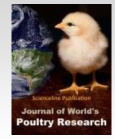
JWPR
Journal of World's Poultry Research

2023, Scienceline Publication
J. World Poult. Res. 13(2): 223-232, June 25, 2023

Research Paper, PII: S2322455X2300025-13
License: CC BY 4.0



DOI: https://dx.doi.org/10.36380/jwpr.2023.25

Comparative Analysis of Contract Farming Effect on Technical Efficiency of Broiler Chicken Farms in Indonesia

Efri Junaidi[1, 2], Jamhari[1], and Masyhuri[1]

[1]*Department of Agricultural Socio-Economics, Faculty of Agriculture, Universitas Gadjah Mada, Bulaksumur, Yogyakarta 55281, Indonesia*
[2]*Bogor Agricultural Development Polytechnic, Agricultural Extension and Human Resource Development Agency, Ministry of Agriculture Republic Indonesia, Cibalagung, Bogor 16001, Indonesia*

*Corresponding author's Email: efri.piliang@gmail.com

Received: 09 April 2023
Accepted: 28 May 2023

ABSTRACT

The development of broiler chicken farms in Indonesia has taken two forms, namely non-contract and contract farming. This study aimed to compare the technical efficiency levels of production in these two types of farming in Banten Province, Indonesia. Data were collected randomly from 180 broiler chicken farmers, consisting of 103 non-contract and 77 contract farmers. The study used the stochastic frontier production function to meet its objectives. The results showed that non-contract broiler chicken farmers were less efficient in their production than those under contract. The mean technical efficiency of the production factor for non-contract broiler chicken farmers was 0.689, ranging from 0.339 to 0.996. On the contrary, broiler chicken farmers under contract had a higher mean efficiency value of 0.893, ranging from 0.638 to 0.988. Moreover, the type of input supplier had a significant positive effect on technical inefficiency in non-contract farms. Non-contract farmers who purchased their production needs from a poultry shop showed higher technical efficiency compared to those who used distributors. This research sheds light on the efficiency of broiler chicken farms, both non-contract and contract, enabling all stakeholders, including the government, to devise appropriate policies for the development of broiler chicken farming. The study provided valuable insights into the technical efficiency levels of broiler chicken farming in Indonesia, which can help farmers identify areas that need improvement and develop strategies to increase productivity and profitability.

Keywords: Broiler farm, Contract farming, Input suppliers, Stochastic frontier, Technical efficiency

INTRODUCTION

Contract farming has been proposed as an instrument to enhance farmer welfare. Contract farming is assessed to solve farmers' classic problems, such as capital limitation, technology mastery limitation, low productivity, and marketing problems. Many studies showed evidence that contract farming could increase farmer income and welfare (Otsuka et al., 2016; Ton et al., 2017; Bellemare and Bloem, 2018) as well as their productivity (Reardon et al., 2009; Bellemare, 2010; Mishra et al., 2022). Most empirical studies about contract farming have indicated a positive and significant effect on farmer income (Otsuka et al., 2016). Contract farming might also increase farmer opportunities to adopt technology and invest more in technology (Mao et al., 2019).

Smallholder farming is a high-risk and vulnerable sector, susceptible to fluctuations in commercial broiler

To cite this paper: Junaidi E, Jamhari, and Masyhuri (2023). Comparative Analysis of Contract Farming Effect on Technical Efficiency of Broiler Chicken Farms in Indonesia. *J. World Poult. Res.,* 13(2): 223-232. DOI: https://dx.doi.org/10.36380/jwpr.2023.25

chicken farming. Smallholder farmers are considered the weakest and most vulnerable group in the commercial broiler chicken business, compared to integrators and semi-integrators (Pambudy, 2013). This vulnerability is due to several factors, including limited knowledge and financial capacity to implement business management, intensive technology, and high biosecurity, smallholder farmers' heavy reliance on obtaining quality inputs, particularly day-old chicks, feed, and medicines; and their exposure to price fluctuations as price takers for both input and live chicken sale prices. These risk factors significantly affect the sustainability of smallholder farming businesses (Pambudy, 2013).

In the risky commercial broiler chicken farming environment, farmers are motivated to manage their farming activities efficiently. Efficient farming activities are closely related to decision-makers' ability to allocate resources efficiently to achieve maximum results (Ellis, 1993). One way to enhance efficiency and expand the scale of commercial broiler chicken farming is through contract farming, which presents a greater likelihood of increasing the scale of smallholder farming businesses (Wakhidati et al., 2018). According to Key and Runsten (1999), contract farming offers several advantages, including facilitating access to markets, credit, and technology, better risk management, and improved job opportunities for farmers. At the same time, core companies can benefit from reduced investment costs and can concentrate on gaining entry into modern and global markets.

The implementation of contract farming in broiler chicken agribusiness has existed for the last three decades alongside non-contract broiler chicken farms. Non-contract broiler chicken farmers are independent farmers who purchase production factors (inputs) and freely sell their output in the market. Production factor is an economic concept that refers to the inputs needed to produce goods and services. The purchase of production factors (inputs) is usually through production agencies, such as distributors, poultry shops, or other non-contract farmers. A contract farmer is a farmer who partners with other parties as a core company, such as an integrator or poultry shop, based on an agreement. In practice, broiler chicken contract farmers can be classified into three types, including profit-sharing contract farmers, makloon" contract farmers, and forward contract farmers. The first group involves smallholder farmers who buy inputs from the core company and sell the output to the core company or other parties with a core company permit, and the sale result is divided according to the agreement. "Makloon" contract farmers are paid by the core company according to the number of day-old chicks (DOC) when starting the production, which is known as the management fee system. Forward contract farmers conduct production according to the contract agreement with the core company and sell the output to the core company with a fixed price stated in the contract (Amam et al., 2019; Indrawan et al., 2020).

