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Risk Based Milk Pricing Model at Dairy Farmers Level

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ABSTRACT

The milk price from a cooperative institution to farmer does not fully cover the production cost. Though, dairy farmers encounter various risks and uncertainties in conducting their business. The highest risk in milk supply lies in the activities at the farm. This study was designed to formulate a model for calculating milk price at farmer's level based on risk. Risks that occur on farms include the risk of cow breeding, sanitation, health care, cattle feed management, milking and milk sales. This research used the location of the farm in West Java region. There were five main stages in the preparation of this model, (1) identification and analysis of influential factors, (2) development of a conceptual model, (3) structural analysis and the amount of production costs, (4) model calculation of production cost with risk factors, and (5) risk based milk pricing model. This research built a relationship between risks on smallholder dairy farms with the production costs to be incurred by the farmers. It was also obtained the formulation of risk adjustment factor calculation for the variable costs of production in dairy cattle farm. The difference in production costs with risk and the total production cost without risk was about 8% to 10%. It could be concluded that the basic price of milk proposed based on the research was around IDR 4,250-IDR 4,350/L for 3 to 4 cows ownership. Increasing farmer income was expected to be obtained by entering the value of this risk in the calculation of production costs.

Keywords: production cost, milk price, risk, dairy farmer, income

ABSTRAK

Harga susu yang diterima peternak dari koperasi saat ini belum sepenuhnya dapat menutupi biaya produksi. Padahal peternak di dalam menjalankan usahanya menghadapi berbagai risiko dan ketidakpastian. Risiko terbesar dalam rantai pasok susu terletak pada kegiatan di peternakan. Penelitian ini bertujuan untuk merumuskan model perhitungan harga susu di tingkat peternak berbasis risiko. Risiko yang terjadi di peternakan di antaranya risiko pembibitan sapi, sanitasi, pemeliharaan kesehatan sapi, manajemen pakan, pemerahan, dan penjualan susu. Lima tahapan utama dalam penyusunan model ini ialah (1) identifikasi dan analisis faktor yang berpengaruh, (2) membangun model konseptual, (3) analisis struktural dan besaran biaya produksi, (4) model perhitungan biaya produksi dengan faktor risiko, dan (5) model harga susu berbasis risiko. Penelitian ini membangun hubungan antara risiko di peternakan dengan biaya produksi yang harus dikeluarkan oleh peternak, seperti biaya penyusutan kandang dipengaruhi oleh risiko kontruksi kandang yang tidak memenuhi syarat dan biaya lainnya. Selain itu juga diperoleh formulasi perhitungan faktor penyesuaian risiko untuk variabel biaya produksi usaha sapi perah. Perbedaan biaya produksi dengan risiko dan biaya produksi total tanpa risiko sekitar 8% sampai dengan 10%. Dapat disimpulkan bahwa harga dasar susu yang diusulkan berdasarkan hasil penelitian ini pada kepemilikan ternak 3-4 ekor sapi berkisar Rp 4,250–Rp 4,350/L. Peningkatan pendapatan peternak diharapkan dapat diperoleh dengan memasukkan nilai risiko ini pada perhitungan biaya produksi.

Kata kunci: biaya produksi, harga susu, risiko, peternak, pendapatan

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INTRODUCTION

The milk price received by dairy farmers from the cooperative institution currently does not fully cover the costs of production. Dairy farmers in doing business face various risks and uncertainties (Gorton *et al.*, 2006; Leppälä *et al.*, 2011). The prices of milk in the cooperative institution are determined by different quality standards including freezing point, fat, Total Plate Count (TPC), Total Solid (TS), and Total Solid Non Fat (TSNF) (Septiani *et al.*, 2016b). The quality of milk is determined by many factors, such as the quality and quantity of feed, milk handling by farmers, cooperative institution, and Dairy Processing Industry (DPI) (Septiani *et al.*, 2014). The quality of milk is also determined by the handling of milk during milk delivery to the cooperative institution or DPI (Septiani & Djatna, 2015). Conditions of dairy farm in Indonesia today for the most part are family business with small-scale enterprises (2-5 workers). The motives of its business are domestic, performed as a side or main effort, still far from innovation, and managed by business management and weak capitalization (Barrett, 1996; Thomassen *et al.*, 2008). Large-scale enterprises are very limited and generally no new dairy cattle farms are grown.

Based on the analysis of survey and expert knowledge representation, four main factors that led to a decrease in income of farmers are the declining selling prices of milk, decreasing the amount of milk production, the low number of cattle ownership, and the increase in production costs (Septiani *et al.*, 2014; Septiani *et al.*, 2016b). The decrease in the amount of milk production is due to a decrease in the productivity of milk cows. A decrease in productivity can occur due to the maintenance of health and feed management, which is not optimal (Melyukhina, 2011). It can also occur due to genetic factors such as the occurrence of inbreeding (mating siblings).

