# Farmer investment into biosecurity on broiler and layer farms in Bali[4]

Ambarawati I.G.A.A.[1], Bugie Kurnianto Prasetyo[2] and Ian Patrick[3]

[1]Agribusiness Study Program, Faculty of Agriculture, Udayana University, Bali, Indonesia, email; iambaraw@yahoo.com
[2]Indonesian Poultry Biosecurity Centre , Faculty Of Veterinary Medicine-Bogor Agricultural University Jl. Agathis Kampus IPB Darmaga, Bogor 16680, Indonesia.
[3]Instutute for Rural Futures, University of New England, Armidale, New South Wales 2351, Australia

## Abstract

This paper discusses the implementation of biosecurity on farms, both broiler and layer, in Bali. Farmer investment in biosecurity is discussed to determine if there is any difference in the implementation of biosecurity on both farm types. While secure boundary fencing and farm gate locks are more common on layer farms, broiler producers are more likely to have a footbath in front of the shed. In this analysis, biosecurity investments only include shed maintenance and chlorination. On average, there is not much difference between small and big layer farms with regard to the amount spent on these biosecurity activities. There was no significant relationship found between amount spent on biosecurity (maintenance and chlorination) and farm size for broiler producers, however there was a significant relationship between these variables for layer producers. Although this study does not include all biosecurity investments on farms, it does provide some idea on how money is spent to protect farm businesses. The study requires a further breakdown of what is spent by farmers on biosecurity, including on farm fences and locks, foot baths, installation of water sources, cost of feed and feed sources. This information would allow more detailed consideration of cost-effective biosecurity implementation on poultry farms.

Key words: biosecurity, poultry, investment, Bali.

## 1. Introduction

High Pathogenic Avian Influenza Virus (HPAI H5N1) has potential impacts on poultry production and human health. Outbreaks have impacted many areas of the poultry industry, including broilers, layers, *kampung* (village) chickens and ducks. The United Nations Food and Agriculture Organization (FAO) identified four factors that facilitate the spread of HPAI 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 (LBM) have a high capacity to spread the virus (Sims (2007)). This is because the markets receive and distribute large numbers of mainly uninspected birds of indeterminate infectious status, with a tendency towards extensive inter-species mixing. Finally, unsafe food preparation, which involves 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 applies to public health measures that reduce contact between animals and humans (WHO 2006).

FAO has defined the four sectors (Sector 1 to 4) of the poultry industry, these are 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 includes 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

[4] This paper is a companion paper for the paper by Prasetyo, Ambarawati and Patrick also presented at this workshop, therefore some sections are similar or the same, the papers will be combined into one paper when the analysis is complete.

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 a goal of improving biosecurity measures in Sector 3, a focus group discussion was carried out involving related post-farm gate stakeholders of the poultry sector in Bali (Sarini 2009). The results of this discussion suggested 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 Sector 3 broiler and layer farms in Bali. It then discusses correlations between farmer investment and biosecurity level.

## 2. Methodology

### *2.1 Survey location and respondents*

A survey was conducted in Bali in April 2009, covering six *Kabupaten* (Regencies/Districts). The survey location was deliberately chosen, based on the poultry population and AI 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); 60 layer and 60 broiler farmers were interviewed. Table 1 summarises the number of respondents in each Regency.

**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 Biosecurity*

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 biosecurity adopted by farmers can be measured in a number of ways from source of farm inputs to susceptibility of birds. The survey collected information from farmers which determined both the risks faced and the control measures adopted. These risks and responses can be categorised into seven areas:

- Risks associated with farm inputs
- Traffic onto the farm
- Distance from shed to sources of risk
- Vulnerability of farm given its size and location
- Biosecurity at the farm gate
- Biosecurity between the farm gate and the shed

- Biosecurity at the shed door
- Traffic into the sheds
- Susceptibility of layer flock

Farmers' responses to questions were ranked with regard to their perceived effect on minimising disease risk. This allowed each farm to receive a final ranking score which identified their 'biosecurity status'. This measure includes both the risks that the farm faced and their response to these risks.

