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Adoptions of Technology on Smallholder Dairy Farming in Bangladesh

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ABSTRACT:

Integrating technology into small-scale dairy production is crucial for enhancing productivity and ensuring long-term sustainability. This research investigates the influence of technology and artificial intelligence on small-scale dairy production in Bangladesh. The results suggest that the use of mobile phones and artificial insemination play a vital role in the process of upgrading dairy farming methods. Mobile phones improve communication, facilitate market access, and enable the transmission of information, resulting in enhanced decision-making and increased efficiency. Artificial insemination enhances the genetic quality and milk output, therefore contributing to the economic sustainability of farmers. The study emphasizes the need of ongoing assistance and education to fully exploit the advantages of these technologies and suggests more investigation to comprehend their lasting effects on small-scale dairy farming in Bangladesh.

Keywords: Smallholder Dairy Farming, Cell phone, Artificial Insemination, Bangladesh

1. Introduction

Livestock production contributes 40% to global agricultural Gross Domestic Product (GDP) and approximately 30% to agricultural GDP in developing countries (Erdaw, 2023). Dairy production, a subset of livestock production, is crucial for the livelihoods of small-scale farmers in developing nations. In Asian countries, small-scale dairy production systems exhibit low productivity and sluggish technology adoption. This is also true in Bangladesh, where the dissemination of dairy technologies has been ineffective despite previous attempts.
The importance of smallholder dairy farming in Bangladesh is now considerable in both rural lives and the national economy. The majority of dairy producers work at a modest scale, often overseeing just a small number of cows. These agricultural establishments are often managed by families and significantly depend on human effort. Smallholder farmers are encountering difficulties such as restricted availability of top-notch feed, veterinary services, and technology (Pandey & Upadhyay, 2022). However, they are progressively reaping the rewards of government and NGO programs that focus on enhancing production by providing training and improved resources. The progressive use of more effective dairy techniques and small-scale technologies is improving milk production, which in turn helps meet the nutritional requirements of the population and ensures economic stability for farmers (Gichohi, 2020).
The use of mobile phones and artificial insemination in smallholder dairy farming in Bangladesh signifies substantial progress towards modernity and enhanced productivity (Erdaw, 2023; Waiswa et al., 2021). Cell phones have become indispensable instruments for farmers, allowing them to instantly access up-to-date market information, communicate with suppliers and customers, and get timely weather forecasts and agricultural advice. This connection enables farmers to make well-informed choices and enhance their commercial operations.

The use of artificial insemination (AI) has had a profound impact on improving dairy output. AI enables farmers to enhance livestock breeding by granting access to better genetic material, resulting in healthier and more productive cattle. This, in turn, leads to increased milk output and improved herd quality over time. The technology is backed by several government and non-governmental initiatives, often providing training and services at reduced costs, so ensuring accessibility for farmers with minimal resources. These technologies are essential for the success and expansion of small-scale dairy farms in Bangladesh, enabling them to flourish in a competitive market.

2. Literature Review

2.1. Cellphones

Farmers and fishermen have used cell phones in many regions of the globe to enhance their companies, presenting advantages and difficulties. In Ghana, the usage of smartphones allowed cocoa farmers to reduce many expenses related to transactions, such as transportation and operational expenditures (including the organization of inputs and communication with buying clerks) (de Dios García-Villegas et al., 2020). An examination of the fishing sector in Ghana revealed that fishermen who had mobile phones were capable of Utilising cellular communication to broaden their customer base. Furthermore, the fishermen could make informed judgments by using real-time information obtained via their mobile devices (Bateki et al., 2021). Farmers in northern Ghana said that they had more contact with providers of agricultural inputs, leading to greater efficiency in their farming practices (Mutuma et al., 2023). Nevertheless, there has been a scarcity of study about the use of cellphones for agricultural education in Bangladesh.

