Research Article

Sustainability Performance of Indonesian Duck Farming and the Related Determinants

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Abstract | This study aimed to create a model for the sustainability of duck farming in Indonesia. Two hundred duck farmers in Brebes Regency were randomly selected as research respondents. Brebes is the duck production center of Indonesia. Approximately 80% of duck egg production originates in this area. The variables utilized include socioeconomic characteristics of duck farmers, social variables, age, education, medicinal seeds, feed, dried-cooked rice, trash fish, processing, business pattern, marketing, technology, and production; the endogenous variable was sustainability. Structural equation modeling (SEM) using TETRAD-IV software was employed to establish the analytical model. The results show that duck farming is sustainable regarding social, economic, and environmental aspects. Medical and technological factors significantly affect production. Social factors, egg processing, technology, and production significantly affect sustainability. To improve the sustainability of duck farming, it is necessary to increase the role of the farmer association, apply feed processing technology, diversify duck egg processing and boost technical efficiency in regard to increasing duck egg production. Focusing on these efforts will increase the sustainability of duck farming in Indonesia. Duck farming is sustainable based on a social perspective, economic analysis, and environmental viability.

Keywords | Poultry farming, Sustainable feasibility, Structural equation modeling,

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INTRODUCTION

Ducks comprise a world commodity that is very important for providing healthy food in the form of meat and eggs. The demand for duck eggs in Indonesia is continuously increasing year after year. Duck egg products such as salted eggs, roasted eggs, and other processed egg products are considered trendy. Ducks are a commodity in the livestock subsector, which is very important in supplying protein to the people of Indonesia. Researchers in several countries have conducted studies on ducks (Banga-Mboko et al., 2007; Hoque et al., 2010; Broyer & Calenge, 2010; Huo et al., 2021: Li et al., 2018; Pham et al., 2021). Sustainability is important in agricultural development (Purbajanti et al., 2016). Furthermore, Purbajanti et al. (2016) stated that economic and environmental factors influence sustainability. Huo et al. (2021) stated that ducks can be maintained by integrating them with rice farming. Ducks reared with rice have good carcass quality. Broyer and Calenge (2010) stated that ducks can be kept integrated with fish. Duck manure can be a food source for fish, and in this way, environmental problems can be resolved. Li et al. (2018) and Sheng et al. (2018) also stated that rice-duck integration can improve egg and meat quality and reduce production costs. Hoque et al. (2010) stated that in Bangladesh, the problems that duck farmers often face are related to the availability of feed and product processing. Alejandria et al. (2019) stated that in the Phil-

ippines, processed eggs are processed into "balut," a trendy traditional food for Filipinos. Santoso et al. (2016) and Lei et al. (2019) stated the need to use agricultural waste, such as seaweed and cassava, to reduce feed costs and increase production.

Sustainability is a crucial indigenous variable in duck farming. Linden et al. (2020) stated that sustainability means that economically viable, environmental problems are resolved and can be accepted by the community. Santoso et al. (2017) stated that a business is considered sustainable if it can generate good income for farmers. Lovarelli et al. (2020) stated that dairy farm production must meet environmentally, economically, and socially sustainable production criteria. Increasing the performance of economic and social variables will lead to increased sustainability. Several researchers have examined the importance of sustainability in livestock development in various countries (Vogel et al., 2021; Wei and Zhen, 2020; Martin et al., 2020; Tsakiridis et al., 2020; Baudron et al., 2015). The sustainability model is fundamental in ensuring duck farming.

Some researchers have used structural equation modeling (SEM) to relate input and indigenous variables. Senger et al. (2017) established a psychological relationship between certain factors and the business performance of dairy cows. Rauber et al. (2021) predicted the body weight of broilers at the time of harvest. Yu et al. (2021) established an association between socioeconomic factors and soil erosion, and Chandra and Kumar (2021) examined the relationship between vaccine use and economic performance. Ankamah et al. (2021) explained the perception of agricultural sustainability in regard to mitigating climate change in Ghana. The results of Ankamah et al. (2021) show that social features and resource information influence the adoption of sustainable agricultural practices. This study uses SEM to construct a model for duck farming sustainability in Indonesia.

