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Farmer investment into biosecurity on broiler and layer farms in Bali

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Abstract

This paper measures the cost of implementing biosecurity on broiler and layer farms in Bali. Farmer investment in biosecurity is analysed to determine if there is any difference in the implementation of biosecurity between broiler and layer farms. Data is taken from a survey of 60 layer and 60 broiler smallholder farmers in Bali in 2009. While secure boundary fencing and farm gate locks are more common on layer farms, broiler producers are more likely to have a footbaths at the shed door. In this analysis, biosecurity investments include the quality of fencing and gates, presence of locks on gates, management changes required to minimise staff and visitor movement onto and in the farm, costs of minimising vehicle entry, use of vaccination and disinfectant, chlorination of water and quality of the chicken shed.

Defining the relationships between present investment decisions and farm type, size and mortality rates will provide useful information to decision makers concerning the cost-effective levels of biosecurity that should be adopted by smallholder farmers in Bali. In Bali, decision makers are not only the individual farmers but also the government and private companies.

Key words: biosecurity, poultry, investment, Bali

1. Introduction

High Pathogenic Avian Influenza Virus (HPAI H5N1) has been discussed widely up to now for its impacts not only on the poultry industry, but also for its potential to cause human fatalities. The outbreaks impacted many areas of the poultry industry, including broilers, layers, kampung chickens and ducks. The United Nations Food and Agriculture Organization (FAO) compiled four factors facilitating the spread of Avian Influenza virus either directly or indirectly (FAO 2004). Firstly, whether the primary production farming system is situated in a rural or urban area, and includes high-risk farming practices. Secondly, unsafe transport of live birds, including vehicles, transportation and caging of birds. Thirdly, live bird markets have a higher capacity to spread the virus, with Sims (2007) indicating that live bird markets (LBM) are important in spreading H5N1 virus in Asian poultry market chains. This is because the markets receive and distribute huge numbers of mainly uninspected birds of indeterminate infectious status, and with a tendency towards extensive inter-species mixing. Finally, unsafe food preparation, referring to improper handling of food by consumers at the end of food chain.

The World Health Organization (WHO) has emphasized the importance of enhancing biosecurity along the food chain to reduce the risk of disease spread. Biosecurity is essentially management of biological and environmental health risks to avoid unnecessary contact between animals and microbes. In addition, biosecurity also applies to public health measures that reduce contact between animals and humans (WHO 2006).

FAO has defined four sectors within the poultry industry based on farm biosecurity and the system used to market products (FAO 2004). Sector 1 includes industrial integrated systems with a high level of biosecurity and birds/products that are marketed commercially. Sector 2 covers commercial poultry production systems with moderate to high biosecurity and birds/products that are sold commercially. Sector 3 involves commercial poultry production systems with low to minimal biosecurity and birds/products that are mostly sold via live bird markets. Finally, Sector 4 involves village or urban backyard production with minimal biosecurity and birds/products that are consumed locally. FAO suggests that the probability of infection is higher in production in Sectors 3 and 4 than it is in Sectors 1 and 2. However, if a virus has spread in Sectors 1 and 2, its impact may be higher as the concentration of susceptible poultry in these farms is much higher than that found in Sectors 3 and 4.

In line with the implementation of improved biosecurity measures in Sector 3, a focus group discussion was carried out inviting related post-farm gate stakeholders of the poultry sector in Bali (Sarini 2009). The results of this discussion indicated that three important stakeholders in the poultry market chain need to be considered: the farmer, slaughterhouse and consumer. It was also agreed by stakeholders that farmers need to implement good biosecurity, and that they should receive a financial incentive for doing so.

This paper aims to identify the level of biosecurity on both broiler and layer producers, in Bali by discussing measures that have been implemented on both farms. It then discusses the amount spent in these areas compared with farm size in quartile to find out whether larger scale farmers spend more in biosecurity.