Low milk prices led to a reduced income of farmers. The decrease in revenue has an impact on the motivation of dairy farmers to develop their business (Hemme *et al.*, 2014). Farmers chose to sell the cows than selling milk. This condition leads to the issue of price of milk to be more complex than to be settled (Sobczyński *et al.*, 2013). Farmers earn a side income from the sale of culling cows, cows and veal calves (Isermeyer *et al.*, 2003). In general, the condition of farmers currently do not have sufficient knowledge to assess the feasibility of its business i.e., the contribution of income from their animals for incomes of farming households (Devendra, 2007; Costa *et al.*, 2013). Dairy farmers always consider favorable results without taking into account other factors, such as the use of family labor and the value of depreciation. As a result, businesses and livestock remain undeveloped.

As indicated above, the issue of risk and uncertainty in agriculture is not a new thing, because in fact, farmers have a lot of decisions relating to risks and uncertainties. The decision depends on many other factors beyond the capability of the farmers to control (Colicchia & Strozzi, 2012; Ehrig *et al.*, 2014; Williams, 2014). According to Bunn (1999), Tsolakis *et al.* (2014), Marra *et al.* (2012), the high variability in production have led to an increase in price variability.

Many factors must be considered in calculating the cost of milk production and milk prices at the farm level (Isermeyer *et al.*, 2003). According to Williams (2014), the risks associated with the price are essential in risk management. Risks associated with earnings, expenses, and costs can be identified, measured, analyzed, and organized theoretically, while the risks associated with weather and biology are not easily calculated and regulated (Nguyen *et al.*, 2007; Kim *et al.*, 2014).

The amount of revenue is directly affected by the sales price and production costs (Kumawat *et al.*, 2014). The production costs consist of fixed costs and variable costs (Horngren *et al.*, 2012). These costs are heavily influenced by the risks involved in the activities undertaken by farmers (Sobczyński *et al.*, 2013; Ehrig *et al.*, 2014; Williams, 2014). The elasticity of supply price and the price of fresh milk concentrates on individual farmer level is sufficiently high, where dairy production is highly responsive to these two variables. The risk of fresh milk price and the price of milk concentrate is very influential in milk production at the farm level (Rusdiana & Sejati, 2009).

Some studies related to the preparation of the prices were reported by Septiani *et al.* (2014), Kumawat *et al.* (2014), Isermeyer *et al.* (2003), Hemme *et al.* (2014), Sobczyński *et al.* (2013), and Ehrig *et al.* (2014). Based on the description of the above issues, the formulated goal of the research is a risk-based modeling calculations of the price of milk at the dairy farmer level, consisting of three sub-goals, namely: (1) determining the adjustment factor of risk in the variable cost of production of dairy cattle farming, (2) developing detailed production costs of dairy cattle farming by including the adjustment factor of risk, (3) calculating the basic price of milk per liter based on the total cost of production with the risk model been relied upon to be an early model for the parties concerned in determining the price of milk at the farmer level with considerable risk.

MATERIALS AND METHODS

Sample Population

The data collection of this study was conducted through (1) literature study from previous research, (2) observation of the activities conducted in each supply chain in the survey area located in west Java from January 2016 until Agustus 2016, with focus on 5 locations in Pangalengan, Lembang, Subang, Bogor, and Garut, (3) Data history about the actual price of milk from the cooperative institution and the amount of milk production, and (4) interview conducted thoroughly to the stakeholders and experts in the dairy supply chain.

Data Analysis

The data in this study were devided into five stages of research, they were building a conceptual model,

structural analysis of the cost of production, developing a formulation of risk rating factor, model calculation of production costs with risk value, and calculating the proposed milk price with the risk value. The development of the stage model is shown in Figure 1. The explanations for each stage are as follows:

Building a conceptual model. Preparation of a conceptual model was begun with identifying and analyzing the factors that affect the income of farmers. The identification and analysis were based on field survey results and discussions with experts in the field of dairy supply chains. The conceptual model was designed to analyze the relationship between the farmers' income, the possible risks in the farm, the production costs, and the selling price of milk at the farm level.