MATERIALS AND METHODS

Study site

This research was conducted in the Brebes Regency. Two hundred duck farmers were randomly selected as research respondents. The variables utilized include the socioeconomic characteristics of duck farmers, social variables, age, education, medicinal seeds, feed, wasted rice, trash fish, processing, business pattern, marketing, technology, and production; the endogenous variable was sustainability. Social factors were measured using indicators of group activity, routine activities in the form of training or counseling, and the leadership of the group leader. Business pattern was measured as 0 = extensive and 1 = intensive. Education was measured as elementary school = 1, junior high school = 2, senior high school = 3, and university = 4. The environment variable was measured as 0 = not processing manure, 1 = processing manure, and the sustainability was measured as 5 = very sustainable, 4 = sustainable, 3 = sustainable enough, 2 = not sustainable, 1 = not very sustainable.

Data analysis

The data obtained were processed in a descriptive quantitative manner. Investment data were calculated from the capital issued by duck farmers for their business processes. Economic analysis was performed by calculating the net present value (NPV), benefit-cost ratio (B/C ratio), payback period (PP), and internal rate of return (IRR) to determine the economic feasibility. The research employed SEM with the help of TETRAD-IV software to test the hypotheses.

RESULTS AND DISCUSSION

Table 1 shows the socioeconomic characteristics of the surveyed duck farmers. On average, the duck farmers in Brebes are still of a productive age, i.e., approximately 50 years old. More than 65% of the duck farmers only graduated from elementary school; this level of education is considered low. Thus, these farmers need to improve their skills and knowledge to increase their farming performance; well-formulated training might be suitable in this case. Approximately 80% of farmers operate their farming on leased lands provided by the government. They pay monthly fees through a livestock farmer association. The average production is 456 eggs per day, produced by 571 female ducks. The main type of duck is the Tegal duck, which is the local type suitable in coastal areas.

Table 1: Socio-economic characteristics of the duck farmers

No	Items	Brebes regency
1	Age (years)	53
2	Educational background	
	Elementary (%)	67
	Junior high school (%)	14
	Senior high school (%)	15
	University (%)	4
4	Land status	
	Own (%)	20
	Rent (%)	80
5	Number of duck (heads)	571
6	Strain	Tegal duck

Table 2 shows the daily cost of the inputs related to duck farming. Duck feed consists of a source of protein and carbohydrates. This composition of physical inputs follows the

Table 2: Daily production, inputs and net revenue of duck farming

No	Item	Number	Unit price (IDR)	Value	Factor share
1.	Production (egg)	456	2,000	912,000	100%
2	Labor (persons)	2	70,000	140,000	15%
3	Wasted rice (kg)	186	450	83,700	9%
4	Trash fish (kg)	98	1,000	98,000	11%
5	Medicines (package)	1	25,000	25,000	3%
6	Concentrate feed (kg)	52	6,600	343,200	38%
8	Net revenue (IDR)			222,400	24%

Table 3: Social factor influence the sustainability

No	Group Activity	Frequency
1	Regular meeting	One/month
2	Extension service by Animal husbandry office	One/week
3.	Training to improve skills by the Livestock Service Office	One/three months
4.	Training to improve skills conducted by university staff	One/ six months

research of Jianbo et al. (2008). An appropriate amount of feed will cause the ducks to produce eggs well. The highest share of the input is related to feeding materials, which accounts for 75% of the total. Medicines, despite representing the lowest share, play an essential role in business since their input reduces the overall risk. The net revenue share accounts for approximately 25%, which is considered moderate in the poultry farming business. The results show that the income obtained is in line with the research results of Dwiloka et al. (2015), which show that duck farming is feasible to develop because ducks can generate considerable income.