Research conducted in India examined the use of cell phones for the distribution of agricultural information. The study found that farmers primarily utilized their phones for social purposes, and receiving extension messages was not a primary focus (Krell et al., 2021). Nevertheless, a more recent research conducted in the same region of India has shown that farmers used mobile phones. Before the 2014 research, there was almost 3 years during which contact took place with universities and veterinary institutes about animal husbandry. The authors suggested using appropriate strategies to encourage the use of smartphone technology in order to effectively distribute and utilize livestock-related information (Chiumia et al., 2020). There has been further progress in agriculture aimed at enhancing the influence of human communication and social relationships on agricultural production and the incomes of small-scale farmers. Specialized apps have facilitated the establishment of social connections by serving as channels for the distribution of information in the United Kingdom (The World Bank, 2012). These advancements are necessary in Bangladesh as well.

In the last ten years, mobile technology has been widely available even in the most rural areas of Kenya (Mavura, 2023). In Pabna, as in the rest of Bangladesh, cell phones are used to exchange and spread information. This includes monitoring diseases and weather conditions, advertising and marketing, conducting financial transactions, promoting businesses, providing access to counsel, and other similar functions (The World Bank, 2012).

Research conducted in Pabna, Bangladesh, found a noteworthy correlation between the enhancement of smallholder dairy farming and the use of cell phones for the delivery of extension services (Resti et al., 2024). However, despite the significant potential of cell phones in enhancing smallholder production, many variables affect the extent of these benefits. The elements that influence the effectiveness of information dissemination in agriculture include the timeliness, quality, and trustworthiness of the information, as well as the kind of agricultural methods, the skills and knowledge levels of the farmers, and the institutional rules and regulations (Uddin et al., 2022). The under-utilization of animal husbandry information via smartphones has had a negative impact on milk production in smallholder dairy farms (SDFs) in Bangladesh, as stated by Smollo et al (2016). There is a growing need to understand the practicality of information and communication technology (ICT) to improve agricultural productivity and increase revenue in small-scale farming businesses (The World Bank, 2012). Nevertheless, there is a need for study to determine the efficacy and use of cellphones, as a kind of information and communication technology (ICT), in educating farmers and distributing extension-related information in Pabna, Bangladesh. The aim of this research was to assess the efficacy of using smartphone technology as a teaching tool for dairy management in improving the knowledge and attitudes of smallholder dairy farmers in rural areas of Pabna, Bangladesh.

2.2. Artificial Insemination

Dairy technologies include the use of artificial insemination (AI), which is now regarded as the most efficient and dependable method for enhancing animal genetics and animal production. Additionally, these technologies include pregnancy diagnostic services, which involve frequent checks to determine the pregnant status of dairy animals. Additional technologies include animal health services, which involve providing guidance and administering appropriate medicine to ailing animals. Furthermore, additional services are available for animal husbandry and nutrition, specifically focused on using enhanced feeds (Khan Shahoria, 2023). The use of dairy farming technology is crucial for enhancing production in the dairy subsector. However, a significant proportion of smallholder dairy farmers either underutilize or do not utilize these technologies at all. It is crucial to comprehend the factors that affect the usage of dairy technologies by smallholder dairy farmers in order to promote the adoption of technology in

rural agricultural businesses. Multiple research have been conducted on the adoption of dairy technology, however, the findings have shown varying outcomes (Rahman et al., 2020).
Furthermore, despite the potential synergy of using dairy technologies, there is a scarcity of research that have concurrently examined the variables that affect the selection of various dairy technologies. This work makes a valuable contribution to the existing literature by using multivariate and ordered probit models to analyze the usage of two dairy technologies jointly. Previous studies have only examined this association in isolation (SARAH et al., 2021).
Cows often have suboptimal body conditions resulting from extended postpartum anoestrus and impaired expression of oestrus owing to adverse environmental conditions and dominant management techniques in Bangladesh (SARAH et al., 2021). Primary indicators, such as mounting behaviours, may not always be reliable for detecting oestrus, particularly when there is limited access to several cows or when cows are restrained. Farmers' lack of comprehension of secondary oestrous signs is the primary factor that hampers the accuracy of oestrus detection. Research has shown that farmers failed to detect 40% of the cows in estrus and inaccurately identified 30% of cows as being in estrus when they were not, according to a study conducted by Shamsuddin et al. in 2006 (Hasan et al., 2023). Identifying the presence of oestrus and determining whether oestrus has returned after failed artificial insemination (AI) is challenging in these circumstances. The lack of effectiveness of AI technicians has been recorded in previous studies (Shamsuddin 1995; Shamsuddin et al. 2001, 2005).

