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The importance of working capital in the sustainability of smallholder farms in West Java (Indonesia)

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ABSTRACT

Smallholder farms represent the largest population of dairy cattle farms in Indonesia. Dairy activities can play an important role to secure the livelihood of smallholder farms. However, small farms have several constraints and challenges to be sustainable in the future. To assess the sustainability of smallholder dairy farms and to understand in what condition farms are more sustainable, we conducted a study in Subang and Bandung Barat district in West Java Province. We collected primary and secondary data from May 2015 to May 2016. We carried out a formal survey of 355 farmers from May to August 2015. From discussions with local stakeholders and literature review, we propose 6 indicators of sustainability scoring from 0 to 100. Result showed that the most sustainable were farms who had high capital and diversified activity (farms pattern 5). Farms who had low capital but who had additional activity (pattern 1) were more sustainable than specialized farms with low (pattern 2 and 3). Capital plays an important role to all 3 pillars of sustainability. In addition, diversity contributes to reduce risks related to dairy business and to benefit from synergies between activities. Our study underlines the importance of enhancing farm capital and diversification of rural households for increasing the sustainability of smallholder farms.

Keywords: Assessment, sustainability, smallholder farms, Indonesia

INTRODUCTION

Smallholder farms play an essential role to the development of dairy sector in Indonesia. They represent the largest ownership (93%) of the national population of dairy cattle. Badan Pusat Statistik (2013) reported that the smallholder on average had two to three heads per farm.

In the worldwide, smallholder dairy farmers want to have profitable and sustainable business to secure their livelihood (Moran, 2009). However, farmers face some challenges to be sustainable. In Africa, the main challenges are lack of finance, shortage of feed, low price of milk, low performance of milk production, and health problem (Atuhaire et al., 2014; Nkya et al., 2007; Tebug et al., 2012). Those challenges are also happen in majority of Asia countries (Moran, 2009). In Indonesia, many studies reported that shortage of capital become main challenge for smallholder dairy farmer to be sustainable (Tawaf and Surianingrat, 2010; Sembada et al., 2016). In addition, majority of farmers also have problem with waste management (Devendra, 2001) that might affect the sustainability of smallholder dairy farming system.

The concept of sustainability evaluation in agriculture is widely proposed by many researchers. López-Ridaura et al., (2002) proposed a MESMIS framework to evaluate the sustainability. The sustainability is defined by seven attributes: productivity, stability, reliability, resilience, adaptability, equity, and self-reliance. To evaluate sustainability of farming system, we need to clearly identify the critical points, the diagnostic criteria and the strategic indicators. The critical points are the aspects that enhance or constrain system's attributes. These might be also of an social, environmental, or/and economic nature. These factors have a critical and important impact on the future or survival of the management system. The diagnostic criteria is a

link between attributes, critical points, and strategic indicators. After the selection of criteria, we can develop the strategic indicators to evaluate the sustainability of farming system.

We conducted a study in Subang and Bandung Barat district, West Java Province to better understand which farms and why some farms have a better sustainability for one or another dimension. We selected the study areas because those are the main work areas of an important milk cooperative in Indonesia. This study focused on evaluating the sustainability of smallholder dairy farming system. We also identified the factors explaining the levels of the sustainability by describing the structure, the practices, and the technical-economic performance of the farms.

METHODS

Study site

We selected two study areas in West Java Province, including Subang and Bandung Barat district. Subang is highland with altitude between 500 – 1500 m. The activities generating income are mainly tea plantation, tourisme (hot spring water), crop land and livestock. The population density is around 620 habitants/km^2 in 2013 (Badan Pusat Statistik Kabupaten Subang, 2014).

Lembang in Bandung Barat district is high plateau with altitude more than 700 m. The main activity are agricultural sector (29%), trading sector (21%) and others. Land use included rice field (3%), non rice field (71%) and non agricultural land (26%) (Badan Pusat Statistik Kabupaten Bandung Barat, 2015). More than 16000 dairy cows were managed by farmers in this area. The farmers are members of the milk cooperative (*Koperasi Peternak Sapi Bandung Utara - KPSBU*).

Research Design

78 We carried out a study on May 2015 to May 2016. To understand in what condition
79 farms are more sustainable, we performed a descriptive and comparative study.