### *2.3 Data analysis*

The discussion below provides some descriptive results with regard to three important biosecurity risks (biosecurity at the farm gate, between the farm gate and the shed and biosecurity at the shed door). It then selects some elements of biosecurity (shed maintenance and water chlorination) and undertakes some preliminary analysis to examine whether or not farm type or farm size has any influence on the level of investment into biosecurity.

## 3. Survey results

### *3.1 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. Farmers are guaranteed a certain price for broilers produced under the conditions agreed to in the contract. Layer farms are generally independently owned and managed.

**Table 2: Distribution of respondents according to their chicken management**

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

On average, layer producers have over twice the experience of farming as broiler producers, the average experience of layer producers being 14.37 years, compared to 6.37 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 | 8,929 |

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

As Table 4 shows, the majority of respondents from both layer and broiler farms are involved in small-scale commercial production. This categorization was based on the average number of chickens managed by farmers. Small broiler farmers manage less than 5,000 birds, while the small layer producers own less than 9,000 birds. Approximately 60 per cent of broiler producers manage less than 5,000 birds, while 75 per cent of layer farmers manage less than 9,000 birds.

**Table 4: Distribution of respondents according to farm size**

| Farm Size | Broiler | | Layer | |
|---|---|---|---|---|
| | Person | % | Person | % |
| Small | 36 | 60 | 45 | 75 |
| Large | 24 | 40 | 15 | 25 |
| Total | 60 | 100 | 60 | 100 |

### *3.2 Biosecurity on poultry farms in Bali*

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

#### *3.2.1 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 layer farms (Table 5).

**Table 5: Risk factor associated with boundary and entrance**

| 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 boundary fence, and in the majority of cases all farm entrances have locks. However, the majority of broiler and layer farms do not keep their gates locked at all times. Only a minority (less than 40 per cent of respondents from both broiler and layer farms) lock their gates until permission is granted to enter.

There is also a low use of a dedicated parking area for 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. Also, only a small proportion of respondents have a footbath at the farm entrance (37 per cent of broiler farms and 18 per cent of the layer farms). Of those who establish a footbath at the farm entrance, it is still generally found that people and animals can step over or walk around the footbath.

Table 6 shows the level of biosecurity at the farm gate for both broiler and layer producers. It shows that layer farms have implemented better biosecurity measures, again with regards to fencing and locks. This was supported by high number of layer farm respondents applying this form of biosecurity. Another good biosecurity practice carried out on the majority of layer farms is that unsold eggs do not get returned to farm, reducing the spread of viruses 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 entrances | 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 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%) | 0 | 51 (85%) | 52 (85%) | 0 | 50 (83%) |
| When selling live chickens do you use your own cages | 5 (8%) | 55 (92%) | 0 | 10 (17%) | 50 (83%) | 0 |
| Cages and equipment returning from market cleaned and disinfected before reentering farm | 44 (73%) | 0 | 16 (27%) | 45 (75%) | 0 | 15 (25%) |

The study also found that both farm types have poor biosecurity performance with regard to signs to warn visitors and employees that access is restricted on certain areas into the farm. Only 8 per cent of broiler and 7 per cent of layer farm respondents put up signs. Overall though, the data suggests 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 the high level of biosecurity achieved in this area (Table 6). This implies that both farm types generally have a limited number of access points to the farm, reducing the risk associated with people and animal traffic onto the farm. Shower and change room facilities for visitors and employees are also relatively common on both farm types (Table 6).

Despite the overall low level of biosecurity found on broiler farms, two useful measures have been employed to minimise the spread of viruses onto these farms. Firstly, the number of entrances is limited (83 per cent of respondents have a high level of biosecurity in this area). Secondly, shower and change rooms for visitors and employees were sufficient to receive a high biosecurity rating on 85 per cent of broiler farms surveyed.

