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RISK ANALYSIS OF BROILER CHICKEN PRODUCTION IN CLOSED HOUSE SYSTEM FARMS WITH PARTNERSHIP PATTERNS IN SEMARANG CITY

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ABSTRACT

This study aims to analyze the expected income and the level of the coefficient of variance. Risk status as seen from the risk source's probability and impact (Value at Risk). It provides alternative strategies to handle the risk of broiler rearing business in the closed house system of the Faculty of Agriculture and Animal Husbandry, Diponegoro University. The analytical method used calculates expected income, variance, standard deviation, coefficient of variation, probability, and impact of production risk sources. The results showed that the due payment of the cage was Rp153,359,387.7 per period with a coefficient of variation level of 0.55. The mortality of broiler chickens is caused by the risk of climate change and disease. Sources of climate change risk have a risk probability level of 45.2%, and sources of disease risk of 40.3%, with each impact of Rp.7,268,931.2 for climate change and disease of Rp 2,799,263.1. An alternative strategy in dealing with heads of climate change and disease risk is using a preventive strategy method.

Keywords: *broiler chicken, production, risk management*

BACKGROUND

The livestock sub-sector has become a sub-sector with a substantial contribution to absorbing labor and can also play a vital role in restoring the economy in Indonesia. Poultry farm companies have the highest level of investment compared to other farms. The development of domestic investment from year to year continues to increase; it is recorded in the Directorate General of PKH (2019) that domestic investment for poultry farming companies in 2014 amounted to Rp 515,205 million and then increased to Rp 632,471 million in 2018. The poultry farming business in demand by the people of Indonesia is broiler chicken farming. The growth period of broiler chickens has a reasonably short period of 4-6 weeks. This is used by business actors to be commercialized because the production process is relatively short (Ekapriyatna, 2016). Broiler chicken farming can be run independently or in partnership.

The Faculty of Animal Husbandry and Agriculture, Diponegoro University (FPP UNDIP), has a broiler farm using a large-scale closed house system in Semarang with a partnership pattern. The capacity per production period is 11,000 chickens in cage A and 22,000 chickens in cage B, which are kept in two closed-house units. The problem faced by these farms is fluctuating production results due to various risk factors that arise during the production period. This study aims to determine the expected income, the level of the coefficient of variance, determine the risk status seen from the probability and impact of the risk source and provide alternative strategies to deal with the risk of broiler rearing business in the closed house system of FPP UNDIP.

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6 (1): 58-70, May 2022

RESEARCH METHODS

This research was conducted during one period of broiler chicken production on a closed house farm at the Faculty of Animal Husbandry and Agriculture, Diponegoro University. Determination of the location with the purposive method because the farm has a high production capacity in the Semarang area. The method used in this research is the case study method. Data collection was carried out through interviews with parties who directly role in rearing broiler chickens and made direct observations. The data collection method in this study was carried out using observation, interviews, and discussions using a questionnaire instrument. The production period of broiler chickens with a closed house system in FPP UNDIP closed-house farms is around 45-50 days. The data observed were secondary data on fast house FPP UNDIP farms, such as operational costs, fixed costs, and mortality rate data, with the limitation that the company did not perform a necropsy in identifying the cause of death of broiler chickens from the risk of climate change, cage density, labor, and disease. Respondents in the study were determined by a purposive approach considering that respondents could provide accurate data. Several parties who became respondents in this study, including supervisors from the core company, became the source for obtaining livestock production and income data. The second source is to the general manager and the cage staff who have experience in chicken rearing techniques.

Income Analysis

Income analysis in this study begins with calculating production costs and total revenue to generate income. Analysis of broiler farm income is calculated based on a mathematical equation according to Rahmah (2015), which is as follows:

$$\pi = TR - TC$$

$$TR = P \times Q$$

$$TC = TFC + TVC$$

Information:

TC : Total Production Cost (Rp/Period)
TFC : Total Fixed Costs (Rp/Period)
TVC : Total Variable Cost (Rp/Period)
R : Total Revenue (Rp/Period)
P : Production Price (Rp/Kg)
Q : Production quantity (Kg/Period)
Π : Income (Rp/period)

The risk analysis is calculated by considering the expected return value, analysis of variance, standard deviation, and coefficient of variation to determine the size of production risk obtained during the Closed-House FPP UNDIP cage production period.