80 In the present, we adapted MESMIS framework to develop the indicators of
81 sustainability. López-Ridaura et al., (2002) proposed this framework to evaluate the
82 sustainability of complex socio-environmental system. Several studies applied and
83 validated this framework to evaluate sustainability in agriculture farming system (Astier
84 et al., 2012; Barbier and Lopez-Ridaura, 2010; Speelman et al., 2007), livestock
85 farming system (Astier et al., 2012; Gaspar et al., 2009; Salcedo and García-Trujillo,
86 2005) as well as dairy farming system (Ripoll-Bosch et al., 2012; Toro-Mujica et al.,
87 2014). We adapted this framework due to the available data and the comphrehensive
88 method.

89 We collected primary data in indepth-interviews with experts and farmers to
90 identify relevant indicators of the sustainability (Table 1). Then, the experts judged the
91 score of the importance level for each relevant indicators (Table 2). We then conducted
92 a formal farm survey and direct observation to evaluate sustainability based on selected
93 indicators. From the evaluation of selected indicators, we built the pattern of
94 sustainability. Furthermore, we compared the sustainability of each pattern and
95 identified factors explaining the differences. To complete information, we collected
96 secondary data from KPSBU and public autorities.

97 The idea was to have an assessment of the sustainability based on a few indicators
98 to simplify the analysis. The aim of the analysis was to understand why and how some
99 farms are more or less sustainable according to their structure, the choice of functioning
100 and the technical and economic performance. We adapted the literature review and the
101 main important and strategic indicators to assess the sustainability for each pillars

(Table 2). Selected indicators were total income per family worker (economic viability), willingness to continue the dairy farming activity (social sustainability), waste management (environmental sustainability), own land per family worker, herd size per family worker, and diversity of activities (vulnerability).

Table 1. The attribute, critical points, criteria and indicators of sustainability of dairy farming system in study areas

Attribute	**Critical point**	**Criteria**	**Indicator**
Self reliance	Land limited	Physical capital	Land ownership
Adaptability	Low income resources	Economic activities of the family	Number of activities
	Low level of education	Family welfare	Level of education
Equity	Generation of fix labor	Employment generation	Percentage of fix family labor
	Abandon of farm	Continuity	farmer's will to continue dairy business by their children in the future
	High dependancy on the activity	Economic activities of the family	contribution of dairy activity to their total income
			Percentage of dairy income per total expenses
	Low labor productivity	Productivity of labor	herd size per worker
			Total land used per worker
Stability, reliability, resilience	High dependency on external resource	Forage production	Forage area per total land used
			total forage production per year per herd size
		Water resources	Additional water resources
	Low biological diversity	Species	Number of species
	Low concern of farm waste	Waste management	Waste management at farm
Productivity	High economic vunerability of activity	profitability	Net dairy income (KPSBU) per labor per year
			Net dairy income (KPSBU) per land used per year

		Net dairy income (KPSBU) per milk sold per year
Inadequate management of resources use	intensification	Milk sold to KPSBU per month per total land used
		Milk sold to KPSBU per month per Animal Unit

Table 2 Indicators and its level of importance from three pillars of sustainability of dairy farming system in study areas

Pillars	Indicator	Unit	Level of importance [1]
economic	number of activities generating income		3,50
economic	net dairy income (KPSBU) per worker per year	IDR/Person/year	3,50
economic	net dairy income (KPSBU) per total land per year	IDR/ha/year	3,17
economic	net dairy income (KPSBU) per milk sold per year	IDR/Liter/year	3,50
economic	milk sold per herd size	Liter/AU/month	3,50
economic	share of dairy income from total income	%	3,33
economic	Percentage of dairy income per total expenses	%	n.a.
economic	land ownership (own land/total area)	%	3,00
Social	education level		2,83
Social	fix family labor per total labor	%	3,33
Social	farmer's will to continue dairy business by their children (no= 0; yes=1; up to them=2)		3,50
Social	worker per herd size	Person/AU	3,17
Social	worker per total land	Person/ha	2,67
Environment	forage land per total land	%	3,33
Environment	Additional water resources (no=0; yes=1)		n.a.
Environment	Forage land per herd size	ha/AU	3,00
Environment	number of species		2,50
Environment	milk sold per total area	Liter/ha/year	2,33
Environment	Waste management	Score (1-3)	3,42

112 **Sampling**

113 Milk producers in Subang and Bandung Barat district are the active members of the
114 milk cooperative (KPSBU) which comprised more than 4000 farmers in 2015. Our
115 surveyed covered a total of 355 farms and randomly chosen among all TPS (*Tempat*
116 *Penampungan Susu*-milk collecting point). According to the officer of KPSBU, new
117 dairy farmers who started dairy farming activity since 2007 are dominant in Subang
118 district. Otherwise, in Bandung Barat, majority of farmers had more experience in dairy
119 farming activity.