Table 3 shows that the respondents belong to a farmer group. They perceive the role of farmer groups as supporting the success of their duck farming. Farmer groups hold regular meetings every month. In these regular meetings, farmers exchange ideas for solving problems. They also share information about the zootechnics of raising ducks in the meetings. Extension workers from the animal husbandry office regularly visit duck farmers to guide them in raising good ducks, selecting seeds, providing proper feed, and managing duck maintenance. The government also regularly provides training to improve the skills of duck farmers. Competition for group activity is also often held to encourage duck farmers to manage their businesses. Training is often carried out, such as local feed processing and duck egg processing. Mentoring for duck farmer groups is also regularly carried out by academics from the university. The training that is often given includes training on bookkeeping, local feed processing, and manure processing. This mentoring is usually carried out by university academics every six months.

As shown in Table 4, the investment required for duck farming is related to building cages and buying female ducks. Eighty percent of duck farmers occupy government land in their business by paying rent annually. Female ducks are usually kept for two years to produce eggs. A cage can also be used for two years before needing repairs. The cages are made of bamboo.

Table 4: Investment in duck farming

No	Items	Number (IDR)
1.	Cage investment	27,300,000
2.	Female duck	65,520,000

As shown in Table 5, an economic analysis was carried out to determine the feasibility of the duck business. The NPV calculation obtained a value of approximately IDR 64 million, which is positive; the value of the B/C ratio was more significant than one; the IRR was greater than the prevailing bank interest rate of 12%, and the funds invested in duck farming are typically returned in less than two years. All indicators of economic feasibility show that the duck business in Indonesia is economically feasible.

Table 5: Economic analysis of duck farming

No	Item	Number
1	Net Present value (NPV)	64,105,621
2	Benefit/Cost ratio (B/C ratio)	1.7
3	Payback period (PP)	1 year, 1 month, 21 days
4	Internal rate of return (IRR)	51.60%

As shown in Table 6, most duck farmers have yet to process duck manure into fertilizer or biogas. Duck farmers who process duck dung into fertilizer also work as shallot farmers or rice farmers. In line with the research of Sheng

(2021), livestock and crop integration can reduce fertilizer costs, and reducing fertilizer costs will significantly reduce production costs in the cultivation of food crops. Processing duck manure will also reduce the odors generated by the duck business. Only recently has the processing of duck manure into biogas, liquid fertilizer, or other products been carried out. Appropriate training is needed to improve the skills of duck farmers in processing duck manure and eventually increasing the environmental viability of the duck business.

Table 6: Environment factor

No	Item	Percentage (%)
1	Percentage of duck farmer process the duck manure	47.5
2	Percentage of duck farmers did not process the duck manure.	52.5

The structural equation model of duck farming is shown in Figure 1. This model seeks to link input costs, technology and production and the relationship between social factors, age, education, egg marketing, egg processing, technology, and production to business sustainability.