Structure analysis of production cost. This section consisted of the following three steps:

a. Identification of variable cost of production
   Production cost comprises of fixed cost and variable cost (Barrett, 1996; Salvatore, 2004; Hemme *et al.*, 2014; Kim *et al.*, 2014) Fixed cost is cost that is relatively fixed in amount and continue to be issued even if the outputs obtained were high (a lot) or low (a little). The variable cost is a factor of production whose numbers change if the resulting production output changes.
b. Determining the scale of the business
   A group of business scale determined three factors, namely the average number of cattle ownership, average milk production, and dairy cow productivity.
c. Calculating total production cost
   Formulations for calculating the total production cost was as follows :
   Total cost (TC)= Fixed cost (FC) + Variable cost (VC)

Developing a formula to calculate risk rating factor. This stage consisted of three parts:

a. Analysing risk factor relationship with variable cost
   Risk factors in farms refer to previous studies that have identified possible risks in farms, i.e. Septiani *et al.* (2014), Septiani *et al.* (2016b), and Mishra & Shekhar (2011). The analysis of the relationship between risk and cost is determined by expert judgment.
b. Calculating the value of risk using a fuzzy logic approach
   Risk value was derived from the calculation of Fuzzy Risk Priority Number (FRPN) which was divided into three boundary values: the lower limit, middle limit, and upper limit. FRPN was assessed based on three dimensions of risk: occurrence, severity, and detectability.
c. Developed formulation of risk rating factor
   Risk rating factors were calculated using the fuzzy risk assessment and comparative measurement performance approaches.

Model calculation of production costs with risk value. This stage of experiment was the formulation of the production cost calculations with risks. Then, the production cost was calculated in three business scales.

Calculation of the proposed milk price at farmer level with risk

a. Counting of BEP Price, calculated by the formula:
   BEP Price (IDR/liter)= TCR/Y
   The formula for calculating average variable cost was:
   AVCR= TVCR/Y

   BEP Production was calculated based on total production cost, average variable cost, and actual milk price (average, the lowest and the highest prices). BEP Production was calculated by the formula:
   BEP Production (liter)= TFCR/(P1-AVCR)

   Where:
   TCR = total cost with risk, IDR/liter
   TFCR = total fixed cost with risk, IDR/liter
   TVCR = total variable cost with risk, IDR/liter
   AVCR = average variable cost with risk, IDR/liter
   Y = amount of milk production, liter
   P1 = actual milk price (average), IDR/liter
   P2 = actual milk price (the lowest), IDR/liter
   P3 = actual milk price (the highest), IDR/liter
b. Farmer income simulation
   Input: Is the actual price of milk from the cooperative institution in the amount of milk production.

Farmers' income was calculated by the following formula:

Number of farmers receiving from milk sales:
Average: TR(P1)= Y * P1
Lowest: TR(P2)= Y * P2
Highest: TR(P3)= Y * P2

BEP sales were calculated as follows:
BEP sales = TFCR/[1-(TVCR/TR)]

Where:
Y = Amount of milk production, liter
TR = Total revenue from milk sales, IDR/liter

The livestock business income was the difference between the receipts earned and the expenses incurred, so the farmers' income based on the milk sales was calculated as follows:

Revenue (P1) = TR (P1) - TCR
Revenue (P2) = Total revenue (P2) - TCR
Revenue (P3) = Total revenue (P3) - TCR

The study was composed of several stages in accordance with the formulation of the above objectives as depicted in Figure 1.

Table 1. Data, types, and sources of data required

No	Necessary data	Type of Data	Source of data
1.	Factors that influence are models	Secondary data	Literature study, field observation, and discussions with experts
2.	The variable costs of dairy production	Secondary data, primary data	Documentation of previous studies, surveys, and discussions with experts
3.	Risks and risk factors	Primary data	Literature study, field observation, and discussions with experts
4.	The risk with fuzzy logic approach	Primary data	Observations in the field and discussions with experts
5.	The linkage of risk to price variable	Primary data	Literature study, field observation, and discussions with experts