Broiler chicken farming is mostly carried out by smallholder broiler chicken farmers in Indonesia. Smallholder farming in Ethiopia generally faces production efficiency problems (Yami et al., 2013; Mezgebo et al., 2021). Production efficiency is an important factor for broiler chicken farmers to increase their productivity, and it depends on how production factors are allocated. The present study aimed to compare the technical efficiency levels of non-contract and contract broiler chicken farming in Banten Province, Indonesia, to shed light on the potential benefits and drawbacks of each approach.

MATERIALS AND METHODS

Ethical approval

This research has been proposed and approved to be carried out by the Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia.

Study design

This study was carried out in Banten Province, Indonesia, using a multistage sampling method. The research location was determined purposively based on the areas that are known for broiler chicken production. The selected regencies were in Tangerang Regency and Serang. The sub-districts in Tangerang Regency were Pakuhaji, Teluknaga, Kemiri, Rajeg, and Cisoka (BPS-Statistics Tangerang Regency, 2014), and Serang Regency was Kopo, Jawilan, Cikande, Pamarayan, and Cinangka (BPS-Statistics Serang Regency, 2014).

The data collection for this study was carried out between May and September of 2021, and the sample population included 324 smallholder broiler chicken farmers, comprising 185 non-contract farmers and 139 contract farmers, from 10 sub-districts. The sample size of 180 farmers was determined using the Slovin technique, and the sample was allocated proportionately to both non-contract and contract farmers, with 103 non-contract farmers and 77 contract farmers being selected. Respondents were randomly selected from each sub-district based on the number of farmers. The data were collected through direct interviews using a questionnaire and only one production period was considered for this cross-sectional study.

The data collected for broiler chicken farming pertained to both production factors (input) and production (output). Production data was measured in kilograms and represented the quantity of live birds harvested during a production period. Production factor data (input) included the number of day-old chicks (DOC), amount of starter and finisher feed, medicine and vitamins, vaccine, number of workers, and the broiler house area, all measured during a production period, and respectively expressed in head, kilograms, grams, milliliters, days, and square meters. Additionally, data was collected on the selling price of live birds per kg and the price of each input. Socio-economic data was also collected, including information on the farmers' age, education, experience, type of job, and input suppliers for non-contract farmers. For contract farmers, data was gathered on the type of integrator company they partnered with, whether it was an integrator or a poultry shop, along with details on the contract form (written or oral) and the contract type (forward contract or profit sharing/management fee).

Statistical analysis

This study employed stochastic frontier analysis using the Cobb-Douglas production function, which was transformed into natural logarithm form and estimated using Maximum Likelihood Estimation (MLE). The Frontier version 4.1 software was used for data processing. Stochastic frontier Cobb-Douglas production function for non-contract broiler chicken farmers and contract farmers were followed as Formula 1:

$$LnY = \alpha_0 + \alpha_1 LnX_1 + \alpha_2 LnX_2 + \alpha_3 LnX_3 + \alpha_4 LnX_4 + \alpha_5 LnX_5 + \alpha_6 LnX_6 + \alpha_7 LnX_7 + (v_i - u_1)$$

(Formula 1)

Where Y, is the output of broiler chicken produced in one period (kg), X_1 denotes the number of day-old chicks in one period (head), X_2 determines the number of starter feed in one period (kg), X_3 signifies the number of finisher feed in one period (kg), X_4 refers to the number of medicines and vitamins in one period (g), X_5 tabulates the number of vaccines in one period (ml), X_6 is the number of labor in one period (days), X_7 stands for the broiler chicken house area (m^2), α_0 presents constant, $\alpha_1 - \alpha_7$ are estimated parameters, $(v_i - u_1)$ is error term (v_i stands for disturbing effect and u_1 determines inefficiency effect). The model is used to estimate the technical efficiency levels of broiler chicken farmers, with the aim of identifying factors that contribute to differences in technical efficiency levels between contract and non-contract farmers.

The analysis of regression coefficients was used to assess the impact of input variables (x) on production. A positive regression coefficient indicates a positive effect of the variable x on production, while a negative regression coefficient implies a negative effect of x on production. The p-value reflects the probability that the observed effect of the variable x on production is due to chance. A p-value less than the significance levels that were $p < 0.05$ indicated that the impact of x on production was statistically significant, and $p < 0.01$ was highly significant.

Analysis of technical efficiency (TE) of broiler chicken farms used the method developed by Coelli et al. (1998). It was obtained from the ratio of the observation output of farmer-ith (Y_i) to the frontier output (Y_i^*), which was followed as Formula 2:

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{Y_i}{exp(X_i\beta)} = \frac{\exp(X,\beta,-u_i)}{exp(X_i\beta)} = \exp(-u_i)$$

(Formula 2)

Where, TE_i denotes technical efficiency of farmer-ith, Y_i is output observed of farmer-ith, Y_i^* signifies output frontier estimated, $\exp(-u_i)$ is expected mean of inefficiency effect (u_i). Evaluation of technical efficiency value using the Criteria of 0 and 1. A technical efficiency value of 1 indicates that the farmer produces an optimal output and uses inputs efficiently. Conversely, a value of 0 suggests that the farmer is not achieving optimal output. For values of technical efficiency less than 1, it implies that the farmer has room for improvement in their production process. A comparative analysis was performed to determine the technical efficiency values of contract and non-contract farming. A two-sample mean-comparison test was employed to conduct the analysis, and the statistical software Stata version 12 was used.

