Synchronize level of precision dairy farming in Indonesian smallholder and rural ranches: A review

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Abstract

Precision dairy farming (PDF) application in smallholder and rural dairy farming to elevate a cow's effectivity, efficiency, and productivity level has been confronted with the ranchers' economic, social, and ecological status. Mainly, for the smallholder and rural dairy rancher, the financial position is the biggest challenge to adopting technology because it is publicly known that it is a costly investment. However, those issues could be cracked with synchronous feasible technology with the rancher situation. Therefore, the present probe was to enlighten the relevant level of PDF performed for the Indonesian smallholder and rural rancher. On the other hand, the crucial priority area that should be improved immediately could be identified with clarity.

Introduction

It has been scientifically proven that dairy cattle in the third country have contributed to scaling down the poverty level in various regions (Dagula & Kiminami, 2008). However, dairy farmers in developing countries are still in low income in the current situation due to the small business scale (Sulistyati & Firman, 2019). In addition, data shows that dairy farming is merely a side job, not the primary one in that area (Juliansyah et al., 2022; Purwantini et al., 2021). Therefore, the condition becomes complex and complicated.

Backwards several decades, the agricultural development strategy of the government generally emphasized the labour-intensive approach, even in America (Martin, 1983). The reason is that the approach verified evidence of positive performance significantly to the farm worker's income (Thị Hong Bui & Huu Le, 2020). Notwithstanding, the income status of the dairy farmers in the third country is continuously at a low level hitherto. Hence, there must be something wrong with the development policy, which was inclined toward the labour-intensive strategy only.

A policy focussing on the labour-intensive tends to avoid using mechanical machines on the farm due to the labour-saving characteristic and substituting human workers (Kurniawan, 2021). Therefore, mechanization is frequently confronted with labour-intensive policy in the antipodal position. Another technology is genetic modification in the comparable condition (Ritter et al., 2019). This situation should not occur. Mechanization and the labour-intensive could be harmonized to achieve higher productivity. However, mechanization is a part of the Precision Dairy Farming (PDF) system. Consequently, the most precise formula of mechanization applied without affecting the number of team members on the farm should be diagnosed conscientiously but as soon as possible, particularly in smallholder dairy farms.

There are various definitions concerning PDF. However, the PDF could be simplified into a description of application technologies on dairy farms to maximize the production potency of each cow (Bewley, 2010; Islam & Saikia, 2021). Execution of the PDF in middle-low income states is only possible by adopting some available technology, notably in smallholder ranches. Still, it should be selected according to the constraints and suitableness of the on-farm situation (Rathod & Dixit, 2020). Hence, the application of righteous modified PDF is encouraged.

Issue of dairy farming in the smallholder

The issue in dairy farming in the middle-low country is a need for better dairy farming practices, high feed cost, small scale flock, low milk yield per cow, and short longevity of dairy cattle (Moran & Morey, 2015). Subsequently, smallholder dairy farmers also have cattle reproductive problems (Yusuf, 2020). In addition, the herd ratio between lactation cows and dry cows in smallholder dairy farmers is in poor condition, and the milk producer's work rate is low (Atmakusuma et al., 2019). Straightforward, smallholder dairy farmers are also categorized as unskilled workers, unaware of the cattle genetic quality and poor quality of feedstock (Oliveros, 2019). In common, the small-scale dairy rancher also has narrow landlord possession (Thirunavukkarasu et al., 2019). Then, fresh milk prices range in middle-low-income countries by merely 0.37 US$ per litre (Nurunisa & Fadila, 2022). Under those prices, the production cost is usually uncovered (Septiani et al., 2017). Thus, dairy ranchers' revenue is generally categorized as low level (Fuah et al., 2011). Those conditions were aggravated by the fluctuating raw milk prices in the extreme slope (Sutawi et al., 2022). Capital limitation also becomes a big issue for dairy ranchers because technology is expensive (Quddus, 2012; Silvi et al., 2021).

With the magnitude number and complexity of the issue, the satisfaction level of the dairy rancher in the middle-low income state is classified as a happy life (Sutawi et al., 2022). It might be sourced from another esteem seized from the dairy farmer profession, like masculinity motive (Deming et al., 2019). On the other hand, smallholder dairy farmers in middle-low income states dominate the population share of dairy cows than the private and public sector-owned (Oliveros, 2019). Thus, the prospect and potency of dairy farming is a relatively ample opportunity.