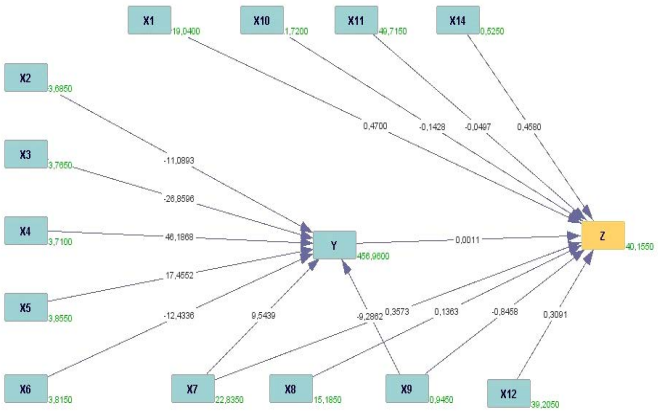

Figure 1: Duck farming sustainability model

As shown in Table 7, social factors significantly influence sustainability. Increasing the group's role in improving duck farmers' skills is very important. Group activities such as regular monthly meetings are effective in solving problems that occur. Routine counseling organized by the Brebes Animal Husbandry Service is also able to improve the sustainability of duck farming. Dentchev et al. (2016) stated that social factors are essential to a business's success. Increased social interaction in the organization effectively increases members' skills. Age does not significantly affect sustainability, contrary to the argument of Sofyan et al. (2019), who stated that age dramatically affects the success of laying hens. The average age of duck farmers is 53 years, which is a productive age at which the training and counseling provided can be appropriately absorbed. Education does not affect business success because the majority (67%) of respondents only graduated from elementary school. The result of the current study contradicts the findings of Utsman et al. (2021), who stated that education is an essential factor in influencing business sustainability; i.e., educated farmers will quickly absorb the information, knowledge, and skills provided. It is necessary to carry out informal education to increase duck farmers' technical efficiency and economic efficiency to improve their skills.

Egg processing significantly affects sustainability. Brebes already offers many processed duck egg products, such as salted eggs, roasted eggs, stuffed onions and meat with duck eggs, and other processed egg items. Arthur et al. (2015) stated that salted eggs are very popular with consumers, and the production process of salted eggs does not affect the nutritional content of duck eggs. Salted eggs are famous for their distinctive taste, attractive color, and high nutritional content. Their flavor is what drives salted eggs to be popular with consumers. The high demand for salted and roasted eggs causes duck farmers to be active in production. The high demand for salted and roasted eggs makes this business sustainable. The breed of duck does not significantly affect production. The results of the current study contradict those of Riek et al. (2021), who stated that breed significantly affects chicken egg production. The better the quality of the breed is, the better the production is. The breed widely used by duck farmers in Brebes is Tegal ducks. Improvements in genetic and feed quality need to be made to increase egg production.

Feed was not found to significantly affect production, which is contrary to the research by Santoso et al. (2016; 2017), which stated that feed is a variable that affects production. Good quality feed will cause production to increase. Duck farmers mostly use feed produced by large feed factories. When the feed price is low, farmers will provide more feed; however, when much more expensive feed is used, farmers tend to release ducks in the rice field, which dramatically reduces the feed cost during the rice harvest season.

Vitamins are essential factors in duck egg production. Farmers always provide vitamin C, vitamin D, and calcium to increase the production and quality of eggs. The avian influenza (AI) vaccine is also regularly given every three months to prevent ducks from developing AI disease. The provision of vitamins also causes ducks to increase their resistance. Wasted rice was not found to significantly affect production. The function of wasted rice is as a source of carbohydrates, but sometimes the quality of the utilized wasted rice is low. However, this does not significantly affect production. Wasted rice is obtained from the local area. Improving the quality of wasted rice is necessary to increase egg production.

Table 7: Determinants of duck business sustainability

From	To	Coefficients	Std error	*p*-Value
X1 (Social)	Z (Sustainability)	0.4652	0,0933	0.0000
X10 (Education)	Z (Sustainability)	-0.1567	0,1875	0.4043
X11 (Age)	Z (Sustainability)	-0.0335	0,0188	0.0762
X12 (Egg processing)	Z (Sustainability)	0.3148	0,0569	0.0000
X14 (Environment)	Z (Sustainability)	0.4580	0.5987	0.4452
X2 (Breed)	Y (Production)	-11.0893	18.2824	0.5448
X3 (Feed)	Y (Production)	-26.8596	18.2072	0.1417
X4 (Medicine and Vitamins)	Y (Production)	46.1868	17.7156	0.0098
X5 (Wasted rice)	Y (Production)	17.4552	19.4152	0.3697
X6 (Trash fish)	Y (Production)	-12.4336	17.2464	0.4718
X7 (Technology)	Y (Production)	9.5439	5.0207	0.0488
X7 (Technology)	Z (Sustainability)	0.3577	0.0780	0.0000
X8 (Egg marketing)	Z (Sustainability)	0.1310	0.1234	0.2896
X9 (Business pattern)	Y (Production)	-9.2862	55.8087	0.8680
X9 (Business pattern)	Z (Sustainability)	-0.8408	0.8022	0.2959
Y (Egg Production)	Z (Sustainability)	0.0011	0.0010	0.0285

Trash fish was not found to significantly affect production; the quality of the trash fish used by duck farmers could be better if it were found to affect production. However, in practice, duck farmers often replace their existing feed; for example, if trash fish is unavailable, they often replace it with field snails or hoops, which are of lower quality than trash fish.