Furthermore, an analysis of technical inefficiency effects and the factors that influence technical inefficiency was carried out using the technical inefficiency effect model from Coelli et al. (1998). The technical inefficiency effect model for non-contract and contract farms were followed as Formula 3:

$$u_i = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 Z_5$$

(Formula 3)

And the technical inefficiency effect model was followed as Formula 4:

$$u_i = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_6 Z_6 + \beta_7 Z_7 + \beta_8 Z_8$$

(Formula 4)

Where u_i is the technical inefficiency effect, Z_1 determines age of the farmer (years), Z_2 presents education level (years), Z_3 denotes the farming experience (years), Z_4 is dummy variable of job type (1 = main job, 0 = side job), Z_5 is a dummy variable of input suppliers, for non-contract farms only (1 = integrator, 0 = poultry shop/other farmers), Z_6 is dummy variable of core company type (1 = integrator, 0 = poultry shop/other farmer), $Z_7$is dummy variable of contract form (1= written, 0 = oral), Z_8 presents dummy variable of contract type (1 = forward contract, 0 = profit sharing/management fee), β_0 signifies constant, $\beta_1 - \beta_8$ is an estimated parameter. Dummy variable is a binary variable that takes the values 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. The coefficients estimated for each explanatory variable would indicate the direction and strength of their impact on technical inefficiency. A statistically significant coefficient indicates evidence suggesting that the explanatory variable has a non-zero effect on technical inefficiency.

RESULTS AND DISCUSSION

Average cost production

The average production cost of broiler chicken farms for both non-contract and contract farms is shown in Table 1. The majority of broiler chicken production costs for both types of farmers was the cost of feed, which was more than 60% of the total production cost. The cost of feed for contract farmers was higher than for non-contract farmers. However, other variable production costs for contract farmers were lower, except for fuel, electricity, and litter.

Table 1. Average production cost of non-contract and contract broiler chicken farms in Banten Province, Indonesia

Variables	Unit	Non-contract farms (n=103)		Contract farms (n=77)	
		Total cost	Percentage	Total cost	Percentage
DOC	IDR	24,542,143.69	30.47	93,268,571.43	26.10
Starter Feed	IDR	26,784,500.00	33.26	72,823,431.82	20.38
Finisher Feed	IDR	23,361,116.50	29.01	169,012,116.88	47.29
Medicine and vitamin	IDR	636,533.98	0.79	1,095,137.66	0.31
Vaccine	IDR	665,756.10	0.83	572,796.43	0.16
Labor	IDR	2,019,478.65	2.51	6,009,713.94	1.68
Fuel, electricity, litter	IDR	1,840,744.34	2.29	11,326,466.91	3.17
Depreciation of broiler chicken house	IDR	475,383.94	0.59	1,988,538.45	0.56
Depreciation of equipment	IDR	208,371.87	0.26	1,283,700.16	0.36
Total cost	IDR	80,534,029.07	100.00	357,380,473.68	100.00

Source: Primary data analysis (2021), n: Number of samples, DOC: Day old chick

Descriptive statistics of production and inputs

Table 2 presents the descriptive statistics of the variables used to analyze stochastic frontier Cobb-Douglas production. The results showed that contract farmers employed significantly higher amounts of production inputs than non-contract farmers, which resulted in higher levels of output for contract farmers (19,440.77 kg) than non-contract farmers (3,929.92 kg). On average, both groups of farmers were above 40 years of age, had 9 years of education, and possessed extensive experience in broiler chicken farming (average of 9 and 11 years for non-contract and contract farmers, respectively). Additionally, broiler chicken farming was the main occupation for both groups of farmers. Most non-contract farmers obtained their production inputs from distributors, while the majority of contract farmers cooperated with integrators and operated under written contracts with a profit-sharing/management fee. These findings provide valuable insights into the differences in production practices between contract and non-contract broiler chicken farmers and underscore the importance of examining the impact of these differences on technical efficiency levels.

Table 2. Descriptive statistics of the variables used in Stochastic Frontier Cobb-Douglas production function for non-contract and contract broiler chicken farms in Banten Province, Indonesia

Variables	Unit	Non-contract farms (n = 103)		Contract farms (n = 77)	
		Mean	SD	Mean	SD
Production	kg	3929.92	7940.64	19440.77	50226.27
DOC	Heads	3165.70	6377.21	11832.47	24614.03
Starter Feed	kg	3330.26	4980.87	8545.70	16657.57
Finisher Feed	kg	3020.29	9981.15	20323.61	62946.18
Medicine and vitamin (g)	g	980.49	1907.36	3586.88	8451.14
Vaccine	ml	210.63	636.63	1515.71	6428.12
Labor	Days	21.19	33.83	81.45	201.82
Broiler chicken house area	m^2	347.58	533.32	1023.23	1730.94
Age	Years	41.79	10.10	45.94	10.65
Education	Years	9.08	3.75	9.77	3.20
Experience	Years	9.93	5.96	11.19	6.48
Type of Job (1 = main job, 0 = side job)	Dummy	0.60	0.49	0.69	0.47
Input suppliers (1 = distributor, 0 = poultry shop)	Dummy	0.43	0.50	-	-
Core company (1 = integrator, 0 = poultry shop/other farmer)	Dummy	-	-	0.58	0.49
Contract form (1 = written, 0 = oral))	Dummy	-	-	0.60	0.49
Contract type (1 = forward contract, 0 = profit sharing/management fee)	Dummy	-	-	0.43	0.50