Expected Return

The expected return is the rate of return or returns expected by investors on their assets or investments. The expected return calculation used is the equation used by Walpole (1992) as follows:

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

$$E(R)_i = \sum_{i=1}^{n} (P_i)(R_i)$$

Information:
E(R)i : Expected value (Rp)
Pi : The probability of getting revenue in period i

In the equation used by Walpole (1992), if the total probability of each event is 1, then mathematically, it can be written as follows:

$$Pi1 + Pi2 + Pi3 + \dots Pm = 1$$

Information:
Ri : Possible net income of period i (Possible Return)

The number of incidents in the closed house FPP UNDIP, namely in cage A, there were 19 events, while in cage B, there were 13 events. The probability value of the event is the same, which is 1. The expected return can be calculated by finding the average (mean) net income (return) of FPP UNDIP closed-house farms during the period or event; therefore, the equation used by Walpole (1992) is mathematical and can be written as follows:

$$E(R)_i = \frac{\sum_{i=1}^{n} R_i}{n}$$

Information:
E(R)i : Expected Return (Rp)
Ri : Possible net income of period i (Possible Return)
n : Number of observations

Variance

The calculation of the variance value in this study is calculated based on the equation adapted from Sofyan (2005), which is as follows:

$$\sigma^2 = \sum_{i=1}^{n} \frac{[R_{ij} - E(R)_i]^2}{n-1}$$

Information:
σ^2 : Variety or variance from return (Rp)
Rij : Return j period (Rp)
E(R)i : Expected Return (Rp)
n : Number of observations

According to Sofyan (2005), the standard deviation is the root of the variance value. Mathematically the calculation of the standard deviation can be written as follows:

$$\sigma = \sqrt{\sigma^2}$$

Information:
σ : Deviation standard (Rp)
σ^2 : Variety or variance from return (Rp)

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

Coefficient Variance

The probability of risk is also obtained using the calculation of the coefficient of variation (coefficient of variation) with the calculation formula used by Ismail (2018), which is as follows:

$$CV = \times 100\% \frac{\sigma}{E(R)_i}$$

Information:

CV : Coefficient of Variation

σ : Deviation standard (Rp)

E(R)i : Expected Return (Rp)

The smaller the coefficient of variance, the smaller the risk. The greater the value of the coefficient of friction, the greater the risk faced.

Risk Probability Analysis

The subsequent analysis to determine the possibility of risk occurrence is the standard value method or z-score. According to the calculation of Kountur (2008), in determining the value of the z-score, several steps must be applied, namely:

1. Calculating the average. Calculating the average is calculating the average mortality of broiler chickens caused by a risk per period. The formula used is:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Information:

$\bar{x}$: Average value (tail)

xi : Value per period per risk source (tail)

n : Number of periods

2. Calculating the standard deviation value. Standard deviation is a statistical value to determine the distribution of data in the sample. The formula used is (Kountur, 2008):

$$S = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n-1}}$$

Information:

S : Standard deviation per risk source (tail)

$\bar{x}$: Average per risk source (tail)

xi : Value per period per risk source (tail)

n : Number of periods

3. Calculates normal limits (X) and standard values (z-score). Calculating the normal limit (X) and the standard value (z-score) is used to find the probability of risk occurrence. The standard limit (X) of risk used is the number of chicken deaths that are considered normal by the manager or supervisor due to each risk source. Calculating the z-score value according to Kountur (2008) with the formula, namely:

$$Z = \frac{X - \bar{x}}{S}$$

ISSN 2580-0566; E-ISSN 2621-9778
http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

Information:
Z : The z-score of each risk source
X : Risk limit within normal limits (tail)
S : Standard deviation per risk source (tail)
$\bar{x}$: Average mortality of chickens (tails)