120 **Information taken into account**

121 To describe farms in the study sites, we collected the information about farmer's socio
122 demographic characteristic, structure and dairy farming practices. Farmer's socio
123 demographic characteristic were age of farmer, experience in dairy farming, and their
124 level of education. Farm structure included herd size and land use. In addition, dairy
125 farming practices were quantity of feed concentrate and forage.

126 We obtained the information of sustainability indicators, including total income
127 per family worker (economic viability), willingness to continue the dairy farming
128 activity (social sustainability), waste management (environmental sustainability), own
129 land per family worker, herd size per family worker, and diversity of activities
130 (vulnerability). Those were the most important indicators considered by stakeholders.

131 Score of sustainability was from 0 to 100 (Table 3). Each selected indicators have
132 different way to obtain the score of sustainability. For scoring of economic pillar, we
133 considered minimum wage and poverty line. The higher total income were considered
134 as higher score of this pillar and higher level of sustainability as well. Total income was
135 defined as [Total income = Net dairy income + Net income from other activity]. To

obtain score of social pillar, we considered three modalities concerning farmers expect their children to continue dairy business. The modalities are: (i) no (low score); (ii) up to them (medium score); (iii) yes (high score). For scoring of environmental pillar, we estimated from their waste management practices. If farmers did not evacuate waste to rivers or surrounding area, it was considered as high score sustainability.

We adapted other ways to obtain the score of vulnerability of family farm (own land, herd size per family worker and diversity). The higher score means less vulnerable farm. We considered data distribution for two indicators, including own land per family worker and herd size per family worker. For the scoring of diversity indicators, we proposed two hypothesis: i) higher is the number of activities, higher is the sustainability, ii) the more balanced are the activities – in term of contribution to total income – higher is the sustainability. In study areas, we identified three main activities generating income included dairy business, crop farming activity and off farming activity. When there is only one activity, the sum $\sum_1^3(xi - \frac{100}{3})^2$ is equal to 6667. It corresponds to the more vulnerable situation. When there are three activities, each of them contributing to 100/3 % of the total income the sum $\sum_1^3(xi - \frac{100}{3})^2$ is null. It corresponds to the less vulnerable situation (three activities with balance contribution).

The information taken into account to characterize farms was divided into four categories adapted from Sembada et al., (2016): (i) structure, (ii) dairy farming practices, (iii) technical-economic performance, and (iv) feeding system. The farm's structure included the total land use (owned and rented), contribution of owned to total land, number of workers, herd size, and number of lactating cow. Dairy farming practices included daily quantity of green forage, dry matter of concentrate calculated using the national standards (Badan Standardisasi Nasional, 2009), and working hour.

160 Technical-economic performance included quantity of milk sold to cooperative,
161 milk productivity per cow, milk productivity per herd size, net dairy income, and
162 contribution of dairy income to total income. Net income was defined as [Net Income =
163 Total milk sales + Cows sales + Calves sales + Manure sales – (Cost of feed + Cost of
164 vet services + Financial cost of credit reimbursement + Cost of hired labor + Cost of
165 rented land)]. We estimated total milk sales from data provided by KPSBU. Feeding
166 system included utilization of feed forage, concentrate, tofu and cassava waste.