Source: Primary data analysis (2021), n: Number of samples, DOC: Day old chick, SD: Standard deviation

The estimation of the stochastic frontier production function

The production function consists of two types of variables, namely independent and dependent variables. The study included several independent variables, namely the number of DOC, starter feed, finisher feed, medicine and vitamins, vaccines, labor, and broiler chicken house area. The dependent variable was the output of the broiler chicken produced. The MLE results of the stochastic frontier Cobb-Douglas production function are presented in Table 3.

The findings revealed that DOC was a significant input for non-contract and contract farmers ($p < 0.01$) and estimated elasticities of 0.9061% and 1.0170%, respectively, indicating its significant impact on broiler chicken production. Similarly, starter and the finisher feeds were significant ($p < 0.05$) for non-contract farmers, with elasticities of 0.0576 Kg and 0.0176 Kg, respectively. For contract farmers, finisher feed and vaccines were significant with elasticities of 0.0183% and 0.0163%, respectively ($p < 0.05$). Increasing the use of these inputs has a positive and significant impact on broiler chicken production.

For non-contract and contract farmers, DOC costs contributed 30.62% and 26.12% to production costs, respectively. The results of this study were in line with the research by Harianto et al. (2019) and Ullah et al. (2019). Ullah (2019) found the estimated coefficient of the amount of DOC was statistically significant. Harianto et al. (2019) also stated that DOC was the major driver for broiler chicken production.

The study also highlighted the significance of starter feed and finisher feed for non-contract farmers ($p < 0.05$). The use of these inputs could lead to a significant increase in production. Previous studies have also reported similar findings, demonstrating the positive effect of feed on production (Udoh and Etim, 2009; Pramita et al., 2018; Wantasen et al., 2021). The present study provides further evidence supporting the importance of feed as a significant input in the production process for both non-contract and contract farmers. The findings underscore the need for farmers to exercise meticulous control over their feed inputs to maximize their production output. In the other hand, starter feed and finisher feed were not significant input for contract farmers ($p > 0.05$). This is due to the fact that feed usage in contract-based broiler chicken farming is determined by the core company.

The feed was categorized into starter and finisher with regard to the type. Starter feed is the type of feed given to the broiler chicken at the age of 2-4 weeks. In contrast, finisher feed is given to the broiler chicken at 4-6 weeks. Production cost for these types of feeds accounted for more than 60% of the total cost of production. The same result was shown by Adeyonu and Odozi (2022), indicating feeding is the primary factor responsible for elevating the broiler chicken production costs by approximately 75% of the variable cost.

Vaccination is a commonly used method by farmers to enhance the immunity of broiler chickens and reduce their susceptibility to diseases. The current results indicated that vaccines significantly and positively affected the production of contract farmers. These positive and significant coefficients suggested that increasing the use of vaccines could lead to higher broiler chicken production ($p < 0.05$). This finding is consistent with previous research by Harianto et al. (2019), indicating the positive effect of vaccines on broiler chicken production. In contrast, the study revealed that the coefficient for the use of vaccines was negative and statistically non-significant for non-contract farmers. This suggests that the quantity of vaccines used by non-contract farmers was consistent across all farmers, as observed in previous research by Ullah et al. (2019).

This study was designed to estimate the value of the gamma parameter (ɣ) in non-contract and contract broiler chicken farms. The estimated value of ɣ in non-contract farms was 0.9878, which was statistically significant ($p < 0.01$). This indicates that 99.99% of the residual variation in the model was due to technical inefficiencies that farmers can control, while the remaining 0.01% was due to stochastic effects (v_i). The high value of ɣ implies that non-contract farmers had a high degree of control over their production processes, and that any inefficiencies can be mitigated by improvements in technical efficiency. On the other hand, the estimated value of ɣ in contract broiler chicken farms was 0.3777%, which was not significant at $p < 0.01$ but statistically significant at $p < 0.05$. This implies that 37.77% of the residual variation in the model was due to technical inefficiencies that farmers can control, while the remaining 62.23% was due to stochastic effects (v_i). The lower value of ɣ in contract farms compared to non-contract farms suggests that farmers in contract farms have less control over their production processes, and are more vulnerable to external factors that affect production efficiency. Overall, the estimated values of ɣ in both non-contract and contract broiler chicken farms suggest that there is room for improvement in the technical efficiency of broiler chicken production.

The Likelihood Ratio test values for non-contract and contract farms were 19.1553 and 27.3582, respectively. Both values were greater than the critical value of χ^2 at $\alpha = 0.01$, as presented in Kodde and Palm's table (1986), which was 17.755 and 20.972, respectively. The LR test values were highly significant at $p < 0.01$, suggesting that technical efficiency and technical inefficiency factors significantly impact broiler chicken production. This implies that the combined inefficiency variables in the inefficiency effect model contribute to technical inefficiency in the broiler chicken production process.

