The Influence Environmental Dimension of Good Dairy Farming Practices on Sustainability Smallholder Farm-Income at Malang Raya, East Java, Indonesia

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Abstract. Smallholder dairy farmer faced many challenges, including fluctuating milk process, rising input cost, and pressure to comply with quality and adopting environmental requirements. Implementing good dairy farming practice (GDFP) particularly in the environment dimension offered most useful in improving efficiency, productivity, and milk quality, hence generating farm income. This study investigates the adoption of environment dimension of GDFP in Jabung sub-district, Malang Raya, East Java Province of Indonesia. The 76 respondents who members of the "KUBE PSP Maju Mapan group were selected by multistage sampling method. They were grouped into two farm-scale based on Animal Unit (AU): farm-scale I (having 1- 6.38 AU; n=46 farmers) and farm-scale II (having 6.39 – 13.75 AU; n=30 farmers). Survey method was applied to gather primary data, whereas secondary data was provided by the related institutions. Descriptive and regression analyses have been carried to analyse the data. Results found that environmental practices vary in the two farm-scales. For farm-scale I, forage planting decrease farm income, while and housing density enhanced the farm return. For farm-scale II, cleaner housing improved farm income, whereas waste treatment activities and heavy water use reduce profitability due to additional operational costs. The study highlights the need future investigation that targeted policy interventions, cooperative-level infrastructure, and more nuanced sustainability strategies that support both environmental sustainability and rural livelihoods.
Keywords: housing density, forage-planting, waste-treatment, livelihoods

1 Introduction

The National milk demand now is projected to rise substantially due to several factors, such as government initiatives to promote animal-source foods in school feeding, reduce dependence on milk's imports, and the government programmes to expand national dairy herd in some other years. These situations can create the opportunities for smallholder

dairy farmers who, currently supply most (80%) Indonesia 's raw milk, positioning farmers as key actors in fulfilling the increase national milk demand and supporting rural livelihood. The dairy industry exhibits the variations in consumption patterns and demand for products [1]. Smallholder dairy farming is not only having economic function but this farming also contributes to income diversification, risk management, asset accumulation among small farmers [2] and food security [3].

Smallholder dairy farming in Indonesia however, is characterised by low and unstable milk yields, variable milk qualities, and infrastructure constraint, often faces challenges related to infrastructure, storage, and transportation [4], weak cold-chain, and limited access to extension, veterinary service and finance [5]. This farm is often undertaken by households with land endowments and limited off-farm opportunities. Generating the profitability and resilience of smallholder dairy farming is therefore critical for the expansion of the dairy sector and for reducing rural poverty, however enhancing this farm must occur in easy that are environmentally sustainable and socially acceptable.

Good dairy farming practices (GDFP) offer an integrated framework to improve animal Health and welfare, milk quality, productivity, and environment sustainability. Environmental components of GDFP involve efficient use water and nutrients, appropriate housing design and stocking density, manure and waste water treatment and energy-efficient technologies [6]. Despite the importance agreement, empirical evidence on economic implication of these environmental practices for smallholder dairy farmer remains limited.

Previous studies found that smallholder dairy sustainability highlights the productivity gains are often a precondition for reducing the environment impacts per unit of milk produced [7]. However, the previous investment and recurrent costs associated with environmental measures- for instance forage planting on scarce land, construction of waste-treatment facilities, or provision of abundant clean water-can be substantial for smallholders. Farmers therefore tend to adopt practices that directly and visibly improve herd performance or reduce labour requirements, while measures targeted primarily at pollution control remain under- implemented. Existing studies furthermore tend to investigate environment practices or technical interventions in isolation and rarely link them quantitatively to farm income in smallholder settings.

Malang Raya is one of the important hub milks that produced by smallholder dairy farmer, where farms typically operate with limited land and capital while supplying formal and informal markets. There farmers face many of structural challenges, including fluctuating milk process, rising input cost, and pressure to comply with quality and environmental requirements. The present study however focused explicitly on the environmental sustainability dimension of GDFP in smallholder dairy farmer in Jabung sub-district of Malang Raya. East Java, Indonesia. The study addressed to investigate the farmer's characteristics based on two farm-scales, examine the implementation environmental dimension of GDFP by two farm-scales, and to explore the influencing of the environmental practices of GDFP involving forage planting, housing density, waste treatment, housing cleanliness, and water availability on farm income for two farm-scale categories.