167 Table 3. Scoring method of six variables of sustainability

Variables	Score	Level of sustain-ability	Modalities
Total income per family worker	0	Low	total income < poverty line
	25	Low to medium	Poverty line < total income < regional minimum wage
	50	Medium	Total income is one to two times of regional minimum wage
	75	Medium to high	Total income is two to three times of regional minimum wage
	100	High	Total income is more than three times of regional minimum wage
Willingness to continue the dairy farming activity (social sustainability)	0	Low	farmers do not want their children to continue dairy business
	50	Medium	farmers let their children choose whether to continue dairy business or no.
	100	High	farmers surely want their children to continue dairy business
Waste management	0	Low	farmers evacuate all waste to river or surrounding area
	50	Medium	farmers still evacuate part of waste to river or surrounding area but some part others are processed to be biogas or fertilizer
	100	High	Farmers do not evacuate waste to river or surrounding area (main point), farmers process waste to be biogas and or fertilizer.
Own land per family worker	0	Low	Own land < Quartile 1
	50	Medium	Quartile 1 < Own land < Quartile 3
	100	High	Own land > quartile 3
Herd size per family worker	0	Low	Own land < Quartile 1
	50	Medium	Quartile 1 < Own land < Quartile 3
	100	High	Own land > quartile 3
Diversity of activities	0	Low	$Score = 100 - (\sum_1^3 \left(xi - \frac{100}{3}\right)^2 * 100/6667)$
	50	Medium	*With:*
	100	High	$\boldsymbol{xi} = contribution\ to\ the\ total\ income\ of\ the\ activity\ x$

$$\mathbf{6667} = maximum\ value\ when\ there\ is\ only\ one\ activity$$

168

169 **Data analysis**

170 The aim of the analysis was to understand which and how some farms are more or less
171 sustainable according to their structure, the choice of functioning and the technical and
172 economic performance. We conducted three steps of analysis. First, we performed a
173 descriptive analysis to describe farms in study area included farms' socio demograpic
174 characteristic, structure and dairy farming practices. Second, we calculated a score of
175 sustainability for six indicators and built the pattern of sustainability to identify which
176 farm have better sustainability than others. In this step, we performed multivariate
177 analysis (PCA and cluster analysis) for six indicators to build the pattern of
178 sustainability. Third, we performed comparative and descriptive analysis based on the
179 pattern of sustainability. In this step, we performed ANOVA, Tukey's test (alpha =
180 0,05) and descriptive analysis for some variables (structure, dairy farming practices,
181 technical-economic performance, and feeding system). From this analysis, we could
182 understand why some farms have a better sustainability for one or another dimension of
183 the sustainability.

184 **RESULTS**

185 **Description of dairy farms in the study areas**

186 The Table 4 present the description of farm in study areas based on their socio-
187 demographic characteristic, structure and practices. On average, farmers were 42 years
188 old. Farmers experience were varied between 2 to 47 years in dairy farming. The
189 farmers' education level was low. More than half farmers attended only elementary
190 school (Table 4). Farmers had on average three to four cows (3,9 AU per farm). Cows
191 were from Friesian Holstein which were mated with local breed since a half century

192 ago. In Indonesia, dairy cows were mostly kept in tie-stall barn and were fed through
193 cut and carry system. On average, total 45 kg of green fodder were given to the cow per
194 day. Dairy farmers accessed 0,3 hectare per farm which is mostly cultivated with napier
195 grass. The quantity of concentrate was around 6 kg of concentrate per cow a day.

196 Table 4. Farm description in study areas

Variable	Mean ± SD (n =355)	Min.	Max.
Farmer's socio-demographic characteristic			
Age	42 ± 11.6	21	70
Experience in dairy farming	12.9 ± 8	2	47
Level of education			
Bachelor degree	3	-	-
High school	27	-	-
Junior high school	64	-	-
Elementary school	261	-	-
Structure			
Herd size (AU/farm)	3.9 ± 3	0.5	27.3
Land use (ha/farm)	0.34 ± 0.42	0.003	3.4
Practice			
Quantity of concentrate	5.9 ± 2.8	0	16.3
Quantity of green forage	44.9 ± 21.3	0	125

197 Source: survey (2015)

198 **Sustainability pattern**

199 We identified five pattern of the sustainability. The characteristic of each pattern are
200 varied. Pattern 1 (P1) was very small and diversified farm. Pattern 2 (P2) was small
201 specialized dairy farm with children want to continue dairy business. Almost similar
202 with P2, Pattern 3 (P3) was also small specialized dairy farm but without children want
203 to continue dairy business. Pattern 4 (P4) was intensive and small specialized dairy
204 farm. The characteristic of Pattern 5 (P5) was small diversified farm.