Risk Impact Analysis

The method used to calculate the impact of a risk is to determine the Value at Risk (VaR). The VaR value obtained is the most significant number of losses due to a risk that may occur at a particular time with a certain level of confidence. VaR calculation using the formula (Kountur, 2008):

$$\mathrm{VaR} = \bar{x} + (Z\frac{S}{\sqrt{n}})$$

Information:
VaR : Value at Risk
Z : z-score from every source of risk
S : Standard deviation per risk source (tail)
$\bar{x}$: Average value per risk source (tail)
n : Number of periods

Risk Mapping

After obtaining the z-score and VaR values for each risk, the two values will show the I/II/III/IV square coordinates on the risk map. Then from the quadrant shown, it will determine the right strategy for each risk source, namely the mitigation or preventive strategy. Risk mapping describes the position of a risk on a map from two axes, namely the vertical axis, namely probability, and the horizontal axis, namely impact.

RESULT AND DISCUSSION

General Condition of FPP UNDIP Closed-House Farms

FPP UNDIP closed-house farm is a plasma partnership with PT Cemerlang Unggas Lestari, a core subsidiary of PT Charoen Pokphand. The close house farm has two cages, cage A, which has an area of 12 x 60 m2 with 11,000 birds, and cage B with 12 x 120 m2 and 22,000 broiler chickens. The farm was established on 27 January 2017, starting with cage A and cage B on 23 September 2017. During the period 1 to 19, the average mortality rate was 1.3%, still in the normal category. According to Lacy and Vest (2000), the mortality of standard broiler chickens considered normal is about 4%.

Analysis of Expected Return

Based on the research results, the production report shows that the income of closed house farms FPP UNDIP fluctuates every period. The following is a graph of income fluctuations experienced by FPP UNDIP closed-house farms:

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

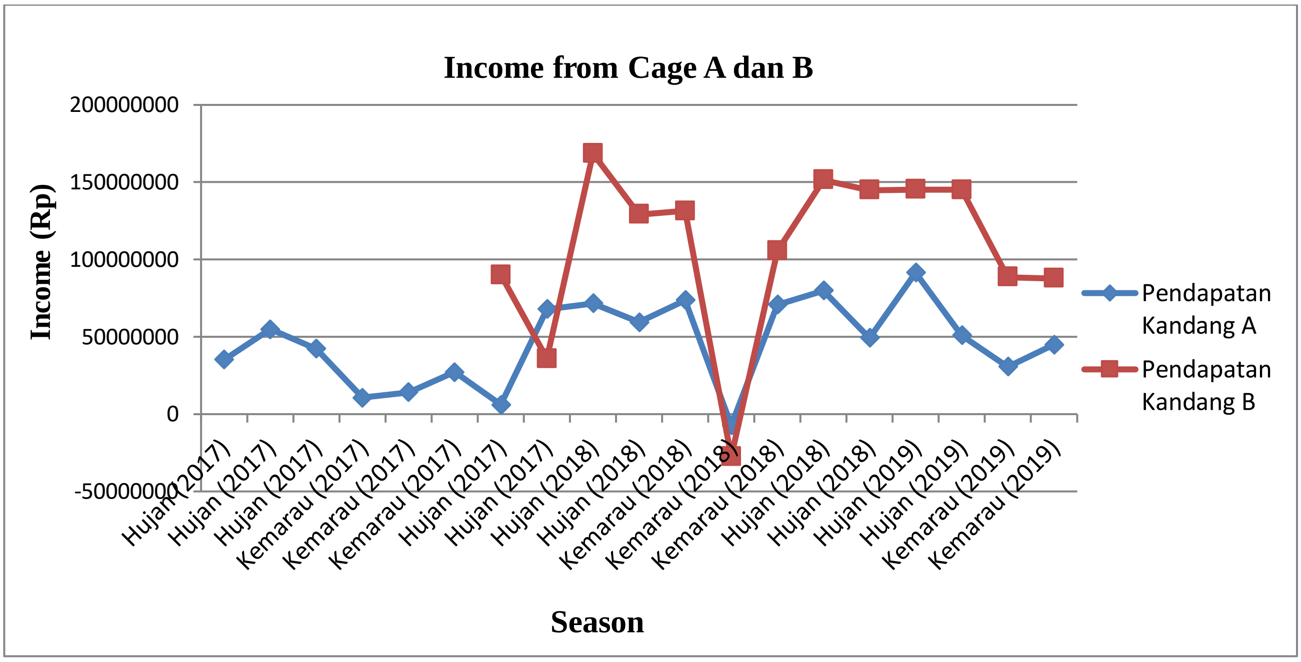

Figure 1. Graph of A and B Cage Income Fluctuations

In Illustration 1. income levels tend to decrease when entering the dry season and increase when entering the rainy season. This indicates a decrease in broiler production during the dry season. The following is the total income of FPP closed-house livestock companies from cages A and B:

Table 1. Value of Income Levels in Cage A and B

Cage A						
Period	**Year**	**Season**	**Mortality (%)**	**Reception (Rp)**	**Production cost (Rp)**	**Income (Rp)**
1.	2017	Rain	0.400	352,936,584	317,648,750	35,287,834
2.	2017	Rain	1.001	372,610,691	317,648,750	54,961,941
3.	2017	Rain	0.982	359,200,732.8	316,863,750	42,336,982.8
4.	2017	Drought	0.582	326,776,428.8	316,078,750	10,697,678.8
5.	2017	Drought	0.382	330,153,582	316,078,750	14,074,832
6.	2017	Drought	1.464	343,249,452	316,078,750	27,170,702
7.	2017	Rain	0.318	323,647,326	317,648,750	5,998,576
8.	2017	Rain	0.182	385,612,110	317,648,750	67,963,360
9.	2018	Rain	1.155	389,253,400	317,648,750	71,604,650
10.	2018	Rain	1.136	377,167,837.5	317,648,750	59,519,087.5
11.	2018	Drought	0.609	389,868,593.4	316,078,750	73,789,843.4
12.	2018	Drought	3.891	308,790,147.6	316,078,750	7,288,602.4
13.	2018	Drought	0.682	387,615,722.5	316,863,750	70,751,972.5
14.	2018	Rain	1.036	397,513,176	317,648,750	798,644,260
15.	2018	Rain	2.064	366,988,708.8	317,648,750	49,339,958.8
16.	2019	Rain	1.773	409,111,876	317,648,750	91,463,126
17.	2019	Rain	2.164	368,564,061.6	317,648,750	50,915,311.6
18.	2019	Drought	3.036	347,476,948	316,863,750	30,613,198
19.	2019	Drought	2.109	360,964,896	316,078,750	44,886,146
Average			**1.314**	**363,026.435.5**	**317,029.013,2**	**45,997,422.3**

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

Cage B						
Period	**Year**	**Season**	**Mortality (%)**	**Reception (Rp)**	**Production cost (Rp)**	**Income (Rp)**
1.	2017	Rain	1.209	720,690,746.4	630,705,000	89,985,746.4
2.	2017	Rain	0.786	668,115,739.2	632,275,000	35,840,739.2
3.	2018	Rain	0.318	800,795,880	632,275,000	168,520,880
4.	2018	Rain	0.950	761,364,465.4	632,275,000	129,089,465.4
5.	2018	Drought	0.941	761,434,344.2	629,920,000	131,514,344.2
6.	2018	Drought	3.350	601,526,017.4	629,135,000	27,608,982.6
7.	2018	Drought	0.382	734,668,152	629,135,000	105,533,152
8.	2018	Rain	0.191	783,017,888.4	631,490,000	151,527,888.4
9.	2018	Rain	0.450	777,040,909.7	632,275,000	144,765,909.7
10.	2019	Rain	2.732	777,575,463	632,275,000	145,300,463
11.	2019	Rain	2.068	777,283,274	632,275,000	145,008,274
12.	2019	Drought	2.050	718,460,899.2	629,920,000	88,540,899.2
13.	2019	Drought	1.950	717,606,771.2	629,920,000	87,686,771,2
Average			**1.337**	**738,429,273.1**	**631,067,307.7**	**107,361,965.4**

Note: The capacity of cage A is 11,000 chickens, and cage capacity is 22,000 chickens

Expected returns how much the average overtime of an investment or strategy (Ilmanen, 2011). Based on Table 1. FPP UNDIP closed-house farms have an average income value of Rp. 45,997,422.32 in cage A and Rp. 107,361,965,4 in cage B. Overall, the total expected return will be obtained by closed-house farms FPP UNDIP which is Rp. 153,359,387.7 for each subsequent period (Cateris Paribus Assumption).