2 Materials and methods

Research was held on Kemiri village, Jabung Sub-district, Malang Raya, Indonesia that selected by purposive sampling method. Total of 76 respondents were selected by multistage sampling method. This area was selected because the Jabung sub-district possesses a large dairy cattle population of approximately 14,167 heads [8]. They were members of the "KUBE PSP Maju Mapan group" with the following inclusion criteria: (i) owning lactating dairy cattle; (ii) participating in formal milk marketing through a cooperative or private collector; and (iii) agreeing to provide detailed information on herd structure, management practices, and income. The 76 respondents were grouped into two farm-scale based on Animal Unit (AU): farm-scale I (having 1- 6.38 AU; n=46 farmers) and farm-scale II (having 6.39 – 13.75 AU; n=30 farmers). Data collection has been carried from May to June 2025. Survey method was held to gather primary data using structured questionnaire. Secondary data was provided by related institutions.

Three data analyses were carried out based on research objectives. The first research objective "to investigate characteristic of smallholder farmers ", was analysed by descriptive analysis. This addressed to delineate the farmer's profile based on gender, age, education, earning and experience in operating dairy farming. Second objective: "examine the implementation environmental dimension of GDFP by two farm-scales "were analyse by descriptive analyses. It aimed to describe the implication environmental dimension of GDFP. The third research objective:" explore the influencing of the environmental practices of GDFP involving forage planting, housing density, waste treatment, housing cleanliness, a water availability on farm income for two farm-scale categories "was analysed by regression technique. This analysis explains how the environmental dimensions of GDFP affect farm income. Model smallholder dairy farming's performance that environmental objectives with income and livelihood security can be developed a s the below formulation:

$$Y=a + b\,X1 + cX2 + \ldots\ldots\ldots\ldots\ldots + iXn$$

Where:

Y : farm income of smallholder dairy farmimg (IDR)
a : constant
X1 ….n : Variables of environment dimension of GDFP
b, c, ….i : Regression coefficient

3 Results and discussion

The discussion divides into three parts, first describe the characteristics of smallholder dairy farmer based on farm-scale, second delineate the implementation of environment dimension of good dairy farming practices (GDFP) based on farm-scale; and third explain the environment dimension of GDFP on smallholder dairy farming based two farm-scales.

Farmer's characteristics

Smallholder dairy farmers are predominantly male aged 32-41 years for farm-scale I, while it was 42-51 years for farm-scale II. Farmers in the farm-scale I have lowest education (Primary school) compared those for farm-scale II (Secondary school). The farmer with higher education in farm-scale II is more likely to apply the environment dimension for improving milk productivity and quality in generating farm income. This finding is in line with previous study that that farmer with higher education is generally to adopt innovative practices and technologies, leading to increased productivity and, consequently, higher incomes [9].

Research indicates that the shorter experience was presence in farm scale I (10-18 years), whereas long experience (19-28 years) involved in farm-scale II. Farmers with long experience in the farm-scale II have possibility more knowledge and skill as potential factor in determining the successful in income enhancement. Similarly, older farmers tend to have more experience adopting innovative practices and technologies, leading to increased productivity and, consequently, higher incomes [9].

The average monthly dairy income is substantially lower or farm-scale I (about IDR 2,000,000) than for farm-scale II (around IDR 5,000,000). Higher income levels in Farm Scale II are derived from multiple sources, with the agricultural sector serving as the primary earner and dairy farming as a secondary return. In contrast, smallholders in Farm Scale I rely solely on dairy farming as their primary livelihood. This pattern is consistent with evidence that dairy households typically combine livestock with crop production, cooperative membership, and occasional off-farm income to manage risk and smooth consumption [10].

Implementation of GDFP -environment dimension for smallholder dairy farming

The environmental dimension of GDFP practices in both farm-scales particularly in Minimize the production environment pollution from dairy farming was very low adoption (<25%) as summarised in figure 1. This investments in pollution control or advanced waste treatment are more likely to be under provided because their benefits are less immediate or accrue to the wider community [11].