205 The result indicated that P4 and P5 had medium to high score of sustainability for
206 almost all indicators. Compared with others, those pattern had the highest score. P5 had
207 higher score of sustainability and significantly different for almost all indicators except

208 economic pillar (48) and herd size per family worker (62). In term of income (economic
209 pillar), P5 had on average one to two times of minimum wage which resulted medium
210 score of sustainability. In addition, P5 had better waste management (environment
211 pillar) because they processed waste to be fertilizer or biogas and did not evacuate it to
212 rivers. Otherwise, P4 had the highest score of herd size per family worker than other
213 patterns. It enable them to generate more income from dairy business. However, they
214 have higher risk from dairy farming activity than P5. We then considered P5 was the
215 most sustainable smallholder dairy farming system due to the more balance for all
216 indicators than P4 (Table 5 and Figure 1).

217 Table 5. Pattern based on sustainability score (1-100)

Variables	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
Total income per family worker	27,9 ± 12,2 ^{B}	21,6 ± 12,6 ^{B}	25,9 ± 16,2 ^{B}	50,4 ± 29,7^{A}	47,8 ± 23,7^{A}
Willingnes to continue dairy business	59,7 ± 28,1 ^{C}	94,4 ± 15,9 ^{A}	25 ± 25,2 ^{D}	60,8 ± 27,8 ^{C}	76,7 ± 25,2 ^{B}
Waste management	60,4 ± 31,8 ^{B}	36 ± 36,9 ^{C}	44,6 ± 35,6 ^{C}	66,7 ± 36,4 ^{B}	87,8 ± 21,7 ^{A}
Own land per family worker	40,9 ± 36 ^{B}	37,6 ± 35,6 ^{B}	45,8 ± 34,9 ^{B}	63,3 ± 30,4 ^{A}	73,3 ± 25,2 ^{A}
Herd size per family worker	20,8 ± 24,8 ^{C}	27 ± 26,2 ^{C}	57,7 ± 22,6 ^{B}	96,7 ± 12,6 ^{A}	62,2 ± 28,5 ^{B}
Diversity	62,6 ± 16,5 ^{A}	11,7 ± 20,4 ^{BC}	15,5 ± 26,9 ^{B}	3,7 ± 7,8 ^{C}	58,1 ± 19,2 ^{A}

Means in the same column with a different superscript differ significantly (P<0.05); NS not significant

Source: survey (2015)