2. Methodology

2.1 Survey location and respondents

A survey was conducted in Bali in April 2009, covering six regencies. The survey locations were based on prior knowledge of the poultry population and HPAI outbreaks in the region. Respondents included farmers who own broiler and layer farms. The number of respondents was determined using a quota sampling method (that is, determined beforehand based on the budget and time available for conducting the survey). The number of respondents for

each type of farm (layer and broiler) was 60 farmers, totaling 120 respondents. Table 1 summarises the number of respondents in each regency in Bali.

Table 1: Survey location and number of respondents in Bali

Type of farm	Regency					
	Karangasem	Bangli	Klungkung	Gianyar	Tabanan	Jembrana
Broiler	0	0	10	10	20	20
Layer	20	20	0	0	20	0
Total	20	20	10	10	40	20

2.2 Data analysis

Biosecurity has three major components including isolation, traffic control and sanitation (WHO 2006). Isolation refers to the confinement of live animals within a controlled environment; traffic control covers both human and vehicular traffic within the controlled environment; and sanitation deals with the cleanliness and disinfection of materials, people and equipment entering the controlled environment. Based on these components, risk factors associated with biosecurity implementation on farm may be determined and analysed.

The level of biosecurity achieved by farms can be measured in a number of ways from farm input to susceptibility of birds. This study focused on three main areas of risk:

- *Level of biosecurity at the farm gate*; fence and lock, number of entrances, parking and vehicle washing, signs around perimeter, footbath to enter farm, shower and change room for visitors and employees, whether using own cages when selling live chickens, whether cages and equipment returning from market are cleaned and disinfected before re-entering the farm.
- *Level of biosecurity between the farm gate and the shed*; feed shed sealed against rodents and birds, tap overflows, spilt feed, chickens and ducks wandering around the shed.
- *Level of biosecurity at the shed door*; shed walls made of good material, shed locked at all times, signs at the doors, concrete footbath in front of shed entrances with disinfectant, wild birds and rodents entering the shed, and steps taken to prevent entry of wild birds and rodents.

These risk areas encompass the three major components of biosecurity according to the WHO criteria: isolation, traffic control and sanitation. Each biosecurity control measure (there were 44 in total) was measured as either a low, medium or high response. These measures were then given a similar weighting and aggregated into a individual farm Biosecurity Control Score (BCS). This aggregated BCS was then divided into three categories: low, medium and high[1].

Farmer investment in biosecurity was estimated based on the amount spent on farm by the farmer to protect their business. It includes the cost of activities that the farmer can choose to do to minimise risk, from the boundary, to the entrance to the shed. For example, farm fences and locks, foot bath availability and use, type of sheds are some examples of costs that can be controlled by farmers to make their business secure. The total amount spent on

[1] For a fuller discussion and description of the BCS, see Patrick and Jubb (2010)

biosecurity of each respondent is then divided by the size of farm to determine how much money spent on biosecurity per bird. A simple regression model was carried out to identify if there is any relationship between farmer investment on biosecurity and farm size for both type of farms.

3. Characteristics of respondents

There are marked differences in chicken management between broiler and layer farms in Bali. Table 2 reveals that most broiler farms are under contract management, while the layer farms are generally independently owned and managed. A contract is usually made by poultry companies to produce broilers. The contract conditions may vary between companies, but the basic principle is that farmers are guaranteed a certain price for broilers produced under the conditions agreed in the contract. These conditions include purchasing day old chicks (DOCs) and feed from the company, receiving company technical support and selling finished product back to the company. In most contracts birds belong to the farmer and inputs paid by the farmer after chicken are sold back to the company.

Table 2: Distribution of respondents according to their contractual arrangement

Chicken management	Broiler		Layer	
	Respondents	%	Respondents	%
Contract	49	82	2	3
Independent	11	18	58	97
Total	60	100	60	100

On average, layer producers have nearly twice as much experience of farming as broiler producers, the average experience of layer producers being 14.4 years, compared to 6.4 years on broiler farms (Table 3).