Table 3. Estimates of the stochastic frontier production function of non-contract and contract broiler chicken farms in Banten Province, Indonesia

Variables	Unit	Non-contract farms (n=103)		Contract farms (n=77)	
		Coefficient	T-ratio	Coefficient	T-ratio
Constant	Kg	0.6949**	2.5383	-0.0234	-0.1132
DOC	Heads	0.9061***	19.1075	1.0170***	17.2030
Starter Feed	Kg	0.0576**	2.2752	0.0347	1.0040
Finisher Feed	Kg	0.0176**	2.1055	0.0183	1.7578
Medicine and vitamin	g	-0.0117	1.1938	-0.0149	-0.6845
Vaccine	ml	-0.0030	-0.3947	0.0163**	2.0693
Labor	Days	0.0503	1.1690	-0.0110	-0.3078
Broiler chicken house Area	m^2	0.0056	0.1520	-0.0067	-0.1359
Sigma-squared		0.0327***	7.2688	0.0362***	3.9777
Gamma		0.9999***	71.2554	0.3777**	2.2774
Log likelihood function		33.7219		28.7530	
LR test		19.1553***		27.3582***	

Source: Primary data analysis (2021), ** $p < 0.05$, *** $p < 0.01$, n: Number of samples, LR test: Likelihood ratio test

The value of the technical efficiency of broiler chicken farmers is presented in Table 4. The technical efficiency value of non-contracted broiler chicken farmers ranges from 0.339 to 0.996, with a mean value of 0.689. The average efficiency value means that the average non-contracted broiler chicken farmer could only achieve a production of 68.9% of the production input that has been used. This implies that the opportunity for non-contracted broiler chicken farmers to increase output is still very large (31.1%) in case they want to be technically efficient and achieve frontier output. Meanwhile, the mean efficiency of contract farms was 0.893, with the lowest value of 0.638 and the highest of 0.988. The average efficiency value showed that contract broiler chicken farmers achieved production of 89.3% of all production inputs used. The implication is that contract broiler chicken farmers still have the opportunity to increase output by 10.7% to be technically efficient and achieve frontier output.

Based on the distribution of technical efficiency value, 56.31% of non-contract farmers with an efficiency value below 0.70, 33.98% of non-contract farmers had technical efficiency of 0.70 to 0.89, and 9.71% of non-contract farmers had technical efficiency above 0.90. Meanwhile, the technical efficiency value of contract farmers below 0.70 was 2.60% of contract farmers, between 0.70 and 0.89 was 42.86%, and the majority of broiler chicken farmers (54.55%) had a technical efficiency above 0.90. The results showed that farmers under contract had greater technical efficiency than non-contract farmers in Banten province. The comparative test results confirmed a significant difference in the level of technical efficiency between non-contract and contract farmers.

Non-contract farmers could be classified as low efficiency because the average value of technical efficiency was only 0.689. It means that efficiency is still low and can still be increased. The low value of mean technical efficiency (TE = 0.6803) was also found in non-contract farming in Nigeria (Adebisi et al., 2020). Meanwhile, contract farmers were categorized as highly efficient because they have a mean technical efficiency value of 0.893 (close to 1). The average value of TE was lower than the average value of TE found in the other studies that are higher than 0.90 (Ullah et al., 2019; Bana et al., 2021; Zimunya and Dube, 2021).

Several studies have indicated that contract farming can increase efficiency (Begum et al., 2012, Suwarta, 2012; Harianto et al., 2019). Begum et al. (2012) found that contract farming had a positive and significant effect on the technical efficiency of poultry farms. Suwarta (2012) investigated the efficiency of broiler chicken farms under the core company integrator and independent broiler chicken farms in Sleman Regency. The study results indicated that farmers under contract were more technically efficient than non-contract farmers. Furthermore, the technical efficiency of broiler chicken farms under contract with the core company integrator was higher than those under contract with an independent broiler chicken farm as the core. Harianto et al. (2019) revealed that broiler chicken farms under written formal and detailed contracts had better technical efficiency than those under non-formal and unwritten contracts. Moreover, contract farming could increase the productivity of broiler chicken farms, as contract farmers have better production performance than non-contract farmers (Bahari et al., 2012; Majid and Hassan, 2014; Saptana et al., 2017). However, a study by Bana et al. (2021) compared contract and non-contract broiler chicken farms in Kupang, East Nusa Tenggara, Indonesia. The result indicated that although both types of farming were technically efficient, contract farming was less efficient than non-contract farming.

The results of the comparative test of technical efficiency levels between contract and non-contract broiler chicken farmers are presented in Table 5. The $p < 0.01$ indicated a significant difference in technical efficiency levels between contract and non-contract farmers. These results indicated a significant difference in the level of technical efficiency between contract and non-contract farmers, with contract farmers exhibiting higher levels of technical efficiency. The finding of this study supported the argument that contract farming could improve the technical efficiency levels of broiler chicken farmers. This may be due to the support and guidance provided by the corporations, which enables contract farmers to access better inputs, such as feed and vaccines, and to implement more efficient farming practices. Non-contract farmers, on the other hand, may face challenges in accessing these resources and may lack the necessary knowledge and skills to optimize their production processes.