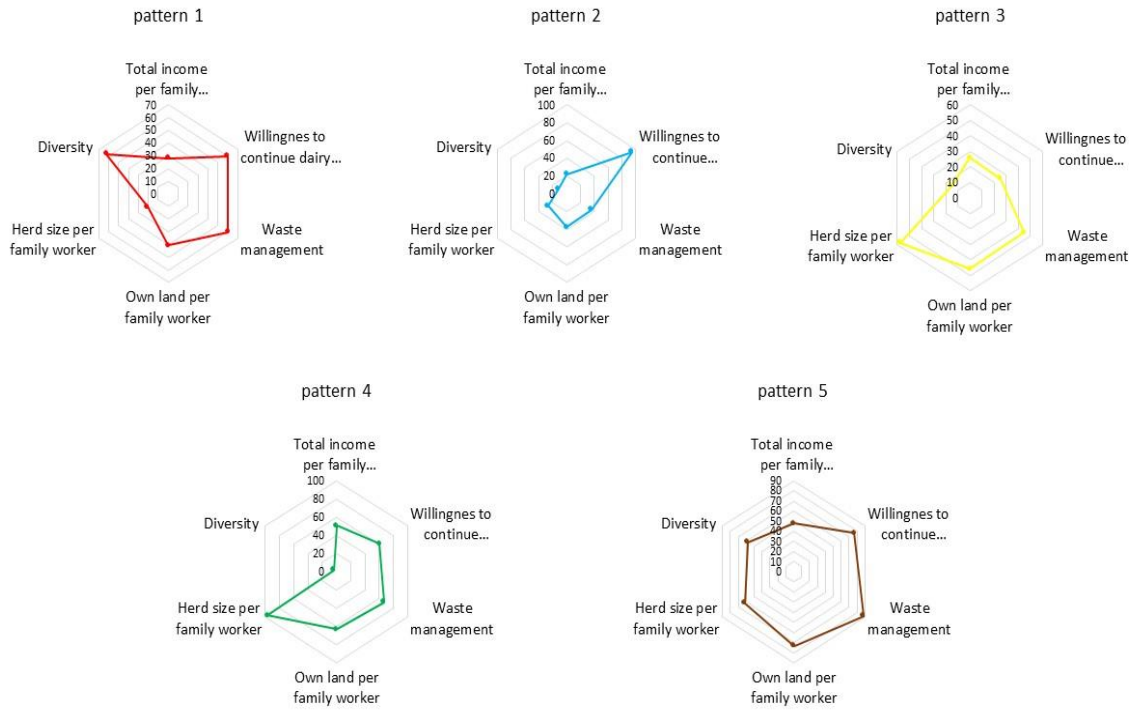

Figure 1. Sustainability pattern

The sustainability score of P2 and P3 were the lowest for almost all indicators (Table 5 and Figure 1). Farms in those patterns were less sustainable than others. Farmers at P2 only had less than 25 (low score of sustainability) for economic pillar and vulnerability. The income from dairy business was even lower than poverty line. Otherwise, their score of social pillar was significantly higher (94). P3 was less vulnerable than P2, meanwhile they had the lowest score in term of social pillar. Majority of farmers did not want their children to continue dairy business.

Characteristically, farmers P1 had the lowest score (20) of the indicator of herd size per family worker. As a response of small herd size and low score of economic pillar, they had another activity generating income to cover daily expenses. It resulted the medium score of sustainability (62) and significantly higher than other patterns on the indicator of diversity.

Characteristic of farms explaining their score of sustainability

Characteristically, farmers at P4 had better capital and technical-economic performance than other patterns. They had higher land use, herd size, and lactating cows and significantly different than other patterns (Table 6). They use more than 4600 m^2 of land per farm. On average, they had seven cows, of which five were lactating cows. Furthermore, for feeding practice, farmers fed the cows with an average 35 kg of forage and 5.5 of dry matter concentrate per cow per day. Even though quantity of forage was significantly lower than other patterns, they still had better technical-economic performance. Farmers sold almost 1800 liters of milk per month to cooperative. In a year, they received on average more than 50 million IDR per farm. It was significantly higher than others. Lower input resulted better performance. In other words, farmers P4 could manage their farms efficiently.

Diversified activity was a main difference between P4 and P5. Farmers P5 had also higher capital, practices, and technical-performance than other patterns which was the 2nd highest after P4. However, dairy business contributed only 65 percent. In other words, farmers P5 had other activity generating income. Quantity of feed even higher than farms at P4. It was because they used paddy straw and other crop residu for forage feed from their additional activity such as crop farming activity.

Majority of farms were farms P2 and P3 (Table 6). Generally, they had low capital and technical-economic performance. On average, they had two to three cows per farm. However, total workers on farms P2 was significantly higher than others. Meanwhile, P3 had the lowest total workers. The net dairy income on average was 1.8 to 1.9 million IDR per month (equivalent to US$ 139 to 144 per month[1]). Majority of

255 farmers at those patterns were specialized in dairy business which generate more than

256 80 percent of total family income.