Table 3: Average years of experience and farm size of respondents in Bali

	Broiler	Layer
Years of experience on farm	6.4	14.4
Number of sheds	1.3	5.2
Land size (m^2)	1,298	1,600
Number of chicken managed	4,875	21,982

Table 3 also shows that, on average, layer farmers also tend to have more sheds, a larger area of land, and a larger number of chickens managed than broiler producers. This information is discussed later as it is relevant to the cost spent for biosecurity enhancement on farms.

Distribution of respondents according to quartile farm size is presented in Table 4. Quartile I represents small farm, Quartile II refers to medium-small, Quartile III denotes medium-large and finally Quartile IV corresponds to large farm. As Table 4 shows, the majority of respondents from both broiler and layer farms are involved in small-scale commercial production. It is evident from the table that 75 per cent of broiler farmers manage less than 8,000 birds, while only 25 per cent of layer farms own more than 20,000 birds.

Table 4: Distribution of respondents according to bird population

Quartile	Broiler		Layer	
	Birds	% from the total birds	Birds	% from the total birds
I (small)	<3,000	10	<4,200	3
II (med-small)	3,000-5,000	17	4,200-8,000	7
III (med-large)	5,000-8,000	28	8,000-20,000	13
IV (large)	>8000	47	>20,000	77

4. Biosecurity on poultry farms in Bali

As previously mentioned, this study focused on the implementation of biosecurity from farm gate to the chicken shed.

4.1 Level of biosecurity at farm gate

Biosecurity implementation on farms can be evaluated initially in terms of the risk associated with the farm boundary and entrance. Results from the survey showed that broiler farms tend to have a less secure boundary than that of the layer farm (Table 5).

Table 5: Level of biosecurity at the farm boundary

Risk Factor	Broiler		Layer	
	Yes	No	Yes	No
• A secure boundary fence that is able to stop people and animal entering the farm	14 (23%)	46 (77%)	36 (60%)	24 (40%)
• All farm entrances have a lock	28 (47%)	32 (53%)	34 (57%)	26 (43%)
• The gates are kept locked at all times until permission is granted to enter	22 (37%)	38 (63%)	21 (35%)	39 (65%)
• A dedicated parking area for all vehicles outside the farm	16 (27%)	44 (73%)	30 (50%)	30 (50%)
• A footbath as you enter the farm	22 (37%)	38 (63%)	11 (18%)	49 (82%)
• People and animals step over or walk around the footbath	7 (32%)	15 (68%)	4 (36%)	7 (64%)

Boundary fencing on layer farms is more concerned with stopping people and animals entering the farm with a secure barrier, and in a majority of cases all farm entrances were locked. However for the majority of broiler and layer farms alike, gates were not kept locked at all times. Only a minority (less than 40 per cent of respondents from both broiler and layer farms) lock their gates at all times until permission is granted to enter (Table 5).

Another poorly performing area of biosecurity for both farm types is the relatively low concern over using a dedicated parking area for all vehicles, 73 per cent and 50 per cent of respondents from broiler and layer farms respectively do not have a designated parking area outside the farm (Table 5). Mostly, vehicles are parked on the road near the farm entrance or inside the farm. Meanwhile, only a small number of respondents set up a footbath at the farm entrance (37 per cent from broiler farms and 18 per cent from the layer farms). Of those who establish a footbath at the farm entrance, most are easily avoided by people and animals.

Table 6 shows the level of biosecurity at farm gate for both broiler and layer producers. It shows that layer farmers have implemented better biosecurity with regard to fencing and locks. This was supported by high number of layer farm respondents applying this type of biosecurity. Another good biosecurity practice on the majority of layer farms is that unsold eggs do not get returned to farm, reducing the possibility of disease spread from the market.