Data collection of artificial intelligence (AI) has posed challenges in several developing nations. In Bangladesh, the prevalent approach is manually capturing and storing AI data. There is currently no technology-based system in place to record and retrieve data on the reproduction and fertility of cows. Retrieving and using manually documented information may be challenging, time-consuming, ineffective, and often unfeasible on a big scale (Hasan et al., 2023). The International Atomic Energy Agency (IAEA) in Vienna, Austria, developed the Asian version of the Artificial Insemination Database Application (AIDA ASIA) to collect reproductive data in areas where subsistence-type farming and cattle management systems are common. However, the potential benefits of this database application for smallholder production systems in Bangladesh have not been previously explored or tested in terms of describing the reproductive characteristics of cows (Hasan et al., 2023; Helen Rayner, 2017).
The female population of the research consisted of cows that were either Bos indicus (nondescript local zebu and crosses of Sahiwal with local zebu) or Bos indicus 9 Bos taurus (zebu dam 9 Friesian sire) submitted for initial service. The cows' heat detection was determined by the farmers' visual observation of oestrus indicators, which were recorded in three categories: (i) mounting actions, (ii) genital discharge, and (iii) other indications such as restlessness and bellowing. Artificial inseminations were conducted either at an AI station or via farm visits by skilled experts. Each technician had a 12-month program of formal training in AI and possessed between 12 and 35 years of practical expertise in the field of AI. Before commencing the field work, all AI technicians had an extensive 3-day refresher training in AI, as documented in the study by Shamsuddin et al. (2005).

After each AI, the technician completed a form to record farm information, cow details, age, breed, parity, last calving date, oestrus behavior, genital discharge characteristics, and the exact location. AI semen deposition. To ascertain the age of the cow, the farmer was interviewed or dentition was used if the owner could not offer accurate information. Farmers' reports were used to record parity, latest calving date, and peripartum occurrences. Cow body condition scores (BCS) were measured on a 1-5 scale at AI (Hasan et al., 2023). Veterinarians in each location identified cow pregnancy with rectal probing between 60 and 90 days after AI. Data acquired during insemination was put into AIDA ASIA (Artificial Insemination Database

Application for Asia and the Pacific, IAEA, Vienna, Austria). We analyzed only cows that were appropriately identified and checked for pregnancy. This study evaluated artificial insemination dairy and smallholder dairy farming in rural Pabna, Bangladesh.

3. Conceptual Framework

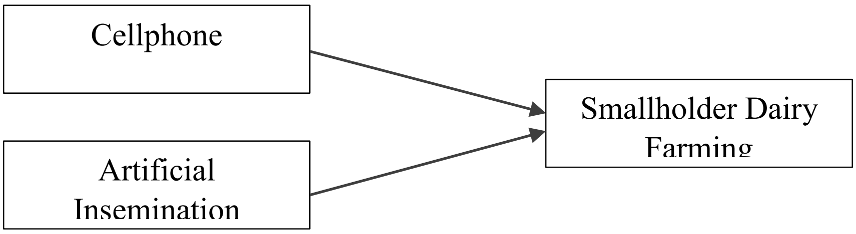

Figure 1: Conceptual Framework

4. Hypothesis

H1: There is a significant relationship between cellphone and smallholder dairy farming.
H2: There is a significant relationship between artificial insemination and smallholder dairy farming.