Coefficient of Variance Analysis

An attempt to get lower production results than the previous production can be a production risk in the business (Harwood et al., 1999). In this study, production risk is calculated by finding the value of variance, standard deviation, and coefficient of variance (Table 2).

Table 2. Value of Variance, Standard Deviation, and Coefficient of Variance of Cages A and B

Risk Analysis	Cage A	Cage B
Value Variety	747,832,216,875,479	2,948,429,866,171,720
Standard Deviation	27,346,521.110	54,299,446.280
Coefficient of Variation	0.594	0.506

Note: The capacity of cage A is 11,000 chickens, and cage capacity B is 22,000 chickens

Based on Table 2. the coefficient of variance for closed house FPP UNDIP farms in cage A is 0.594, and cage B is 0.506. If the average coefficient of cage A and cage B is the income of a closed house farm, FPP UNDIP has a coefficient of variance level of 0.55, which means every Rp. 1 return received by the farm will result in a risk of 0.55. According to Sekarrini et al. (2016), if the value of CV (Coefficient Variation) is 0.5 then the business is likely to experience a low loss, while if the CV value > 0.5, then the business has an excellent opportunity to suffer losses. The closed house farm FPP UNDIP can suffer losses because it has a coefficient of variance level of more than 0.5, which indicates that there is a risk in the business.

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6 (1): 58-70, May 2022

Chicken Farm Production Risk

Production risk analysis, according to Kountur (2008), can be calculated by determining the probability level of the risk source that occurs using the standard value method (z-score), knowing the impact value of the risk source using the VaR method, and mapping the sources of risk faced by the company to determine the risk management strategy.

1. Risk Probability

The company can reduce the source of risk experienced to minimize losses resulting from a source of that risk. Based on observations and interviews, there are two sources of threat experienced by closed-house FPP farms: seeds of climate change and disease risks. According to Irawan et al. (2018), the risk of raising broiler chickens is from the density of the cage, labor, disease, and weather changes. Following are the results of the probability analysis due to each risk source:

Table 3. Risk Probability Value of Cage A and Cage B

Period	Number of Chicken Deaths			
	Due to Climate Change		Due to Disease	
	Cage A (tail)	Cage B (tail)	Cage A (tail)	Cage B (tail)
1	40	-	4	-
2	88	-	23	-
3	72	-	36	-
4	57	-	7	-
5	30	-	12	-
6	142	-	19	-
7	29	218	6	48
8	14	157	6	16
9	101	60	26	10
10	100	179	25	30
11	55	177	12	30
12	109	262	319	475
13	62	70	13	14
14	78	36	36	6
15	197	81	30	18
16	162	532	33	69
17	206	399	32	56
18	276	391	60	60
19	196	369	36	60
Total	**2014**	**2931**	**735**	**892**
Average	**106**	**225,4615385**	**38.68421053**	**68.61538462**
Standard Deviation	**72.07634841**	**155.7196281**	**69.36782206**	**124.0070821**
X	**100**	**200**	**20**	**40**
Z	**-0.083245061**	**-0.163508857**	**-0.269349822**	**-0.230756051**
Z-table value	**0.4681**	**0.4364**	**0.3974**	**0.4090**
Probability	**46.8%**	**43.6%**	**39.7%**	**40.9%**

Note: The capacity of cage A is 11,000 chickens, and cage capacity B is 22,000 chickens

According to Kountur (2008), a high-risk probability of 20% and above in general. Based on Table 3. the sources of climate change and disease risk have a high chance because more than 20%. The probability value of climate change risk is the highest probability level compared to the source