Table 6: Level of biosecurity at farm gate

Risk factor	Level of biosecurity for broiler			Level of biosecurity for layer		
	Low	Med	High	Low	Med	High
• Fence and lock	27 (45%)	11 (18%)	22 (37%)	16 (27%)	12 (20%)	32 (53%)
• Number of entrance	5 (8%)	6 (10%)	49 (82%)	7 (12%)	8 (13%)	45 (75%)
• Parking and vehicle washing	40 (67%)	15 (25%)	15 (25%)	26 (43%)	27 (45%)	7 (12%)
• Sign around perimeter	52 (87%)	6 (10%)	2 (3%)	56 (93%)	1 (2%)	3 (5%)
• Unsold eggs get returned to farm				12 (20%)	0	48 (80%)
• Activity family living off-farm family enter the property	46 (77%)	0	14 (23%)	43 (72%)	0	17 (28%)
• Activity non-family employees living off-farm enter the property	36 (60%)	0	24 (40%)	36 (60%)	0	24 (40%)
• Activity visitors enter the property	56 (93%)	0	4 (7%)	52 (87%)	0	8 (13%)
• Shower and change room for visitors and employees	9 (15%)		51 (85%)	10 (17%)		50 (83%)
• When selling live chickens do you use your own cages	5 (8%)	55 (92%)		10 (17%)	50 (83%)	
• Cages and equipment returning from market cleaned and disinfected before reentering farm	44 (73%)		16 (27%)	45 (75%)		15 (25%)

This study also found that both layer and broiler farms have poor utilization of signs to warn visitors and employees of restricted access to certain areas into the farm. Only 8 per cent of broiler and 7 per cent of layer farm respondents put up signs, ranging from one to four in number. Overall, it can be said that layer farms have more effective biosecurity measures in place than broiler farms.

Both broiler and layer producers have paid attention to the number of entrances on their farm, shown by high level of biosecurity achievement in this area (Table 6). This implies that both farms have a limited number of access points to the farm, reducing the risks associated with traffic of animal and people onto the farms. Shower and change room facilities for visitors and employees are also relatively common on both farm types (Table 6).

Despite the low performance of biosecurity viewed on broiler farms, there are two good things applied on the farm to reduce the virus spread into the farm. Firstly, the number of entrances is small (83 per cent of respondents are considered to have a high level of biosecurity in this area). Secondly, shower and changing rooms for visitors and employees

are sufficient to receive a high level biosecurity rating (85 per cent of broiler farms surveyed had adequate facilities).

4.2 Level of biosecurity between the farm gate and the shed

While there is a need to reinforce biosecurity implementation at the farm gate for both broiler and layer farms, the likelihood of the HPAI virus spreading from the farm gate to the shed is lower on broiler farms than layer farms (Table 7). Feed sheds sealed against rodents and birds, overflow taps, split feed and chickens and ducks wandering the shed are better managed in broiler farms than in layer farms. In all these areas, the majority of respondents from broiler farms have achieved a high level of biosecurity.

Table 7: Level of biosecurity between the farm gate and the shed

Risk factor	Level of biosecurity for broiler			Level of biosecurity for layer		
	Low	Med	High	Low	Med	High
• Feed is sealed against rodents and birds	28 (47%)		32 (53%)	36 (60%)		24 (40%)
• Tap overflows	4 (7%)		56 (93%)	8 (13%)		52 (87%)
• Split feed	9 (15%)		51 (85%)	37 (62%)		23 (38%)
• Chickens and ducks wandering around the shed	17 (28%)	7 (12%)	36 (60%)	22 (37%)	3 (5%)	35 (58%)

Broiler farms tend to have a separate shed for the feed, This may be a contractual obligation for these farmers. Free-ranging chickens and ducks were still commonly found around the shed on both layer and broiler farms, however in both cases the level of biosecurity achieved is rated as high for the majority of farms. This implies that the number of free-ranging chickens and ducks wandering the shed can be limited.

4.3 Level of biosecurity at the shed door

Taking action to enhance biosecurity implementation on farms can also be observed within the shed. For the majority of farms the shed walls were made of good quality materials (Table 8). In addition, sheds are mostly locked at all times ensuring only selected people are allowed to enter.

The data presented in Table 8 also suggests that signage on shed doors is neglected on nearly all farms. Furthermore, provision of a concrete footbath in front shed entrance is negligible for layer farms.