5. Methodology

5.1. Population and Sample Size

The research follows a quantitative method and aims to examine the correlation between cell phones, artificial insemination and smallholder dairy farming. The data was collected randomly from local farmers in Pabna, Bangladesh, using a survey questionnaire. There are a total 1098 number of registered farmers in Pabna, Bangladesh. This study considered a minimum of ten years of experience with key informants (farmers). Among 1098, the targeted population is 270 (Haq et al., 2023), and according to Krejcie & Morgan's table, the total sample size is 159. The researcher self-collected the questions and answers from the key informants (farmers).

5.2. Data Instrument and Data Analysis Technique

The questionnaire, which included 20 questions, was derived from the State Statistical Office (SSO, 2009). There are a total of 20 questions, consisting of 5 demographic questions and 15 variable-related questions. The questionnaire included inquiries on mobile devices, the process of artificial fertilization, and the practice of small-scale dairy farming. The questionnaire aimed to evaluate the influence of technical progress on small-scale dairy farming among rural farmers. A 5-point Likert scale is used to evaluate answers that span from "not at all satisfied" to "completely satisfied". Researchers usually consider statistical programs to be the most effective and reliable instruments for properly analyzing huge datasets (Buglear, 2005). Statistical analysis is performed with software such as "Statistical Package for Social Sciences" (SPSS) and smartPls. Factor analysis is performed on datasets with a sample size of $n \geq 5$ (Hair et al., 2010).The study postulated that the work environment impacts job satisfaction, therefore necessitating the use of regression analysis as a suitable approach for this research (Bridgmon & Martin, 2012).

6. Findings

Following the identification of important correlations using SmartPLS 3.2.8, a thorough knowledge of the model was attained via the use of the PLS-SEM approach with bootstrapping.

Table 1 shows the graphical representation of the completed model that was created after the building process was finished.

Table 1 Bootstrapping Parameters

Subsamples	300
Number of Results	Complete Bootstrapping
Test Type	Two-Tailed
Significance Level	5%