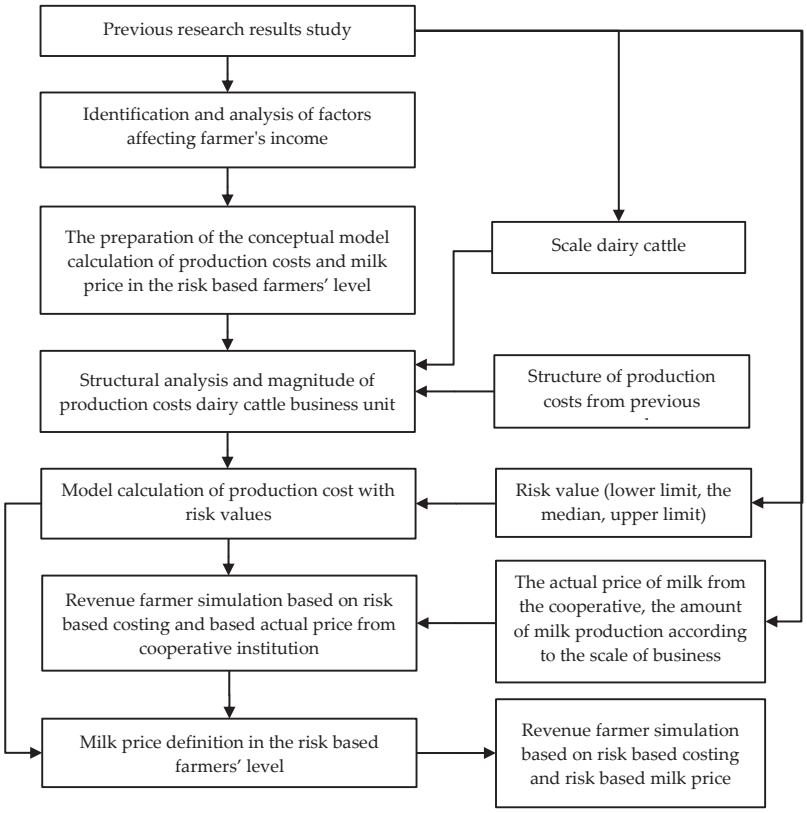

Figure 1. Stages of designing a model calculation of milk prices at farm level based on risk

RESULTS

Identification and Analysis of Factors Affecting the Farmers Income

The selling price of milk directly affects farmer income. Decline in the income of farmers will have a great impact on the survival of farming (Yigrem *et al.*, 2008), so it is necessary to identify the factors that influence the farmer's income, as follows:

a. The low selling price of milk
The selling price of milk is low due to the fact that milk quality does not meet the quality standards. Factors causing the low quality of milk include the lack of proper milk handling, sanitation, quality and quantity of feed concentrates as well as the quality and quantity of forage feed (Mishra and Shekhar, 2011; Septiani *et al.*, 2016b).

b. The decrease in total milk production
Decrease in total milk production is caused by the decreased productivity of cows. The causes of the decline in the productivity of milk in these cows include health care, feed management, but the main cause of the decline in productivity is the genetic problems, the occurrence of inbreeding (mating siblings) that affect lactation period (Assefa *et al.*, 2011; Mishra & Shekhar, 2011; Septiani *et al.*, 2016b).

c. Increased milk production costs
Production costs were calculated based on the fixed costs and variable costs (Horngren *et al.*, 2012). The increase in fuel prices has increased the costs of the farm production including the price

of feed and feed transportation costs (Assefa *et al.*, 2011; Melyukhina, 2011; Glover *et al.*, 2014). This situation makes farmers select the other feed alternatives that are cheaper and this condition has a strong impact on the quality and quantity of milk production.

d. Low ownership of cow
The business of dairy cows breeding in Indonesia are classified into three types: (1) The business of the farm as a sideline, with the rates of contribution less than 30% of farmer income, (2) Livestock industry as the mix farming business with income levels of 30%-70%, (3) breeding business as a main business where farmers' income from this business can support farmers needs (Septiani *et al.*, 2016b).

Conceptual Model Factors that Influence the Risk-Based Formulation of Milk Price

The model was developed to describe the relationship between the price of milk at the farm level with the farmers' income, the cost of production of dairy cattle farming, and the risk factors on the farm (Figure 2).

Review of the theoretical relationship with the price according to risk (Ehrig *et al.*, 2014; Williams, 2014) can be seen in Figure 3. Risk has a high effect on the price; the higher the risk, the greater the impact on prices (Ramirez, 2000; Travisi & Nijkamp, 2008). Price is determined by the production costs incurred. The risk factors that affect the cost of production of dairy cattle farming (Septiani *et al.*, 2016b) is (1) a risk factor for the construction of cages that do not meet the requirements, (2) the risk factors of inbreeding (mating siblings), (3) the risk factors of mistake in feeding, (4) the low quality and the quantity of forage, (5) the risk factors of low quality and quantity of concentrate feed, (6) the risk factors of sick cows (gastrointestinal, nail disease, abscess), (7) the risk factors of cows affected by mastitis, (8) the risk factors of reproductive disorders, (9) the risk factors of the availability of clean water, and (10) factors of unhygienic milk cans.

Structural Analysis and Production Cost in Dairy Cattle Farming

Production costs are composed of fixed costs and variable costs (Barrett, 1996; Salvatore, 2004; Kim *et al.*, 2014; Kumawat *et al.*, 2014). Fixed costs are relatively fixed amount and continue to be issued even if the output obtained high or low.