257 Table 2. Structure, dairy farming practices, and technical-economic performance of
258 dairy farm

Variables	Pattern of sustainability				
	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
Structure					
Total land (m2)	3060 ± 3440 ^{AB}	2620 ± 2810 ^{B}	3190 ± 3790 ^{AB}	4660 ± 5700 ^{A}	4580 ± 5470 ^{AB}
Contribution of own land to total land (%) ^{NS}	40,1 ± 41,2	51,2 ± 43,8	43 ± 40,6	50,1 ± 40,3	54,3 ± 35,8
Total workers (person)	2,1 ± 0,6 ^{AB}	2,2 ± 0,7 ^{A}	1,9 ± 0,7 ^{B}	1,9 ± 0,9 ^{AB}	1,9 ± 0,7 ^{AB}
Herd size (LU)	2,3 ± 1 ^{D}	3 ± 1,6 ^{CD}	3,8 ± 1,7 ^{BC}	7 ± 4,8 ^{A}	4,3 ± 3 ^{B}
Lactating cow (LU)	1,7 ± 0,8 ^{C}	2,2 ± 1,5 ^{BC}	2,8 ± 1,5 ^{B}	5 ± 3,6 ^{A}	3 ± 2,2 ^{B}
Dairy farming practices					
Quantity of forage (kg/cow/day)	53,1 ± 23,3 ^{A}	44,1 ± 19,6 ^{B}	45,1 ± 20,7 ^{AB}	34,5 ± 17,3 ^{C}	46,5 ± 21,2 ^{AB}
Quantity of concentrate (Kg DM/cow/day) ^{NS}	5,5 ± 3	6,1 ± 2,8	5,9 ± 2,8	5,5 ± 2,8	6,3 ± 3
Working hours (hours/farm/day) ^{NS}	9,6 ± 5,1	10,6 ± 4,8	10,3 ± 4,2	11,7 ± 6,6	10 ± 4,7
Technical-economic performance					
Milk sold to cooperative (liters/farm/month)	640 ± 332 ^{B}	733 ± 480 ^{B}	862 ± 433 ^{B}	1782 ± 1413 ^{A}	994 ± 713 ^{B}
Milk productivity (liters milk sold/LU/day) ^{NS}	9,5 ± 4,1	8,5 ± 3,3	8 ± 3,2	8,5 ± 3,9	8,4 ± 3,9
Milk productivity per lactating cow (liters milk sold /lactating cow/day) ^{NS}	12,5 ± 4,4	12,2 ± 5,9	11 ± 4,3	12,3 ± 5,9	11,8 ± 4,7
Dairy income (million IDR/farm/year)	20,9 ± 14 ^{B}	23 ± 21,1 ^{B}	22 ± 20,1 ^{B}	51,9 ± 59,5 ^{A}	31,8 ± 19,9 ^{B}
Contribution dairy income to total income (%)	58,9 ± 21,4 ^{B}	85,6 ± 29,3 ^{A}	82,1 ± 31,5 ^{A}	88,7 ± 29,9 ^{A}	64,8 ± 21,2 ^{B}

Means in the same column with a different superscript differ significantly (P<0.05); NS not significant
Source: survey 2015
Note: 1 US$=13385 IDR in August 2017

259

P1 also had low capital and technical-economic performance. In term of herd size, farmers P1 had the lowest capital than others. They had less than three cows, of which two were lactating cows (Table 6). Due to their smaller size of herd, farmers fed the cows with an average 53 kg per cow per day and it was significantly higher. In addition, the milk productivity per cow was slightly higher but no statistical difference. Higher input (forage feed) resulted only slight higher milk productivity. In other words, it indicated less efficient than P4. Furthermore, dairy business only contributed less than 60 percent to total income. Farmers did not only depend on this activity to generate income. Diversified actvity was a response to face their limitation of low capital and low dairy business performance.

Feeding system

All cows were fed with green forage (cut and carry system) which mostly napier and natural grass, and in zero grazing system. As a member of cooperative, farmers purchased concentrate feed from milk cooperative. Majority of farmers mixed concentrate with tofu and or cassava waste as well as water. Feeding time was two to three times a day. Farmers provided water to the cows through ad libitum, twice a day or even only once a day.

Majority of farmers produced forage on their land (owned and rented). They also purchased tofu or cassava waste (Table 7). However, some farmers purchased all feed (forage, tofu, and cassava waste) particularly those who were located in the center of city. They could not access land for forage production due to high price of land. In addition, land was mostly for housing.

Table 3. link between feeding system and pattern of sustainability (number of farm)

Feeding system	Pattern of sustainability

	1 (n = 77)	2 (n = 89)	3 (n = 84)	4 (n = 60)	5 (n = 45)
1 (n = 48)	9	17	9	7	6
2 (n = 219)	51	47	54	37	30
3 (n = 15)	1	6	3	4	1
4 (n = 73)	16	19	18	12	8

1 = only produce forage, no additional tofu or cassava waste; 2 = produce forage, purchase tofu or cassava waste; 3 = purchase forage, no additional tofu or cassava waste; 4 = purchase forage, tofu, and cassava waste

DISCUSSION

Our result confirmed that capital play a key role to promote the level of sustainability in particular economic pillar. Higher capital such as herd size, land access, and know-how might resulting high technical-economic performance. Higher asset (land and herd size) enable farmers to produce more milk and calves to have better income (Lebacq et al., 2015). It then hence the higher sustainability.