The detrimental effect of the labour-intensive policy

The "minimum wage law" would be on duty automatically and instantly when the labour-intensive policy was taken (McCulloch, 1974). This law is the most intrusive issue in the labour-intensive strategy. In due course, that issue would derivate many specific problems. Therefore, this law is the root issue of that policy. As a precedent, a sector implementing a labour-intensive program as the primary approach would accommodate and hire unskilled workers due to the low wages offered (Wood, 1995). Due to skilful labour, they would be uninterested in a lower salary according to the human motivation theory (Meesook et al., 2022). Prospective young, educated people would refrain from incorporating sector-applied labour-intensive policy in the vying occupation market (Kalenkoski, 2016).

According to data, a teenager needs to be more interested in plunging into the dairy farming sector, even if the youngster is a descendant of a dairy rancher family, indicating a similar phenomenon (Thirunavukkarasu et al., 2019). Even though contrariety data indicates the parent profession predisposed the perception and behaviour of the juvenile to entangle in the dairy farming field. (Beecher et al., 2019). On the secondary level of education, the schoolboy perception also signifies a symptom that a career in the dairy farming sector is not prospective due to unprosperous. However, the loftiest argument is that the high physical workload is the primary motivation to preclude joining dairy farming (Beecher et al., 2022). Afterwards, the ageing ranch labour propensity would emerge due to the lack of a regeneration process (Kato et al., 2022). In the long term, this phenomenon could jeopardize the sustainability of dairy farming as a system. To avoid that calamitous situation, adopting a technology is a solution.

Pros and cons of technology adoption in smallholder dairy farmers

As mentioned, adopting technology in dairy farming in middle-low states has become a hot topic and has been renounced broadly. However, a researcher stated that technological gaps influence dairy ranchers' productivity levels (Latruffe et al., 2023). Therefore, a dispute arose when embracing technology in dairy farming, especially on the small scale of the ranch. In order to get an objective consideration between approved or unapproved technology adoption in the dairy ranch, the pros and cons point of view should be served in minutiae and dichotomy. A detail of pros and cons is dished up in Table 1 below.

Table 1. Pros and cons of technology in Dairy Ranch

Pros rationale	Reference	Cons rationale	Reference
Improve output capacity	(El-Osta & Morehart, 2000)	High-cost investment	(Upton et al., 2015)
Elevate good dairy farming practices	(Singh et al., 2021)	Lessen the human worker field.	(Butler et al., 2012)
High efficiency	(Lyashenko et al., 2022)	Oblige a particular competence.	(Eastwood et al., 2017)
Ensure sustainability	(Kozina & Semkiv, 2020)	Require additional infrastructure	(Harrison et al., 2017)
Competitiveness uplift	(Frick & Sauer, 2021)	Unfamiliar with new technology	(Jensen, 1982)
Minimize calamitous factors of productivity	(Akbar et al., 2020)	Short term uneconomical	(Rathod & Dixit, 2020)
Rectify the health and animal welfare quality.	(Jacobs & Siegford, 2012)	Inflexible or unpractical	(Galina et al., 2016)
Time consume efficiency	(Wildridge et al., 2020)	Lack of technical assistance	(Diro et al., 2019)

From the different opinions concerning the technology used in dairy ranches, Table 1 is a fundamental reasoning that guarantees the continuous process of the dairy ranches from time to time. Hence, eminent reasoning is sustainable insurance proposed by technology due to the thriving technology committed to escalating dairy management quality, particularly in high milk yield cows (Spahr, 1993). To it, the competing ability of the dairy sector increases parallel with the adoption level of technology (Kondratieva et al., 2021). Accordingly, technology infiltration in the dairy farming system is an inevitable process. Still, one thing should be ascertained: technology adoption's gradual alteration with smooth movement. Besides, projections between dairy ranchers' technology needs and invented innovation become vital to dairy farm manufacturing technology (Borchers & Bewley, 2015).

Rancher's rationale for adopting a technology

A handy technology, return on investment (ROI) period and the on-farm suitability level are the primary arguments for adopting technology (Silvi et al., 2021). Specifically, the feeding and milking system area is critical and prioritized by a rancher to adopt the technology over the other sectors (Khanal et al., 2010). In addition, mastitis detectors, oestrus detectors, and daily milk yield instruments are mostly advantageous and applicative technologies in the ranch (Borchers & Bewley, 2015). Another, dairy ranch location and cow number become factors in implementing a new technology (Gillespie et al., 2014; Korir et al., 2023). In the bold line, technology acceptance factors are influenced by general aspects such as socioeconomic, agric-ecological, constitution, knowledge, perception, attitudes, and technology concerns (Tey & Brindal, 2012).

Available technology in dairy farming

In broad outline, present existing technology in dairy farming can be classified into several major groups, such as digitalization, mechanization, genetic engineering, feed technology, and health and reproduction technology. This classification is based on the rancher's assumption of necessity, importance, and contribution, as explained in the subchapter issue on dairy farming. Despite this, those groups still break into further. Each group of the technology category could derivate toward an exact technology sample in Table 2.