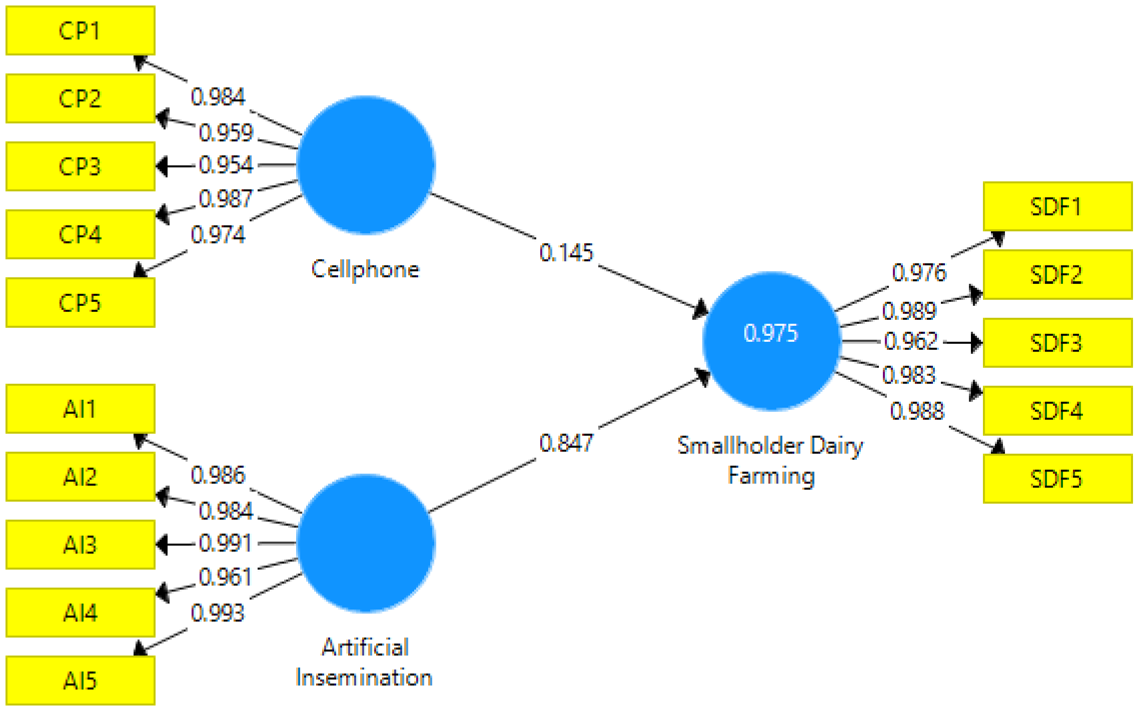

Figure 2 The Conceptual model with outer loading, path coefficients and constructs as Cronbach's Alpha

6.1. Convergent and Discriminant Validity

Convergent validity, a facet of construct validity, evaluates the extent to which a measurement aligns with other measures that are deemed to evaluate the same fundamental concept. Essentially, it assesses the degree to which a measurement shows consistency with other measurements of the same subject.

Table 2 Construct Reliability and Validity

	Cronbach's Alpha	**rho _A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
Cell phone (CP)	0.985	0.986	0.988	0.944
Artificial Insemination (AI)	0.991	0.992	0.993	0.966

Smallholder Dairy Farming (SDF)	0.989	0.990	0.992	0,959

This table presents the dependability and accuracy of cell phones, artificial insemination, and smallholder dairy farming. Assesses the degree of internal consistency by evaluating the extent to which the items on a scale measure the same underlying idea. All four combinations are acceptable if their Cronbach's Alpha ratings are above 0.7. Rho_A is another metric used to assess internal consistency, as described in the provided reference. This version of Cronbach's Alpha takes into account the quantity of items present on the scale. All structures have high rho_A values, all of which above 0.8. Composite Reliability is a statistical method used to assess the internal consistency of a measurement scale using structural equation modeling. Every building has Composite Reliability levels that surpass 0.8. The Average Variance Extracted (AVE) is a quantitative measure used to assess the degree of convergent validity. The metric assesses the extent to which scale elements effectively capture the same fundamental concept. All buildings have AVE values that must be greater than 0.5. The table demonstrates that the four structures are reliable and accurate. This implies that they have the ability to accurately assess the measures of their planned buildings (Lamm & Lamm, 2019).
The Fornell-Larcker criteria is a technique used by researchers to assess the discriminant validity of measurement models. According to this criteria, the square root of the average variance calculated from a concept should be greater than the correlation between that concept and any other concept. Once these prerequisites are met, discriminant validity is achieved.

Table 3 Fornell-Larcker criterion

	Artificial Insemination	**Cell phone**	**Smallholder Dairy Farming**
Artificial Insemination (AI)	0.983		
Cell phone (CP)	0.966	0.972	
Smallholder Dairy Farming (SDF)	0.987	0.963	0.979

The Fornell-Larcker criterion is a method used in structural equation modelling (SEM) to assess the discriminant validity of latent constructs in a measurement model. Discriminant validity refers to the extent to which the constructs inside the model are distinct from one other. The Fornell-Larcker criterion assesses the connection between each construct's square root of the Average Variance Extracted (AVE) and the correlations between constructs.

The correlation coefficient between the AI and itself is 0.983, calculated by taking the square root of the Average Variance Extracted (AVE) for AI. The correlation coefficient between the CP and itself is 0.972, calculated by taking the square root of the Average Variance Extracted (AVE) for CP. This yields a correlation coefficient of 1, which corresponds to the value on the diagonal of the correlation matrix. Employee SDF the square root of the average value (AVE) for this subject, is 0.979.

6.2. Hypotheses Testing

Table 4 Hypotheses Testing

		Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**	**Decision**

H 1	**CP-> SDF**	0.145	0.152	0.057	2.535	**0.00 0**	**Supp orted**
H 2	**AI-> SDF**	0847	0.839	0.056	15.028	**0.00 0**	**Supp orted**

The results obtained from the analysis of two hypotheses indicate a strong and positive correlation between Cell phone and smallholder dairy farming (H1= CP→SDF). And positive correlation between Artificial insemination and smallholder dairy farming (H2= AI→SDF).