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

of disease risk. Many chickens die suddenly due to heat stress, especially during the dry season. The main factors that affect the efficiency of broiler production are stress due to heat in hot areas, summer, and climate change (Lin et al., 2006). Based on the interview results, the source of the disease risk has a high probability of being killed by CRD (Chronic Respiratory Disease) and colibasolysis. It has also been affected by an ND (Newcastle Disease) outbreak. Diseases often found in broiler chickens are colibasolysis, ascites, CRD, gumboro, ND, Pulorum, and Necrotic Enteritis (Wiedosari and Sutiastuti, 2015).

2. Impact Source of Risk

The death of broiler chickens due to the risk of climate change and disease is indeed a lost production, so the company's acceptance rate is reduced, which is part of the loss for the company. The following is the value of the impact of losses experienced by FPP UNDIP closed-house farms:

Table 4. Risk Impact Value of Cage A and Cage B

Period	Total Loss			
	Due to Climate Change		Due to Disease	
	Cage A (Rp)	Cage B (Rp)	Cage A (Rp)	Cage B (Rp)
1	1,275,816	-	127,581.6	-
2	2,981,176	-	779,171	-
3	2,350,857.6	-	1,175,428.8	-
4	1,690,118.4	-	207,558.4	-
5	894,960	-	357,984	-
6	4,452,381,6	-	595,741.2	-
7	849,398.4	7,156,983.6	175,737.6	1,575,849.6
8	486,759	4,768,780.8	208,611	485,990.4
9	3,579,440	2,168,928	921,440	361,488
10	3,441,190	6,191,645.8	860,297.5	1,037,706
11	1,941,687	6,122,465.4	423,640.8	1,037,706
12	3,152,508.9	7,339,301.2	9,226,149.9	13,305,985
13	2,177,756.2	2,323,230	456,626.3	464,646
14	2,819,606.4	1,270,922.4	1,301,356.8	211,820.4
15	6,644,258.4	2,845,133.1	1,011,816	632,251.8
16	6,072,019.2	19,136,891.2	1,236,892.8	2,482,040.4
17	6,984,759.6	14,281,965,6	1,085,011.2	2,004,486.4
18	8,902,600.8	12,906,753.6	1,935,348	1,980,576
19	6,505,044	12,180,542.4	1,194,804	1,980,576
Total	**67.202.337.5**	**98,693,543.1**	**23,281,196.9**	**29,540,046**
Average	**3,536,965.1**	**7,591,811**	**1,225,326.2**	**2.110.003.3**
Standard Deviation	**2,417,743.3**	**5,472,233.5**	**1,996,873.5**	**3,308,775.9**
Z (0.05)	**1.645**	**1.645**	**1.645**	**1.645**
Value at Risk (VaR)	**4,449,394.6**	**10,088,467.8**	**1,978,924**	**3,619,602,2**

Note: The capacity of cage A is 11,000 chickens, and cage capacity B is 22,000 chickens

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6 (1): 58-70, May 2022

Based on Table 4. the most significant impact of losses experienced by closed-house farms FPP UNDIP comes from the source of climate change risk with a 95% confidence level of Value at Risk and an error rate of 5%. The amount of loss is calculated based on the number of chicken deaths due to risk sources and multiplied by the contract price for the period. The following is the average value of the probability and impact of climate change and disease risk sources:

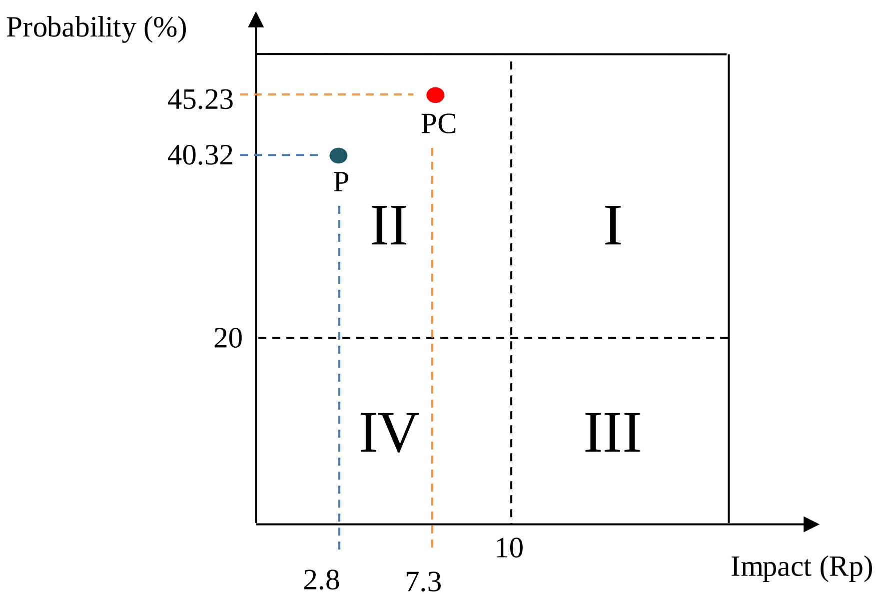
Table 5. Average Probability and Impact of Risk Sources

Pen	Climate Change Risk		Disease Risk	
	Probability (%)	Impact (Rp)	Probability (%)	Impact (Rp)
Cage A	46.8	4,449,394.6	39.7	1,978,924
Cage B	43.6	10,088,467.8	40.9	3,619,602.2
Average	45.2	7,268,931.2	40.3	2,799,263.1

According to Kountur (2008), in general, risks that have a probability of 20% and above, risks that have an impact of Rp. 10 million and above, can be said to have a significant effect. Still, some companies set Rp. 100 million, including oversized, depending on the management. Based on Table 5. the average impact value from climate change risk sources is Rp. 7,268,931.2, and the average impact value from disease risk sources is Rp. 2,799,263.1, which is still relatively low because it is under Rp. 10 million.

3. Risk Mapping

Risk mapping can be done after all risk sources have measured the level of probability and impact. The following is the result of mapping the sources of risk experienced by the company:



Information:
PC : Climate Change
P : Disease

Figure 2. Climate Change and Disease Risk Map

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http://ejournal2.undip.ac.id/index.php/agrisocionomics
6 (1): 58-70, May 2022

Based on the results of risk mapping from climate change and disease risk sources, the appropriate management strategy is a preventive strategy. Preventive strategies are carried out to deal with sources of production risk where the source of risk is in quadrant II position, namely risk that has a high probability. Kountur's (2008) statement states that the preventive strategy will seek to shift the risks in quadrant I to quadrant III and those in quadrant II to shift to quadrant IV.

4. Risk Management Strategy

Preventive risk management strategies to reduce the probability of climate change and disease risk sources on FPP farms. The following are alternative preventive strategies to reduce the likelihood of climate change and disease risks:

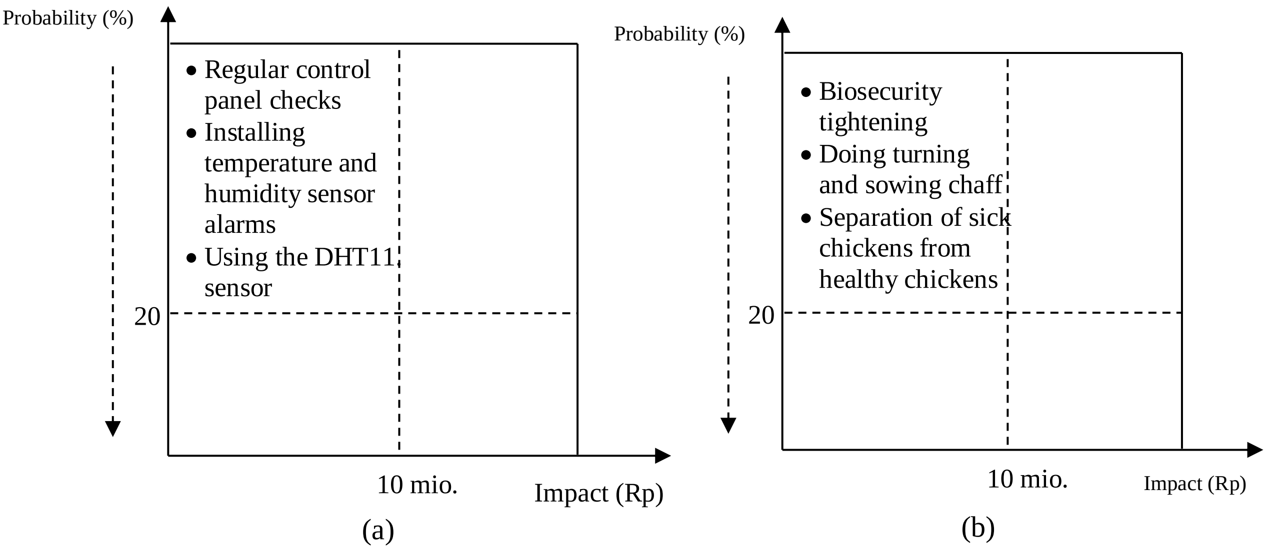

Figure 3. Preventive Strategies for Climate Change Risk (a) and Disease (b)

The preventive strategy to reduce the probability of climate change risk is by increasing the discipline of the cage crew in controlling the temperature of the closed house cage so that it always conforms to the ideal cage temperature standard that the core company has provided. Temperature control can be done by constantly checking the control panel on the cage. In addition, giving warning signs in the form of an alarm will alert the cage's crew if the temperature and humidity of the cage room are not by the standard temperature and humidity so that the cage's staff will always be disciplined in setting the cage temperature using the existing Exhaust Fan system. The sensor used can use the DHT11 sensor with Naïve Bayes calculations so that the output accuracy on the Exhaust Fan has more precise accuracy to minimize mortality due to heat stress. This is to Putra et al. (2018), which state that using the DHT11 sensor with the Naïve Bayes calculation method on the automation system has an accuracy of 98.06% reading temperature and 95.58% reading humidity. Also, fan output accuracy is 87.03%, and curtain output is 96.29%. This is to Kountur's (2008) statement, which states that preventive strategies can be carried out in several ways, including repairing or installing physical facilities, developing human resources, and creating or improving systems and procedures.

The preventive strategy that the management of FPP UNDIP must carry out closed-house farms to reduce the probability of disease risk is by strictly increasing biosecurity. According to Fadhilah (2004), the application of strict biosecurity includes the provision of disinfectants for visitors to cages and closed house employees and limiting the traffic of visitors and employees. The probability of the risk of disease can also be done by properly managing the reversal and sowing of

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6 (1): 58-70, May 2022

husks so that the husks' condition is always dry and not humid to avoid the growth of protozoa germs. Then provide a place of separation between diseased chickens and healthy chickens. Temperature regulation is an excellent closed-house cage system and is also very influential in reducing the possibility of disease. A closed house system is easy to monitor and regulate temperature, light, and humidity and has good ventilation to overcome the spread of illness easily.

CONCLUSION AND SUGGESTION

Based on the research on risk analysis of broiler chickens in Closed House Animal Husbandry cages, Faculty of Animal Husbandry and Agriculture, Diponegoro University, the value expected return of Rp153,359,387.70. The value of the coefficient of variation (CV) of the company's income is 0.55, thus indicating a risk to the company. Sources of risk experienced by companies are sources of climate change and disease risks. The probability of risk sources is high, namely for climate change by 45.23% and disease by 40.32%. The impact rate of risk sources is low, i.e., for climate change, amounting to Rp. 7,268,931,196 and Rp. 2,799,263,110 for disease. The results of the risk source mapping are still classified as risk management with preventive strategies. Suggestions that can be given include: this research prioritizes historical data on mortality and income from closed-house farms, Faculty of Animal Husbandry and Agriculture, Diponegoro University. The source of risk is determined based on interviews and field observations without performing a necropsy test. Suggestions for developing this research are to achieve a necropsy test on broiler chickens that experience death to identify the source of risk in detail and accurately.

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