Table 2. Sample of available technology in dairy farming

Digitalization	Mechanization	Genetic	Feed techno	Repro tech.
Internet of thing – IoT (Vate-U-Lan et al., 2016; Wang et al., 2019)	Automatic milking systems – AMS (Matson et al., 2021)	Omics (Lippolis et al., 2019)	Silage and hay (Brown et al., 1963)	Artificial insemination (AI) (Gwazdauskas et al., 1981)
Artificial intelligence – AI (De Vries et al., 2023)	Milking parlours (O'Brien et al., 2012)	Selection (Hansen, 2000)	Urea mineral block (Insoongnern et al., 2021)	Embryo transfer (ET) (Hasler, 1992)
Big data (Cabrera et al., 2020)	Dairy robotics (Rodenburg, 2017)	Crossbreeding (Sørensen et al., 2008)	Precision diet formulation (White & Capper, 2014)	Superovulation (Fernandes et al., 2020)

Table 2 is merely a glance description of actual technology today. There is much technological invention in dairy farming. The sampling served to snapshot the probable technology for smallholder ranches.

Synchronized precision dairy farming in smallholder and rural

As contemplation, reconciliation between the prominent issue in smallholder and existing technology must be mapped precisely. According to rancher perception, the prominent factor in adopting a technology could be summarized into a few main constituents: affordability, effectivity, user-friendly, and physical workload abatement. Subsequently, Table 3 aligns existing technology with the prominent issues in dairy farms.

Table 3. Juxtaposition of existing technology and issues in smallholder ranches

Tech and issues	Affordable	Potent	User-friendly	Workload lessen
Digitalization	◔	◑	◔	◔
Mechanization	◔	●	◔	●
Genetic	◑	◕	◔	○
Feed tech.	◕	◕	◕	◔
Reproduction tech.	◑	◑	◑	○

Note: ○: almost none, ◔: less, ◑: partially, ◕: dominantly, ●: almost fully

As mentioned, the most critical factor for a smallholder rancher to adopt technology is the capacity to reduce the workload on the farm. Due to this, smallholder farming generally is a family business. Therefore, mechanization technology is the rendezvous point between the most expected technology to be adopted by the ranchers. However, this area of technology has a shortcoming in the price level. Subsequently, the second place is taken by feed technology, followed by digitalization, reproduction technology, and genetic improvement sequentially.

Forthcoming proposed PDF research in smallholder and rural ranches

Modernizing the process approach of the dairy ranch has an impact on elevating the level of effectiveness and efficiency in the production system (St Aisyah et al., 2020). Then, PDF is eye-catching and engaging with the youth perception (Hostiou et al., 2017). Besides that, implementing the mechanization in the individual farm did not affect the number of labour occupied for an extended period but distinctively in the non-individual farms (Reimer, 1984). Despite the issue of the resource boundary in the smallholder dairy farmers, the logiest strategy to lift the farmer's income is to boost the milk yield of each cow by upgrading the genetic quality of the cattle and feed quality as well as balancing nutrition (Tricarico et al., 2020). In harmony, proper feed and stocking techniques, barn modification, and cow genetic improvement significantly influence the ranch revenue (Tawaf & Russanti, 2017). Nevertheless, the effectiveness level of implementing PDFs in smallholder and rural ranches is dependent on economic social factors, and ecological situations (Rathod & Dixit, 2020). Therefore, the most appropriate PDF implementation for smallholder and rural area dairy farmers is merely at the entry-level, not the advanced technology (Jago et al., 2013).

The situation of unskilled labour in dairy ranchers, thus they are also unwilling to adopt some technology like a milking machine and chopper even though this technology is categorized as "entry-level" (Das et al., 2016). Consequently, the future defiance for all experts in dairy farming is to design a mechanization system and feed technology for small-scale dairy farming with the ability to alleviate the workload, be low-cost, powerful, easy to use, effective and efficient in a small herd, and extraordinary skill needless. Alternatively, existing technology could be modified into simpler ones with condition coverage of the criteria previously mentioned, thus being suitable for smallholder and rural dairy ranchers in Indonesia.

Conclusion

From scrutinizing this paper, implementing precision dairy farming in smallholder ranches and rural areas should emphasize mechanization as an initial priority to improve immediately, followed by the feed technology sector. As a consideration, those two areas have the most arduous workload area, and the rancher would instantly seize the impact of the technology in the economic value aspect. However, the most reasonable PDF technology applied to the smallholder and rural ranches is in the "entry-level", not "advanced-level" of technology and appropriate with the herd scale. In addition, reproductive technology and genetic improvement aspects should be interfered with and confiscated by the local government.

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