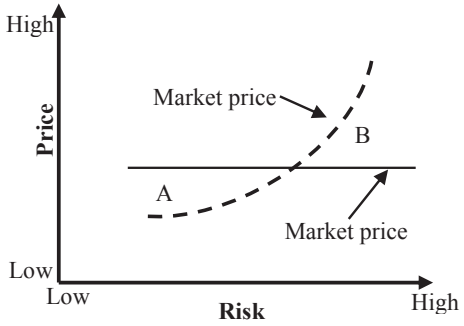

Figure 3. Overview of the theoretical relationship between price and risk

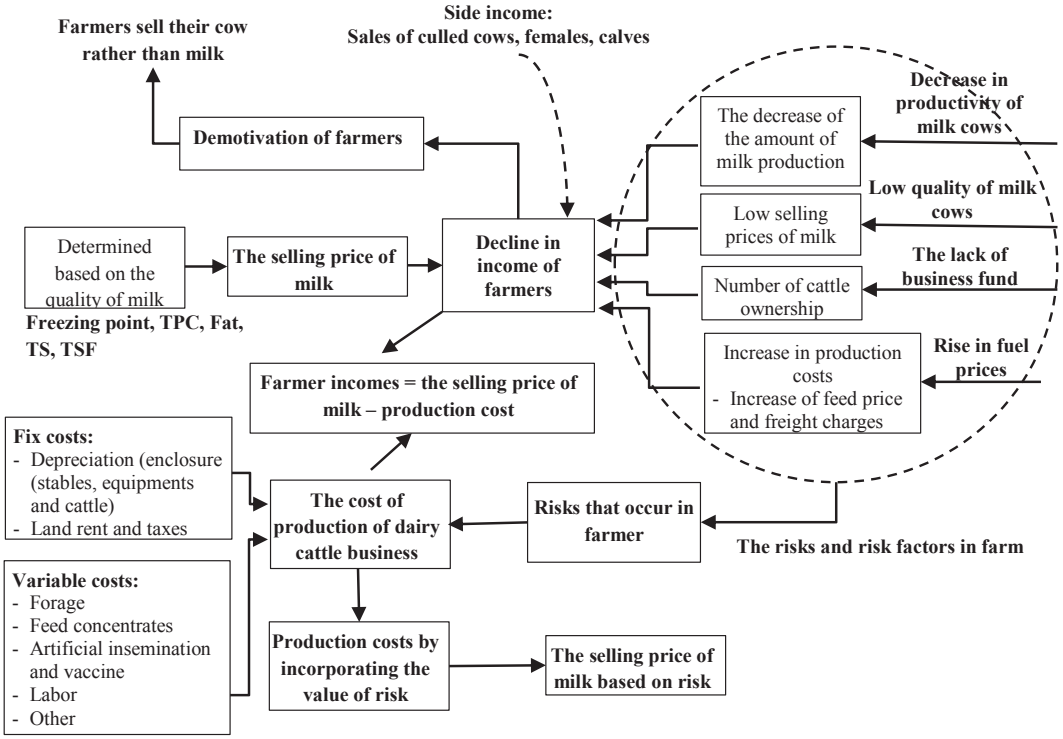

Figure 2. Conceptual model of the relationship between price by revenue, cost of production, and risk

The fixed costs of dairy cattle farming include the depreciation, durable equipment depreciation, deterioration of livestock, land rent, and taxes. Cost variables include grass feed, bran, pulp, pharmaceuticals, artificial insemination, the wages of family labor and non-family labor, and other equipment that is not durable. Preparation of production costs is grouped into three business groups of cattle such as those resulting from research of Barret (Barrett, 1996). The average number of cattle ownership, average milk production, and productivity of milk cows can be seen in Table 2.

Formulation for the Calculation of Risk Rating Factor

Preparation of formulations for the calculation of risk adjustment factor begins with the identification and analysis of the relationship variable production costs with the risks and risk factors that may occur at the farm (Table 3). The formulation for the calculation of risk rating factor was based on fuzzy risk assessment (Moeinzadeh & Hajfathaliha, 2009; Bajpai *et al*., 2010; Septiani *et al*., 2016b, 2016a) and comparative measurement performance (Morley *et al*., 2001). The risk value for each risk factor was obtained from the calculation of fuzzy risk priority number. Risk Rating Factor (RRF) was calculated by the following calculation formula:

1. Calculating the risk weight value :
   Risk weight value=
   $\text{Risk value}_{\text{lower limit}}$ / $\text{Risk amount}_{\text{upper limit}}$

2. The minimum risk value was given as value 1
   Other risks values were transformed proportionally

$\text{RRF}_{\text{lower limit}}$ = Risk weight value x 1

$\text{RRF}_{\text{middle limit}}$ = ($\text{Risk value}_{\text{middle limit}}$ / $\text{Risk value}_{\text{lower limit}}$) x Risk weight value

$\text{RRF}_{\text{upper limit}}$ = ($\text{Risk value}_{\text{upper limit}}$ / $\text{Risk value}_{\text{lower limit}}$) x Risk weight value

Depreciation cost of equipment **(FCR**2), rent and land taxes **(FCR**4),wage of labor in the family **(VCR**5) and wage of labor outside the family **(VCR**6), had no relationship with the risks identified in the farm (Table 4).