Table 6 presents the estimated technical inefficiency effect model of broiler chicken production. This study has identified a significant variable impacting technical inefficiency among non-contracted and contracted farmers. For non-contracted farmers, input suppliers were significant ($p < 0.01$). The input supplier variable has a positive coefficient value, indicating that buying inputs from an integrator through a distributor will cause technical inefficiency to increase for non-contract farmers. However, purchasing inputs from a poultry shop can improve technical efficiency for non-contract farmers. These findings are significant for non-contract broiler chicken farmers. The results focus on the importance of carefully selecting input suppliers and utilizing experience to enhance technical efficiency and improve production outcomes.

Experience was a significant variable for contracted farmers ($p < 0.01$). Experience was the variable that impacts technical inefficiency in contracted farmers. The positive coefficient sign for contracted farmers indicates that more experienced farmers will increase technical inefficiency or become less efficient. This shows that technical inefficiency will increase in line with the increase in experience. The observed positive effect of experience on technical inefficiency can be attributed to the fact that contract farmers work according to the instructions of the core company, limiting the role of experience in improving efficiency.

Compared to non-contract farms, the efficiency of contract farms can be attributed to the involvement of the core company in the production process. Although in the current study, the variables of core company type, contract form, and contract type were not significant ($p > 0.05$), the core company plays a role in providing inputs and offering technical guidance on production, enabling contract farmers to understand resource allocation better and allocate them more efficiently. This was found in studies conducted by Eaton and Sheperd (2001), Simmons (2002), Bellemare et al. (2013), and Cahyadi and Waibel (2016).

Table 4. Technical efficiency level of non-contract and contract broiler chicken farms in Banten Province, Indonesia

Level of technical efficiency	Non-contract farms (n=103)		Contract farms (n=77)	
	Total	Percentage	Total	Percentage
< 0.70	58.00	56.31	2.00	2.60
0.70 - 0.79	28.00	27.18	16.00	20.78
0.80 - 0.89	7.00	6.80	17.00	22.08
≥ 0.90	10.00	9.71	42.00	54.55
Total	103.00	100.00	77.00	100.00
Maximum	0.996		0.988	
Minimum	0.339		0.638	
Average	0.689		0.893	

Source: Primary data analysis (2021), n: Number of samples

Table 5. Comparative test results of technical efficiency level of non-contract and contract broiler chicken farms in Banten Province, Indonesia

Variables	Non-contract farms (n=103)		Contract farms (n=77)		T-ratio	Significant
	Mean	SD	Mean	SD		
Technical efficiency	0.6887	0.1321	0.8933	0.1003	-11.8114	0.0001^{***}

Source: Primary data analysis (2021), $^{***}p < 0.01$, n: Number of samples

Table 6. Estimates of technical inefficiency of non-contract and contract broiler chicken farms in Banten Province, Indonesia

Variables	Units	Non-contract farms (n=103)		Contract farms (n=77)	
		Coefficient	T-ratio	Coefficient	T-ratio
Constant		0.3833	1.8677	0.1180	0.3257
Age	Years	0.0002	0.1011	-0.0031	-0.5584
Education	Years	0.0003	0.0584	-0.0030	-0.1952
Experience	Years	-0.0080	1.9634	0.0217^{***}	2.4704
Type of Job (1 = main job, 0 = side job)	Dummy	0.0159	0.3942	-0.0287	-0.2565
Input Suppliers (1 = distributor, 0 = poultry shop)	Dummy	0.1529^{***}	3.3857	-	-
Core company (1 = integrator, 0 = poultry shop/other farmer)	Dummy	-	-	-0.0872	-0.5141
Contract form (1 = written, 0 = oral)	Dummy	-	-	0.0526	0.3298
Contract type (1 = forward contract, 0 = profit sharing/management fee)	Dummy	-	-	-0.0900	1.7560

Source: Primary data analysis (2021), *** $p < 0.01$, n: Number of samples, T-ratio: T-value or T-statistic

CONCLUSION

Non-contract broiler chicken farms were less technically efficient than those under contract. The mean value of technical efficiency on non-contract broiler chicken farmers was 0.689 ranging from 0.339 to 0.996. Meanwhile, broiler chicken farmers under contract had a higher mean efficiency value of 0.893, with the lowest value of 0.638 and the highest of 0.988. The input suppliers' type had a positive and significant effect on technical inefficiency in non-contract farming, where buying input from a poultry shop increases technical efficiency compared to buying input from the distributor. Technical efficiency improvements in production need to be made by contract and non-contract farmers through improved production management. In addition, the availability of production inputs and ease of access to inputs can support farmers' technical efficiency improvements. The findings could have important implications for broiler chicken farmers as the study highlights the critical role of inputs, such as DOC and feed in the production process. Farmers should ensure that these inputs are readily available as their optimal utilization positively affects production outcomes. Government support through regulation is crucial to ensure the availability of inputs and ease of access for farmers. Future research is related to the input market structure, distribution of the input supply to farmers and strategy for selecting input suppliers and core companies.

DECLARATION

Acknowledgments

This research was funded by the Ministry of Agriculture Republic Indonesia through the scholarships program of the Agricultural Extension and Human Resource Development Agency.

Authors' contributions

Efri Junaidi contributed to data collecting, data analysis, analysis of the results, and preparing the manuscript. Jamhari and Masyhuri contributed to the design and supervision of the research, analysis of the results, and revised the manuscript. All authors have checked and approved the final version of the manuscript for publication in the present journal.

Competing interests

The authors confirm that there was no conflict of interest with any financial, personal, or other relationships with other people or organizations related to this paper.

