiency is 0.92 or 92%, higher improvement can still be achieved through proper and strict implementation of good animal husbandry practices in breeding management, improved breeding stocks, and provision of effective and efficient technical assistance for better utilization of the existing resources.

STATEMENT ON COMPETING INTEREST

The authors have no competing interests to declare.

AUTHOR'S CONTRIBUTION

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by JCS and CNM. All authors read and approved the final manuscript.

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