Model Calculation of Production Costs with Risk Value

Williams (2014) stated that risk affect on production costs. The increasing value of risk was directly proportional to the cost (Ibarra dan Skees, 2007; Travisi & Nijkamp, 2008). Theoretically, the production costs will be higher if the value of risk is higher (Nguyen *et al*., 2007), so the prepared formulations variable cost and fixed cost adjustment factor is as follows:
Fixed costs by a factor of risk adjustment:
FCR= FC x (1 + RRF)

The variable cost adjusted by factors of risk:
VCR= VC x (1 + RRF)

The cost of total production by factors of risk adjustment:
TCR= TVCR + TFCR

Calculation results of total production costs with risk value can be seen in Table 5.

Table 2. Grouping dairy cattle farming

Business scale	The average number of lactating cow	Average milk production	Milk cows productivity
Business Scale 1	3.20 AU	449.33 L/month	8.05 L/cow/day
Business Scale 2	6.80 AU	917.77 L/month	8.11 L/cow/day
Business Scale 3	15.83 AU	2,184 L/month	10.40 L/cow/day

Table 3. The relationship between the variable cost of the risks and risk factors in the farm

No	Price variable	Risk	Risk factors
1.	Depreciation of housing	**R.2** Sanitation	**P.FR.21** Construction of the housing are not eligible
2.	Depreciation of cattle	**Q.1** Breeding	**P.FR.11** Inbreeding (mating siblings)
		Q.4 Feed	**P.FR.43** Errors in feeding
3.	Forage feed	**R4** Feed	**PFR41** Low quality and quantity of forage feed
4.	Concentrate feed	**R4** Feed	**PFR42** Low quality and quantity of concentrate feed
5.	Drugs	**R3** Healthcare of cow	**PFR31** Sick cow
			PFR32 Mastitis cow disease
			PFR33 Reproductive disorders
6.	Artificial insemination	**R1** Cattle breeding	**PFR11** Inbreeding (mating siblings)
7.	Other	**R2** Sanitation	**PFR23** Fresh water availability
8.	Non durable equipment	**R2** Sanitation	**PFR22** Unhygienic milk can

Table 4. Factors of risk adjustment in the variable cost of producing milk farm

Variable production costs	Risk factors	Fuzzy Risk Priority Number (FRPN)			Risk rating factor		
		Lower	Middle	Upper	Lower limit	Middle	Upper limit
Fixed costs							
Depreciation of housing (FCR1)	PFR21	443	500	602	0.065	0.073	0.088
Depreciation of cow (FCR3)	PFR11 PFR43	1520	1691	1784	0.222	0.247	0.261
Rent and land tax (FC4)		0	0	0	0.000	0.000	0.000
Costs variable							
Forage (VCR1)	PFR41	636	758	846	0.093	0.111	0.124
Feed concentrates (VCR2)	PFR42	593	758	834	0.087	0.111	0.122
Vaccine (VCR3)	PFR31 PFR32 PFR33	1875	2304	2488	0.274	0.337	0.364
Artificial insemination (VCR4)	PFR11	760	924	926	0.111	0.135	0.136
Other (VCR7)	PFR23	381	434	500	0.056	0.064	0.073
Non-durable equipment (VCR8)	PFR22	625	758	817	0.091	0.111	0.120

Note:
VCR = Variable Cost with Risk Factor, variable costs taking into account risk rating factor.
TVCR = Total Variable Cost with Risk Factor, the total variable costs by taking into account risk rating factor.
FCR = Fixed Cost with Risk Factor, fixed costs by taking into account risk rating factor.
TFCR = Total Fixed Cost with Risk Factor, total fixed costs by taking into account risk rating factor.
RRF = Risk Rating Factor, in the variable cost of production.
TCR = Total Cost of Risk Factor, total production costs taking into account risk rating factor.

Table 5. Calculation results of total production costs with risk value (IDR)

Scale of enterprises	Production costs with risk factor		
	Lower limit	Middle	Upper limit
Business scale 1			
Production costs	1,903,640.95	1,933,874.08	1,950,282.88
Business scale 2			
Production costs	3,964,831.48	4,040,979.44	4,080,073.86
Business scale 3			
Production costs	8,184,080.83	8,333,646.78	8,411,116.15

Simulation of Farmers Revenue Based on Risk Based Costing

The simulation results in milk prices based on risk to revenues in the three business scale can be seen in Table 6. The comparison with actual milk price received by the farmers and the current price was quite significant. The base price of milk is now on average IDR 3 650.00/liter. Based on the calculation of the period 2014 and 2015, prices received by the farmers was currently an average of IDR 4,231.8, the lowest price was IDR 3,514.72, and the highest price was IDR 4,518.26.