It is clear from the survey that wild birds and rodents are able to freely enter the sheds; approximately 90 per cent of respondents are rated as low biosecurity score in this area. However, actions have been taken by farmers to prevent entry of wild birds and rodents by minimising gaps between boards in wall, building sheds off the ground, and the occasional use of rat bait. Interestingly, bird-proof netting is rarely used.

Table 8: Level of biosecurity at the shed door

Risk factor	Level of biosecurity for broiler			Level of biosecurity for layer		
	Low	Med	High	Low	Med	High
• Shed wall made of good material	29 (48%)		31 (52%)	13 (22%)	0	47 (79%)
• Shed locked at all times	16 (27%)		44 (73%)	23 (38%)		37 (62%)
• Signs at the door	60 (100%)		0	56 (93%)		4 (7%)
• Concrete footbath in front of shed entrances and disinfectant	23 (38%)	22 (37%)	15 (25%)	53 (88%)	7 (12%)	0 (0%)
• Wild birds and rodents can enter the sheds	53 (88%)	0 (0%)	7 (12%)	59 (98%)	0	1 (2%)
• Things have been done to prevent entry of wild birds and rodents		42 (70%)	18 (30%)		45 (75%)	15 (25%)

5. Farmer investment in biosecurity

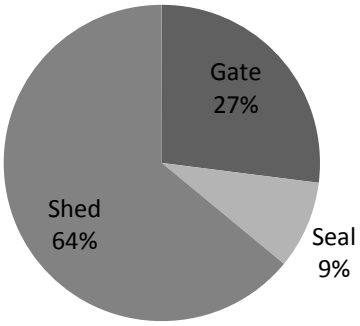
The above discussion indicates that broiler farms, to a large extent, have higher biosecurity implementation than that of layer producers. This may be because broiler producers, who are mostly under contract to companies, have many obligations that they must meet as prerequisites for obtaining a contract. In addition, broiler farms may receive good technical support from the company. All actions taken by farmers to protect their business is expected to be in line with the amount spent to make it secure. A larger farm size may spend more in biosecurity than the smaller farm.

In this study, farmer investment in biosecurity is divided into three parts; costs incurred at the farm gate, between farm gate and the shed and at the shed door. The biosecurity cost does not include the cost of feed and supplements as they are considered to be costs of production. In fact, it is expected that purchasing processed feeds from reputable sources may reduce the risk of disease outbreak. The amount spent on those activities was estimated over a four month period and is presented as part of the farmer investment into biosecurity. Although it may not reflect the entire farmer investment into biosecurity, it gives the idea of how much is spent to protect the business.

The average amount spent in biosecurity measures for broiler farms was Rp.443/bird, ranging from Rp.251 to Rp.1,442. On the other hand, layer producers spent Rp.687/bird, (Rp.261 to Rp.4,470). It is clear that layer producers spent about 50 per cent more on biosecurity than broiler farmers.

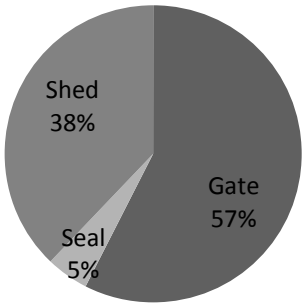
Biosecurity investment in layer farms is higher than on broiler farms. This may be because layer farmers tend to be independent producers, hence responsible for their own risk, and also layer chickens require a greater investment and are more difficult to replace. Broiler respondents invested a greater proportion on biosecurity at the shed door and within the shed (Figure 1).

Figure 1: Distribution of biosecurity cost of broiler farm in Bali



The shed investment comprises the amount spent on shed walls, locks, signage, footbaths and disinfectant. Layer producers spent a greater proportion on the boundary fence and entrance; 57 per cent of the biosecurity investment (Figure 2). Farm gate investment includes boundary fence, parking facilities, signs around perimeter and footbath availability. However, it is must be remembered that the investment in some of these infrastructure components such as fences and locks have security as well as biosecurity benefits, hence the total cost of these cannot solely be attributed to biosecurity.