Technology was found to significantly influence production. Feed processing technology is one example of a technology capable of increasing egg production. The technology of utilizing seaweed waste as feed for ducks can increase production (Santoso et al., 2016). Using Kariba weed as duck feed can also increase production (Santoso et al., 2017).

Technology was found to significantly affect sustainability. Barth et al. (2021) stated that technology can make a business more sustainable. Cheap feed-making technology from alternative feeds and egg processing technology are examples of technology applications that can make duck farming sustainable. Livestock farmer groups play a role in facilitating the transfer of technology and knowledge from academia and government because of the low education level of duck farmers. Mutually beneficial cooperation needs to be designed between higher education institutions, the government, and business actors in the duck business to improve duck farmers' skills.

Egg marketing was not found to significantly affect sustainability because the egg market is very well established. The wholesaler usually goes directly to the duck farmer's cage and buys at the agreed price. In Brebes, many shops sell salted eggs, roasted eggs, and other processed egg products; thus, the duck egg market is very secure.

Business patterns were not found to affect production. Duck farmers usually release their ducks in the rice field when harvesting rice and house them during the planting season. Therefore, duck farmers alternate between the use of an extensive system and the use of an intensive system. This pattern is thought to cause lower production costs when compared to duck farmers who only confine their ducks in cages. However, the business pattern used was not found to significantly affect sustainability. Of course, this is because duck farmers often change their maintenance patterns according to the availability of available feed during the current season.

Egg production is greatly affected the sustainability of duck farming. Increasing egg production will also increase business sustainability. The growing demand for eggs, coupled with the public's awareness of the importance of nutrition, causes the demand for duck eggs in Indonesia to continuously increase. Duck farmers can increase the number of eggs produced by increasing the number of ducks kept, using excellent quality feed, and applying appropriate technology in regard to feed processing. Increasing egg production can also be accomplished by increasing technical efficiency and economic efficiency. The health condition of the ducks needs to be maintained by providing vitamins and maintaining a clean environment. Vaccinations need to be carried out regularly to prevent dangerous diseases such as AI, Newcastle disease (ND), and other diseases.

Environmental factors were not found to significantly

affect sustainability because not all duck farmers process duck dung into fertilizer; only 47.5% of duck farmers were found to do so. This is why the environment only significantly affects sustainability. Based on the results of SEM analysis, the variables that affect the sustainability of duck farming in Indonesia are social factors, egg processing, technology, and egg production. Duck farming is able to generate viable income for duck farmers. However, most duck farmers do not process their livestock manure into fertilizer, biogas, or other products.

CONCLUSION

The structural equation model used herein to analyze duck farming illustrates the relationship of input variables to the amount of production, the effect of production on sustainability, and the variables that directly affect sustainability. The results show that social variables and economic variables (e.g., amount of production) significantly affect sustainability, while environmental variables do not significantly affect sustainability. Duck farming is economically viable and socially capable of community acceptance and group activities. An appropriate recommendation to improve sustainability is that duck farmers need to enhance their knowledge and innovation capability in regard to utilizing waste, such as processing manure and leftover feed into biofertilizers, biogas, and other environmentally friendly products.

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CONFLICT OF INTEREST

The authors state that there are no conflicts of interest.

NOVELTY STATEMENT

The sustainability of duck farming in Indonesia needs to develop some factors such as social, Technology, and Environment. The development of duck farming would fulfill meat demand in Indonesia.

AUTHOR'S CONTRIBUTION

All authors contributed to the conduct of the research, the writing process, and the data analysis.

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