Preparation of Schematic Model of Milk Prices in the Risk-Based Farmers

Risk and cost of production become input in formulating risk-based calculation of production costs. Formulation of this calculation is also affecting cattle ownership scale. From the calculation of production costs, it can be determined that BEP price becomes the basis for calculating the price of milk at the farmer level. Milk price received by farmers will also be affected by the penalty and reward of the quality of milk produced. The base price of milk is determined based on a risk-based production cost and is expected to increase the income of farmers. The relationship between some of the variables described above is described in the model schematically in Figure 4.

DISCUSSION

Risk factors that affect the production cost of dairy cattle farming are (1) construction of the housing are not eligible, (2) inbreeding, (3) error of feeding, (4) quality and quantity of low forage, (5) quality and quantity of concentrate feed, (6) sick cow, (7) mastitis disease, (8) reproductive disorders, (9) fresh water availability, and (10) unhygienic milk can. Risk factor has a relationship with the variable cost of production. For example, risk

Table 6. Milk price risk based on three scales of milk farms business

Milk price risk based	Lower limit	Middle	Upper limit
Scale Business 1			
The basic price	4,236.62	4,303.91	4,340.42
Price + reward/ penalty	6,329.20	6,429.93	4,987.90
Revenue	940,256.94	955,189.86	963,294.09
Scale Business 2			
The basic price	4,320.07	4,403.04	4,445.64
Price + reward/ penalty	6,453.86	6,577.82	6,641.45
Revenue	1,958,331.66	1,995,943.08	2,015,252.81
Scale Business 3			
The basic price	3,747.29	3,815.77	3,851.24
Price + reward/ penalty	5,598.17	5,700.48	5,753.47
Revenue	4,042,326.8	4,116,201.25	4,154,465.35

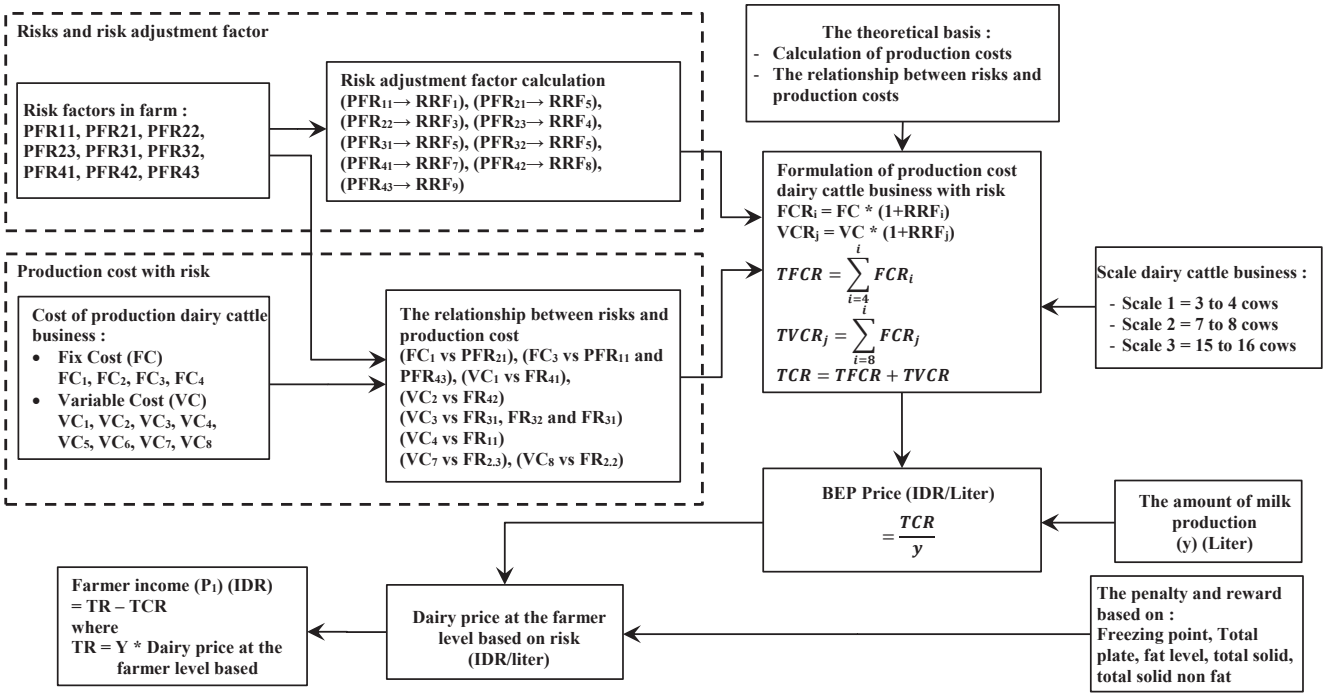

Figure 4. Schematic Model preparation of the production cost and the selling price of milk at the farmer level based on risk based

factor of construction of the housing are not eligible affected by housing depreciating cost. The risk factor of inbreeding and errors in feeding are affected by depreciation of cattle cost. The cost of forage and concentrate feed is affected by the risk of quality and quantity of feed. The higher the risk will lead to the higher cost of dairy cattle farming. This risk factor could not be eliminated but the opportunity and its impact can be mitigated by efforts to deal with risk.