Ethical consideration

Before publication in the present journal, the authors have checked the ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy.

Availability of data and materials

The data presented in this study are available on request from the corresponding author.

REFERENCES

Adebisi L, Adebisi O, Owolabi M, Hemshaw E, and Asiyanbi O (2020). Economic analysis of contract farming and technical efficiency of broiler chicken farmers. Cercetari Agronomice in Moldova, 4(184): 246-433. DOI: https://www.doi.org/10.46909/cerce-2020-036

Adeyonu AG and Odozi JC (2022). What are the drivers of profitability of broiler chicken farms in the north-central and south-west geo-political zones of Nigeria?. Sage Open, 12(1): 1-13. DOI: https://www.doi.org/10.1177/21582440211071076

Amam, Fanani Z, Hartono B, and Nugroho BA (2019). The development of broiler chicken farming business through a profit-sharing partnership system based on accessibility of farmers to resources. Journal of Tropical Animal Science and Technology, 6(2): 146-153. DOI: http://www.doi.org/10.33772/jitro.v6i2.5578

Bahari N, Mustadjab MM, Hanani N, and Nugroho BA (2012). An analysis of broiler chicken contract farming. Jurnal Agro Ekonomi, 30(2): 109-127. DOI: https://www.doi.org/10.21082/jae.v30n2.2012.109-127

Bana MVM, Tinaprilla N, and Pambudy R (2021). Technical efficiency and profitability of smallholder broiler chicken farms in Kupang regency. Jurnal Agro Ekonomi, 39(1): 29-49. DOI: https://www.doi.org/10.21082/jae.v39n1.2021.29-49

Begum IA, Alam MJ, Buysee J, Frija A, and Huylenbroeck GH (2012). Contract farmer and poultry farm efficiency in Bangladesh: A data envelopment analysis. Applied Economics, 44(28): 3737-3747. DOI: https://www.doi.org/10.1080/00036846.2011.581216

Bellemare MF (2010). Agricultural extension and imperfect supervision in contract farming: evidence from Madagaskar. Agricultural Economics, 41(6): 507-517. DOI: https://www.doi.org/10.1111/j.1574-0862.2010.00462.x

Bellemare MF, Barret CB, and Just DR (2013). The welfare impacts of commodity price volatility: Evidence from rural Ethiopia. American Journal of Agricultural Economics, 95(4): 877-899. DOI: https://www.doi.org/10.1093/ajae/aat018

Bellemare MF and Bloem JR (2018). Does contract farming improve welfare? A review. World Development, 112: 259-271. DOI: https://www.doi.org/10.1016/j.worlddev.2018.08.018.

BPS-statistics Tangerang Regency (2014). Agricultural business portrait of Serang Tangerang regency by subsector. BPS-Statistics Tangerang Regency. Banten. Indonesia. Available at: https://tangerangkab.bps.go.id/publication.html?Publikasi%5BtahunJudul%5D=2014&Publikasi%5BkataKunci%5D=&Publikasi%5BcekJudul%5D=0&yt0=Tampilkan

Cahyadi ER and Waibel H (2016). Contract farming and vulnerability to poverty among oil palm smallholders in Indonesia. The Journal of Development Studies, 52(5): 681-695. DOI: https://www.doi.org/10.1080/00220388.2015.1098627

Coelli T, Rao DSP, and Battese GE (1998). An introduction to efficiency and productivity analysis. Springer., New York. pp. 183-198. Available at: https://dl.icdst.org/pdfs/files/3a67240be4e2274e4c95655ec16931de.pdf

Eaton C and Sheperd A (2001). Contract farming: Partnership for growth. FAO agricultural services bulletin 145. Food and Agriculture Organization of the United Nations., Rome. pp. 7-25. Available at: https://pacificfarmers.com/wp-content/uploads/2014/07/Contract-farming-by-CharlesEatonA.Shepherd-.pdf

Ellis F (1993). Peasant economics, farm households in agrarian development, 2nd Edition. Cambridge University Press., Cambridge. Available at: https://www.cambridge.org/id/academic/subjects/life-sciences/natural-resource-management-agriculture-horticulture-and/peasant-economics-farm-households-agrarian-development-2nd-edition?format=PB&isbn=9780521457118

Harianto, Kusnadi N, and Paramita DA (2019). The impact of vertical integration intensity on broiler chicken farms technical efficiency: The case of contract farming in West Sumatera. Tropical Animal Science Journal, 42(2): 167-174. DOI: https://wwww.doi.org/10.5398/tasj.2019.42.2.167

Key N and Runsten D (1999). Contract farming, smallholders, and rural development in Latin America: The organization of agroprocessing firms and the scale of outgrower production. World Development, 27(2): 381-401. DOI: https://doi.org/10.1016/S0305-750X(98)00144-2

Kodde DA and Palm FC (1986). Wald criteria for jointly interesting equality and inequality restriction. Econometrcia, 54(5): 1243-1248. DOI: https://www.doi.org/10.2307/1912331

Indrawan D, Cahyadi ER, Daryanto A, and Hogeveen H (2020). The role of farm business type on biosecurity practices in West Java broiler farms. Preventive Veterinary Medicine, 176: 104910. DOI: https://www.doi.org/10.1016/j.prevetmed.2020.104910