Figure 2: Distribution of biosecurity cost of layer farm in Bali



The 'seal' section in Figures 1 and 2 represents the percentage spent on biosecurity activities between the farm gate and the shed. This is predominantly the management of the feed shed. Both farm types invested only a small percentage (less than 10 per cent). Investment in biosecurity between the farm gate and the shed is higher in broiler farms, broiler respondents spent 9 per cent, while the layer respondents used only 5 per cent of the total biosecurity investment between the farm and shed gates.

Larger farm size, to some extent, may encourage farmers to invest into biosecurity enhancement to protect their business. This is logical because the larger the farm, the more likely a biosecurity risk and the greater the potential losses. Average returns to biosecurity would increase with the size of the flock. This study found that the larger the layer farm, the

higher the investment in biosecurity (Table 9). However, this is not the case for broiler producers. The larger-scale broiler farmers (Quartile IV) spent less than the medium-small farms (Quartile II).

Table 9: Average cost spent on biosecurity for broiler and layer farms in Bali

Quartile	Average cost spent for broiler (Rp/bird)	Average cost spent for layer (Rp/bird)
I	555	636
II	422	713
III	374	620
IV	418	781

It is interesting to explore the reasons why smaller scale broiler producers spent more on biosecurity than bigger farms. The survey response suggested that small broiler farms used more money to enhance their biosecurity performance for certain numbers of birds. This could be due to poultry companies requiring better management from small broiler farms in order for them to continue their contract. It could also be a matter of economies of size. Contract companies demand the same levels of biosecurity in all their farms irrespective of size. Therefore, if there is a fixed cost component the average cost per bird would be higher in smaller farms.

A simple linear regression was carried out to determine if there is any significant relationship between money spent for biosecurity and the size of farm. The linear regression result indicated that there is significant relationship (although at the 90 per cent level of significance) between biosecurity investment and the size of the broiler farm. The coefficient of determination was 0.049 indicating that only almost 5 per cent of the variation of the amount spent in biosecurity can be explained by the variation of the farm size. The other 95 per cent of the variation is explained by other variables not included in the model. This linear regression result is presented in Table 10.

Table 10: Linear regression result for money spent on biosecurity and the size of broiler farm

	Coefficient	T test	Sig
Size of farm	-0.010	0.006*	-1.726
Constant	500.786	39.507	0.000

Remark: $R^2 = 0.049$

Negative sign on the regression result for money spent on biosecurity and the size of broiler farms suggests large farms have economies to size in biosecurity. A policy implication of this may be that contract companies should be encouraging broiler producers to get bigger to better spread the cost of biosecurity investment.

On the other hand, another linear regression suggests that there is no significant relationship between the amount spent on biosecurity and the farm size for layer producers (Table 11).

Table 11: Linear regression result for money spent on biosecurity and the size of layer farm

	Coefficient	T test	Sig
Size of farm	0.001	0.521	0.001
Constant	-7.478	-2.036	0.046

Remark: $R^2 = 0.005$

6. Conclusion

The results of this study suggest that broiler and layer producers have a similar investment in biosecurity between the farm gate and the shed. However, there is a slight difference with regard to a secure boundary fence and the use of locks on gates. Layer farm producers tended to have more consideration of these factors. On the other hand, broiler producers showed a higher biosecurity investment at the shed level compared to layer producers.

In terms of cost spent on biosecurity, on average, there is quite big difference between broiler and layer producers. Broiler farms spent Rp.443/bird on biosecurity measures, while layer producers spent Rp.687/bird.

The linear regression result indicated that there is significant relationship between money spent on biosecurity and the size of farm for broiler producers. However, linear regression revealed no significant relationship for layer producers.

The study provides information upon which to plan and determine the most cost-effective approach to improve the implementation of biosecurity on small scale layer and broiler farms in Indonesia. It provides preliminary information on the farm investment decision and the farm areas where this investment may have the biggest pay-off.

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