Our result confirmed that diversified activity also play an important role not only to reduce risk of dairy business (uncertainty of milk price and input price) but also to have synergy between activity. However, our result is different with a study conducted by Khanh et al., (2017) that mentioning specialized dairy farms have lower production costs, and hence higher economic sustainability. In the study sites, farmers used paddy straw from their crop land to reduce cost of feed and used manure from dairy farm to be organic fertilizer. The efficiency is higher. It is explaining why farms in P5 were considered as more sustainable dairy farm than in P4. Eventhough, P4 had better capital but they were specialized in dairy that might have higher risk in the future such as instability of milk price and input price. Otherwise, P5 had strategy to diversify their activity generating income. More diversified farming system enable farmer to get more total family income by using available time and family worker. Farmers can use resource optimally (Gaspar et al., 2009; Lebacq et al., 2013; Ryschawy et al., 2013).

303 The result underlines the specificity of small-scale family agriculture that needs to be
304 able to switch from one activity to another in case of crisis or problem. Or this
305 underlines the fact that total farm income must be considered (instead of partial dairy
306 margin) (García-Martínez et al., 2011; Ripoll-Bosch et al., 2012).

307 Majority of farmers accessed land of State Forestry Enterprise (*Perhutani*) or of
308 State Tea Plantation (*Perusahaan Terbuka Perkebunan Nusantara/ PTPN*). It is a kind
309 of land use right / arrangement which is formal (in the case of forestry) and informal (in
310 the case of Tea Plantation). Since 2001, Perhutani invited community surrounding area
311 to manage forest (*Pengelolaan Hutan bersama Masyarakat-PHBM*). This community
312 based forest management allow farmers surrounding area to cultivate grass on forestry
313 land. There is also a tolerance from tea plantation as long as farmers only cultivate
314 grass. However, this arrangements are fragile and uncertain. In addition, the
315 infrastructure and location are not comfortable. It takes time and energy or even needed
316 additional worker to get the forage from this location. This is why the owned land is so
317 important in the sustainability indicator. It is also important to increase efficiency of
318 dairy business (Lebacq et al., 2015). It can reduce cost of feed or hire outside worker.

319 In social pillar, the result showed that P3 had the lowest score of sustainability.
320 Majority of farmers expect their children to have other activity. Due to their small size
321 of herd and land, dairy income generate less than minimum wage. Some studies
322 reported that economic is linked with social pillar (Lebacq et al., 2013; Van
323 Cauwenbergh et al., 2007). In addition, they only focused on dairy business. It is more
324 vulnerable. Otherwise, P2 who also had same characteristic with P3, but they had the
325 highest score of sustainability in social pillar. It is related to high availability of
326 workers. They had no choice to convert to other activity.

In term of environment pillar, it was explained by capital (owned land) and total income. Farms who had larger size of owned land and higher total income, they also had higher level of environment pillar. It is in line with study reported by Lebacq et al., (2015). Majority of farmers received biogas equipment and installation from dairy development project by cooperative, NGO, government and others. They obtained it for free, and some others by credit scheme through dairy cooperative. In other words, every farmers could access it. However, some farmers did not install biogas equipment due to limited space (small size of owned land) at barn. It underlines the importance of owned land to increase waste management practices.

Majority of farmers able to produce forage for the cows. In addition, about 20 percent of farms in P2 did not depend on cassava or tofu waste. Farmers had opportunity to cultivate forage on unused land of PTPN or Perhutani. However, in the future they will have uncertainty since PTPN and Perhutani would convert those land to cultivate horticulture and to be tourism area. In other words, input self sufficiency (particularly feed) has an important role to promote sustainable farming system (Lebacq et al., 2015; López-Ridaura et al., 2002; Ripoll-Bosch et al., 2012).

As a conclusion, working capital and diversity play an essential role to promote sustainability. Increasing know-how (human capital) is also important to enhance performance. Farms with higher capital will be more sustainable due to generate better technical-economic performance. This enhancement affect the indicators of sustainability. In addition, diversity could reduce the risk from only one activity generating income. Farmers will be less vulnerable. It might resulting the more balance of sustainability. We indicated that increased working capital and diversity can boost the level of the sustainability of smallholder dairy farming system.

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STATEMENT OF HUMAN AND ANIMAL RIGHTS

"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

"This article does not contain any studies with animals performed by any of the authors."

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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