Majid RB and Hassan S (2014). Performance of broiler chicken contract farmers: A case study in Perak, Malaysia. UMK Procedia, 1: 18-25. DOI: https://www.doi/10.1016/j.umkpro.2014.07.003

Mao H, Zhou L, Ifft J, and Ying R (2019). Risk preferences, production contracts and technology adoption by broiler chicken farmers in China. China Economic Review, 54: 147-159. DOI: https://www.doi.org/10.1016/j.chieco.2018.10.014

Mezgebo GK, Mekonen DG, and Gebrezgiabher KT (2021). Do smallholder farmers ensure resource use efficiency in developing countries? Technical efficiency of sesame production in Western Tigrai, Ethiopia. Heliyon, 7(6): e07315. DOI: https://www.doi.org/10.1016/j.heliyon.2021.e07315

Mishra AK, Mayorga J, and Kumar A (2022). Technology and managerial gaps in contract farming: The case of specialty crop production. Journal of Agricultural and Resource Economics, 47(1): 77-96. DOI: http://www.doi.org/10.22004/ag.econ.307460

Otsuka K, Nakano Y, and Takashashi K (2016). Contract farming in developed and developing countries. Annual Review of Resource Economics, 8: 353-376. DOI: https://www.doi.org/10.1146/annurev-resource-100815-095459

Pambudy R (2013). Reassessment, formulation, and recommendation of alternative policies and strategies for the development of commercial broiler and layer poultry farming system in Indonesia. In: D. Rachmina, R. Nurmalina, R. Winandi, N. Kusnadi, Burhanuddin, and A. Fariyanti (Editors), Proceedings of the Outstanding Research Seminar of Department of Agribusiness. IPB University, Bogor. pp. 151-176. Available at: http://agribisnis.ipb.ac.id/wp-content/uploads/2019/03/09-Rachmat-Pambudy-Pengkajian-Ulang-Perumusan-dan-Rekomendasi........pdf

Pramita DA, Kusnadi N, and Harianto (2018). Efficiency of contract broiler chicken farm in Limapuluh Kota Regency. Journal of Indonesia Agribusiness, 5(1): 1-10. DOI: https://www.doi.org/10.29244/jai.2017.5.1.1-10

Reardon T, Barrett CB, Berdegue JA, and Swinnen JFM (2009). Agrifood industry transformation and small farmers in developing countries. World Development, 37(11): 1717-1727. DOI: https://www.doi.org/10.1016/j.worlddev.2008.08.023

Saptana, Maulana M, and Ningsih R (2017). Production and broiler chicken marketing in West Java. Journal of Management and Agribusiness, 14(2): 152-164. DOI: https://www.doi.org/10.17358/jma.14.2.152

Simmons P (2002). Overview of smallholder contract farming in developing countries. ESA Working Paper 02-04. Food and Agriculture Organization of the United Nations., Rome. pp. 1-27. Available at: https://www.fao.org/3/ae023e/ae023e00.htm

Suwarta I (2012). Productivity, efficiency, business risk of nucleus contract broiler chicken farm and non-contract broiler chicken farm in Sleman Regency. PhD Thesis, Universitas Gadjah Mada, Yogyakarta. Available at: http://etd.repository.ugm.ac.id/penelitian/detail/54435

Ton G, Desiere S, Vellema W, Weituscat S, and D'Haese M (2017). The effectiveness of contract farming for raising income of smallholder farmers in low and middle-income countries: A systematic review. Campbell Systematic Review, 13(1): 1-131. DOI: https://www.doi.org/10.4073/csr.2017.13

Udoh EJ and Etim NA (2009). Measurement of farm level efficiency of broiler chicken production in Uyo, Akwa Ibom State, Nigeria. World Journal of Agricultural Science, 5(S): 832-836. Available at: http://www.idosi.org/wjas/wjas5(S)/5.pdf

Ullah I, Ali S, Khan SU, and Sajjad M (2019). Assessment of technical efficiency of open shed broiler chicken farms: The case study of Khyber Pakhtunkhwa province Pakistan. Journal of the Saudi Society of Agricultural Sciences, 18(4): 361-366. DOI: https://www.doi.org/10.1016/j.jssas.2017.12.002

Wakhidati YN, Mastuti S, Nur S, and Einstein A (2018). Efficiency of broiler chicken farming business in Magelang Regency. Proceedings of National Seminar on Livestock Agribusiness Technology, pp. 396-403. Available at: http://jnp.fapet.unsoed.ac.id/index.php/psv/article/view/98/89

Wantasen E, Umboh SJK, Leke JR, and Sompie FN (2021). Production and production risk of broiler chicken farms in the Regency of North Minahasa-Indonesia. Indonesian Journal of Animal and Sciences, 31(2): 121-132. DOI: https://www.doi.org/10.21776/ub.jiip.2021.031.02.05

Yami M, Solomon T, Begna B, Fufa F, Alemu T, and Alemu D (2013). Source of technical inefficiency of smallholder wheat farmers in selected waterlogged areas of Ethiopia: A translog production function approach. African Journal of Agricultural Research, 8(29): 3930-3940. Available at: https://www.cabdirect.org/cabdirect/abstract/20133369603

Zimunya KT and Dube L (2021). Technical efficiency of broiler chicken contract growers in Chegutu district of Zimbabwe: A stochastic frontier analysis. Scholar Journal of Agriculture and Veterinary Sciences, 8(9): 95-101. DOI: https://www.doi.org/10.36347/sjavs.2021.v08i09.003