*3.2.2 Biosecurity between the farm gate and the shed*

While there is a need to reinforce biosecurity implementation at farm gate for both broiler and layer farms, the likelihood of the HPAI virus spreading in the area between the farm gate and the shed is lower on broiler farms than layer farms. This can be seen from the level of biosecurity achieved in this area by broiler farms (Table 7). Risk factors including whether feed is sealed against rodents and birds, overflow taps, spilt feed and chickens and ducks wandering the shed are better managed on broiler farms than on 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%) |
| Spilt 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 are considered to have adopted a high level of biosecurity in terms of feed sealed against rodents and birds because most farms have a separate shed for feed, and it is kept in a protected place. As most broiler farms are under contract with integrated poultry companies, a safe place for feed could be one of the contract conditions.

Free-ranging chickens and ducks wandering around sheds were still commonly found on both types of farm, however in both cases the level of biosecurity achieved is considered high for the majority of farms. This implies that the number of free-ranging chickens and ducks wandering around sheds is small.

### *3.2.3 Biosecurity at the shed door*

Taking action to enhance biosecurity implementation on farm can be observed in the shed. It is very encouraging that, for the majority of farms of both types, the shed walls were made of good material to protect the birds from virus spread (Table 8). In addition, sheds were mostly locked at all times ensuring only selected people are allowed to enter.

However, 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 shed, approximately 90 per cent of respondents achieving a 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 on the wall, building sheds off ground, and 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 used | 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%) |

## 4. Farmer investment in biosecurity

Farmer investment in biosecurity is the amount spent on farm by the farmer to make it secure. This includes the cost of farm fencing and locks, foot bath availability, type of water source and chlorination, type of feed and feed source, and maintenance of the shed. In this study, the cost of shed maintenance and chlorination over a four month period is presented to illustrate farmer investment into biosecurity. Although it may not reflect the entire investment into biosecurity, it does give some idea as to how much is spent to protect the business.

One limitation of the study is that the cost of shed maintenance is influenced by the year the shed was built. Accordingly, the figure presented does not include the whole investment of farmers in

their sheds. For instance, if the farmers did not carry out any repairs during the four-month period, it suggests that nothing is spent on shed maintenance, whereas in fact the farmer may have spent their money on maintenance before the survey was conducted.

A larger farm size, to some extent, may encourage farmers to invest more in biosecurity enhancement to protect their business. This is logical because the larger the farm, the more likely a biosecurity problem may occur and the greater the potential loss from a disease incident. This study found that only 30 broiler farm respondents (50 per cent), and 36 layer farm respondents (60 per cent), were concerned about enhancing biosecurity on their farms over the four month period (Table 9). This included repair and maintenance (R&M) of the sheds as well as water chlorination. However, as Table 9 also shows, small farms tended to do more R&M than the large farms.

When looking more closely at the data presented in Table 9, there are marked differences in number of birds and amount spent on R&M on farms. Broiler farm respondents spent Rp.1.7m for 134,500 birds, while layer farm respondents spent Rp.252.8m for 349,100 birds in the last four months. That is, layer farms spent three times the amount of broiler producers, though the number of birds was only 2.5 times higher. On average, there is not much difference in amount spent for small and big layer farms on R&M. Big layer farms spent Rp.703/bird, whereas Rp.770/bird was spent on small layer farms. In contrast, big broiler farms spent Rp.397/bird on biosecurity measures, while more than twice this amount was spent on small broiler farms, amounting to Rp.857/bird.

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

| | **Broiler** | | | **Layer** | | |
|---|---|---|---|---|---|---|
| | Small | Large | Total | Small | Large | Total |
| Number of respondents | 20 | 10 | 30 | 26 | 10 | 36 |
| Money spent (Rp.m) | 52.7 | 29.0 | 81.7 | 84.4 | 168.4 | 252.8 |
| Number of birds | 61,500 | 73,000 | 134,500 | 109,600 | 239,500 | 349,100 |
| Average money spent on R&M (Rp./bird) | 857 | 397 | | 770 | 703 | |

It is interesting to explore the reasons why small broiler producers spent so much more on R&M than large producers. The survey response suggested that small broiler farms used more money to fix and maintain the sheds for certain numbers of birds. This could be due to poultry companies asking for a better performance from small broiler farms in order to continue their contract. It could also be a matter of economies of size.