Risk value with the fuzzy logic approach was divided into three value limits, namely lower limit, middle limit, upper limit. Risk value used to calculate risk rating factor in production cost calculation, either variable cost or fixed cost. The production costs were grouped into three business scale of cattle holdings based on the number of cattle per farmer. The first business scales had an average number of cattle holdings 3.2 cattle per farmer. The second business scale had 6.80 cattle per farmer and the third scale had 15.83 cattle per farmer. This research resulted three risk adjustment factors (lower, middle, and upper) for three business scales. Risk rating factor of depreciation cattle cost (0.065; 0.073; 0.088), housing depreciation cost (0.222; 0.247; 0.261), feed forage cost (0.093; 0.111; 0.124), feed concentrates cost (0.087; 0.111; 0.111), vaccine cost (0.274; 0.337; 0.364), artificial insemination cost (0.111; 0.135; 0.136), equipment which is not durable (0.091; 0.111; 0.120), and others (0.056; 0.064; 0.073).

The simulation results showed that BEP milk price strongly influenced the business scale. The price of milk

received by farmers from cooperative institutions is currently in the range of IDR 3,514.72 up to IDR 4,518.26/ liter. On the scale of business 3, farmers still make a profit if they get the highest milk price, but at the low milk price the farmer still suffers losses, whereas on the business scale 1 and 2, the farmer loses. The results of this calculation indicate that the base price of milk obtained could not cover the production costs.

The proposed basic milk price is around IDR 4,250 - IDR 4,350/liter based on 3 to 4 cows ownership. The price of milk per liter which was taken into the reward or penalty and profit was obtained as follows:
On a business scale of 1: IDR 6,329.2; 6,429.72; 6,484.27
On a business scale of 2: IDR 6,453.86; 6,577.82; 6,641.45
On a business scale of 3: IDR 5,598.17; 5,700.48; 5,753.47

The previous price had a significant difference because the calculation of the price had included risk factors. The biggest risk factor was the cost of deterioration of livestock and the cost of medicines. This risk could be borne by the breeder and charged to the cost, or the value of this risk was charged to other parties, such as agricultural insurance. Law No. 19/2012 on the Protection and Empowerment of Farmers had mandated that the state should provide protection and empowerment to farmers in a planned, directed and sustainable manner. In detail the law mandates farmer protection strategies provided through (1) agricultural inputs and equipment, (2) business certainty, (3) cost of agricultural items, (3) removal of high-cost economic practices, (4) extraordinary events, (5) early warning system and handling impact of climate change, (6) agricultural insurance.

One of the new things in the law is agricultural insurance. In this case, the central government and local governments are mandated to provide agricultural insurance facilities to farmers. There are two main principles in insurance, i.e: (1) Indemnity principle: the insurer will provide compensation in accordance with the losses actually experienced by the insured. Payment of claims, according to agreed damage, not risk-based, simple insurance program, a high moral hazard in the field, high administrative costs, especially for field verification. (2) Parametric principle: the insurer will give to the insured in case of triggering event which has been agreed together.

The principle of insurance that can use the results of this assessment is the parametric principle. The parametric insurance principle requires a risk base, requiring trigger events to be mutually agreed upon. Currently, the principle of insurance is not difficult to implement because of the unavailability of high-risk database and data as the basis for the implementation of the agricultural insurance system.

CONCLUSION

The formulation of the calculation of risk adjustment factor to the variable production cost of dairy cattle farming was calculated based on the value of risk as identified and assessed by experts in the form of fuzzy linguistics. The proposed basic milk price in this research was around IDR 4,250-IDR 4,350/liter for 3 to 4 cows ownership. Increasing farmer income was expected to be obtained by entering the value of this risk in the calculation of production costs.

The price of milk per liter which was taken into the reward or penalty and profit was obtained as follows:
On a business scale of 1: IDR 6,329.2; 6,429.72; 6,484.27
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On a business scale of 3: IDR 5,598.17; 5,700.48; 5,753.47
The average price received by the dairy farmers was IDR 4,231.18, the lowest price was IDR 3,514.72 and the highest price was IDR 4,518.26. Prices were obtained from the research carried out by calculating the value of risk accepted by farmers. Finally, this model can be developed to model alternative risk-based milk prices, shifting the risk to others, such as agricultural insurance.

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