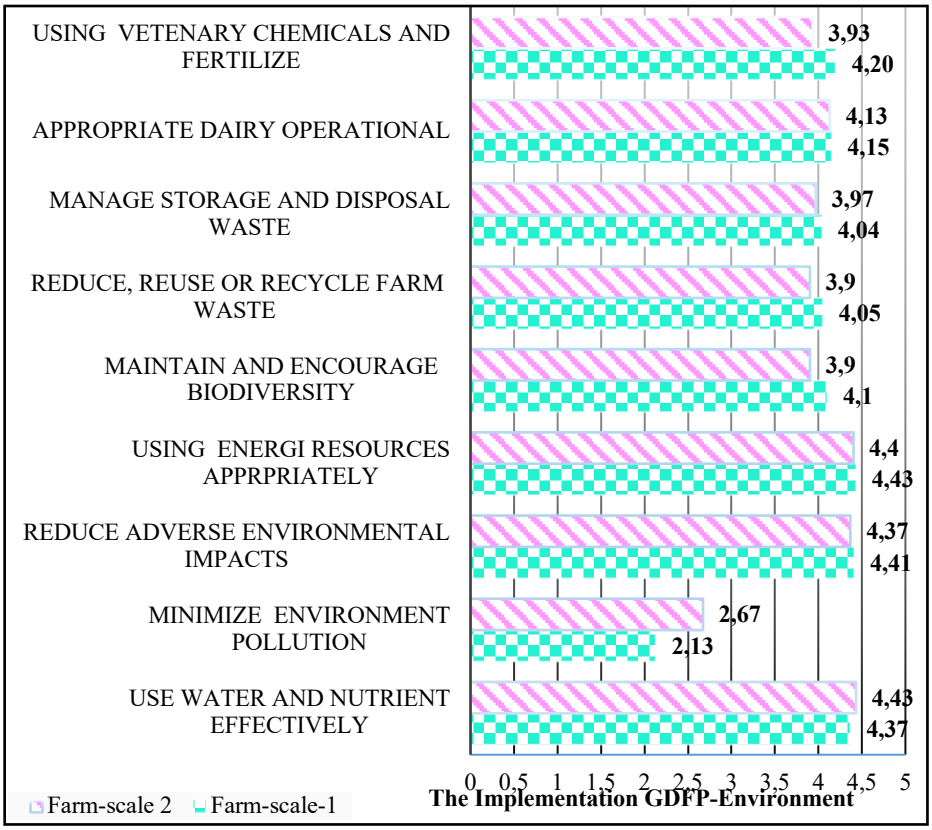

Figure 1. Implementation The environment dimension of GDFP on smallholder Dairy farming

Noted:
1 = not implemented yet GDFP-Environment (=0%)
2= implemented GDFP-Environment around 1-24%
3= implemented GDFP-Environment around 25-49%
4= implemented GDFP-Environment around 50-75%
5= implemented GDFP-Environment more than 75%

Figure 1. states the implementation of environment dimension of GDFP in both farm-scales related efficient input use (select and use energy resources appropriately), animal health (manage livestock to minimize adverse environment impacts), and the use of energy (Select and use energy resources appropriately) represented the good adoption in category about more than 75%. This asymmetry aligns with international findings that farmers tend to prioritise practices with visible short-term productivity or animal health benefits, such as basic hygiene and disease [12].

These farm-scales differentiated results underscore the need for more nuanced interpretations of environment sustainability in dairy farming, environment practices do not uniformly enhance profitability, and without supportive institutional mechanisms - such as cooperative waste-treatment facilities, subsidies, or cost sharing arrangements- they may place disproportionate burdens on smallholder dairy farmers. At the same time, neglect of waste and waste water management risk exacerbating public health hazards,

including antimicrobial resistance, which is well documented in dairy effluents in East Java. Thus, the broader policy challenge lies in aligning environment goals with farmer incentives.

The determinant of environment dimension influencing on smallholder income based on farm-scales

The nine environment dimension variables include (i)Use such inputs like water and nutrients effectively and sustainably, (ii) Minimize the production environment pollution from dairy farming, (iii)Manage livestock to minimize adverse environment impacts, (iv)Select and use energy resources appropriately, (v)Maintain and encourage biodiversity on the farm, (vi)implement practice to reduce, (vii) reuse or recycle farm waste appropriate, (viii) Manage storage and disposal of waste to minimize of environment impacts, and (ix) ensure the overall appearance the dairy operation is appropriate for facility in which high quality food harvested, use agriculture and veterinary chemicals and fertilizers appropriately. The regression technique is carried out to analyse the nine-environment dimension of GDFP that influence on smallholder dairy farming income-based farm-scale and table 1. explains the regression results.