Correlation analyses to determine whether there was a relationship between amount spent on R&M and farm size for both broiler and layer farms were carried out. Using Spearman's correlation test, a very weak correlation was found between amount spent and size of farm both for broiler and layer producers. Spearman's correlation coefficient for broiler farms was 0.081 (insignificant). A similarly insignificant result was obtained for layer farmers, where the Spearman's correlation coefficient was 0.226.

A simple linear regression was also carried out to determine if there was any significant relationship between amount spent on R&M and farm size. The linear regression result also indicated that there was no significant relationship between amount spent on R&M and the size of farm for broiler producers. 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 | 0.256 | 0.318 | 0.752 |
| Constant | 1.721 | 1.439 | 0.155 |

Remark: $R^2 = 0.042$

However, linear regression suggests there is a significant relationship between the amount spent on biosecurity and farm size for layer producers (Table 11). The coefficient of determination was 0.404, indicating that only approximately 40 per cent of the variation of money spent on biosecurity can be explained by the variation of farm size. The other 60 per cent of the variation is explained by other variables not included in the model.

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

| | Coefficient | T test | Sig |
|---|---|---|---|
| Size of farm | 9.353 | 3.368* | 0.001 |
| Constant | -7.478 | -2.036 | 0.046 |

Remark: $R^2 = 0.40$ * = significant at 99%

Another linear regression was conducted to distinguish if there was any difference regarding the amount spent on R&M for broiler and layer producers. The result suggests a significant relationship between the amount spent on R&M for broiler and layer farms (Table 12). This significant result confirms that layer producers spend a lot more than broiler producers.

**Table 12: Linear regression result for money spent on biosecurity for broiler and layer farms**

| | Coefficient | T test | Sig |
|---|---|---|---|
| Type of farm | -2.852 | -2.095** | 0.001 |
| Constant | 7.065 | 3.283 | 3.283 |

Remark: $R^2 = 0.189$ ** = significant at 95%

This is an important result to further support producers to enhance their biosecurity measures. The coefficient of determination for this regression was only 0.189, implying that approximately 19 per cent of variation of the amount spent on R&M is explained by the variation in farm size. The rest is explained by other variables that are not included in the model.

## 5. Conclusions

The results of this study suggest that a similar profile of biosecurity implementation from farm gate to the sheds exists for both broiler and layer producers. However, there was a slight difference with regard to boundary fences and locks, where layer farm producers are more likely to consider these factors. On the other hand, broiler producers were more likely to provide footbaths in front of the shed compared to layer producers.

In terms of amount spent on R&M, on average, there is not much difference for small and big layer farms. Big layer farms spent Rp.703/bird on R&M, whereas Rp.770/bird was spent on small farms. In

contrast, big broiler farms spent Rp.397/bird on R&M activities, a figure that more than doubled on small farms, amounting to Rp.857/bird. The study found that there was a very weak (though statistically insignificant) correlation between amount spent and size of farm for both broiler and layer producers.

Similarly, the linear regression result indicated that there was no significant relationship between amount spent on R&M and the size of farm for broiler producers. However, linear regression revealed a significant relationship for layer producers. Furthermore, analysis suggests a significant relationship regarding the amount spent on R&M when comparing broiler and layer farms.

The study provides a basis upon which to plan and determine the most cost-effective approach to improve the implementation of biosecurity at the point of production. In particular, it helps focus planning and action on those risk factors most likely to be involved in virus spread, and it allows the impact of measures on biosecurity enhancement to be assessed.

This study needs to be further refined by exploring in more detail the amount spent by farmers on other areas of biosecurity, including farm fences and locks, foot baths, water sources, and cost of feed and feed source. This information will allow a more complete analysis of farmer investments into biosecurity and the definition of cost-effective biosecurity activities for sector 3 farms in Indonesia.

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