Table 1. Variables environment dimension of GDFP that influencing on smallholder farm income based on farm-scales

Model Applikasi GDFP Environment dimension of GDP	**Farm-scale-I (1–6.38AU)**	**Farm-scale -II (6.39–13.75 AU)**
	Model I: Y1=11,03-0.46 X1+6.19 X2 Where: Y2 = Dairy farming income X1=Forage planting X2 =Housing density R2=88% R2 Adj.- 81% F test = 10.35	Model II: Y2=5.33+0,82X1+1.95 X2 -4.12 X3 Where: Y = Dairy Framing Income X1=Waste treatment X2 = Cleanliness Housing X3 = Abundant water use R=80% R2 Adj= 71% Ftest = 12.46

Note :
AU = Animal Unit

Table 1. delineates the results of regression analysis of the Farm-scale I with coefficient determination R^2 is about 81%. It means that nine environment variables can explain 81% of the farm income, whereas 19% is affected by excluding variable that haven't available in this research. F-test indicates the very significant ($P< 0.005$) that can be interpreted that nine variables dimension environment together influence simultaneously significant ($P<0.005$) on fam income. Result for t-test exhibited that two variables, forage planting (X1) and housing density (X2) show significant influencing on farm income. The model of farm-scale I is presented as below:

$$Y=11.03-0.46\ X1+\ 6.19\ X2$$

In regard to farm-scale I, forage planting is negatively significant ($P<0.05$) influencing in farm income. The findings highlight the opportunity costs associated with forage planting under land scarcity, and risk that intensification without adequate infrastructure may heighten disease risk or heat stress. Consequently, these farms have not achieved optimal profitability, as they have not fully implemented environmentally sustainable farming systems. On the other hand, housing density is positively influencing in farm income. Farmers in Farm Scale I have already applied good management practices regarding appropriate dairy housing, which has led to increased milk production. The increase productivity can be obtained with consider local contexts an environment sustainability and showcasing a path forward that leverages the unique strengths of small farms [13].

Regression analysis of the Farm-scale II has coefficient determination R^2 is around 71% (Table 1.). It means that nine environment variables can explain 71% of the farm income, and 29% is affected by excluding variable that no available in this study. F-test indicates the very significant ($P< 0.000$) that can be interpreted that nine variables dimension environment together influence simultaneously significant ($P<0.000$) on fam income. Result for t-test exhibited that three variables, housing cleaning (X1), waste treatment (X2) and the use high water(X3) have significant effected on farm income. The model of farm-scale II can be formulated:

$$Y=5.33+0,82X1+1.95\ X2\ -4.12\ X3$$

For Farm-scale-2, housing cleanliness is positively significant ($P< 0,05$) influencing in farm income, confirming the economic value of improved hygiene and mastitis prevention. Likewise, waste treatment and high-water use show positive significant ($P< 0.05$) affected in farm income, (P-4). This farmer in farm-scale II can better absorb the cost associated with implementing advanced environmental technologies, such as nutrient management system s and waste recycling processes, leading to improved sustainable income [14]. Conversely, the use high water presents negative associations with farm income suggesting that these environmental measures impose additional costs without short-term financial returns. Hence, environmental factors, mediated by engagement, were not significant with sustainable profit [15].

4 Conclusion

The smallholder implementation of the Good Dairy Farming practices (GDFP) particularly in environment dimension can conclude as follow: Smallholder dairy farmers in farm-scale I are predominantly men aged 32-41 years with primary school education, 10-18 years' experience in operating dairy farming and monthly income less than IDR 2,000,000). Smallholder dairy farmers in farm-scale II are represented by men aged 42-51 years with secondary school education, 19-28 years' experience in running dairy farming and monthly income around IDR 5,000,000. Many dairy farmers readily adopt hygiene- and animal health-related GDFP elements, while practices specifically intended to reduce environmental pollution-such as manure treatment and waste water

management-remain limited. This asymmetry reflects broader patterns in both farm-scales income, where resource constraints, labour demands and uncertain private returns have historically slowed the uptake of environmental practices.For farm-scale I, forage planting can decrease farm income, while housing density enhances the farm return. For farm-scale II, housing cleanness and waste treatments can improve farm income, whereas the use heavy water reduces profitability due to additional operational costs.

Future research could address to the comparative studies across regions and farm type, linked to cooperative preperformance and policy to identify scalable pathways that reconcile environmental objectives with income and livelihood security.

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