6. Recommendation

It is recommended that future studies adopt longitudinal designs to evaluate the ways in which smallholder dairy farming and sophisticated technology evolve over time and how these changes affect farmers' day-to-day lives.

7. Conclusion

The integration of technology, particularly mobile phones and artificial insemination, has greatly revolutionized small-scale dairy farming in Bangladesh. Cellular devices have enhanced communication and facilitated access to market intelligence, enabling farmers to make more informed choices about selling their goods and managing their resources. The use of artificial insemination has bolstered genetic variety and augmented milk output, resulting in elevated yields and better economic stability for producers. These innovations have increased production and supported the sustainability and expansion of the dairy industry in Bangladesh, providing a positive picture for the future of small-scale farms.

8. References

1. Bateki, C. A., Daum, T., Salvatierra-Rojas, A., Müller, J., Birner, R., & Dickhoefer, U. (2021). Of milk and mobiles: Assessing the potential of cellphone applications to reduce cattle milk yield gaps in Africa using a case study. Computers and Electronics in Agriculture, 191, 106516. https://www.sciencedirect.com/science/article/pii/S0168169921005330
2. Chiumia, D., Gondwe, T. N., Banda, L. J., Sivaselvam, S. N., Ulbrich, S. E., & Chagunda, M. G. G. (2020). Enhancing knowledge exchange and performance recording through use of short messaging service in smallholder dairy farming systems in Malawi. Cogent Food & Agriculture, 6(1), 1801214. https://doi.org/10.1080/23311932.2020.1801214
3. de Dios García-Villegas, J., García-Martínez, A., Arriaga-Jordán, C. M., Ruiz-Torres, M. E., Rayas-Amor, A. A., Dorward, P., & Martínez-García, C. G. (2020). Use of information and communication technologies in small-scale dairy production systems in central Mexico. Experimental Agriculture, 56(5), 767–779. https://www.cambridge.org/core/journals/experimental-agriculture/article/use-of-information-and-communication-technologies-in-smallscale-dairy-production-systems-in-central-mexico/6A59938D56467A9E69D5DB49840F932B
4. Erdaw, M. M. (2023). Contribution, prospects and trends of livestock production in sub-Saharan Africa: A review. International Journal of Agricultural Sustainability, 21(1), 2247776. https://doi.org/10.1080/14735903.2023.2247776
5. Gichohi, P. M. (2020). The role of record keeping and maintenance in enhancing decision making among smallholder dairy farmers in Gitugi Ward in Murang'a County, Kenya. Information Development, 36(4), 535–545. https://doi.org/10.1177/0266666919879728

6. Haq, M. K., Valliappan Raju, D. M. D., Nazera, F., & Tanvir, K. (2023). Factors Affecting Sustainability in the Smallholder Dairy Farming in Bangladesh: Using A Tripple-Bottom-Line the Effect of Engagement as Mediator and Policy as Moderator. Tuijin Jishu/Journal of Propulsion Technology, 44(4), 2023. https://www.researchgate.net/profile/Kazi-Tanvir-3/publication/375758837_Factors_Affecting_Sustainability_in_the_Smallholder_Dairy_Farming_in_Bangladesh_Using_A_Tripple-Bottom-Line_the_Effect_of_Engagement_as_Mediator_and_Policy_as_Moderator/links/655b2414b1398a779da07167/Factors-Affecting-Sustainability-in-the-Smallholder-Dairy-Farming-in-Bangladesh-Using-A-Tripple-Bottom-Line-the-Effect-of-Engagement-as-Mediator-and-Policy-as-Moderator.pdf
7. Hasan, M., Islam, M. R., Tanzin, M., Juyena, N. S., & Bhuiyan, M. M. U. (2023). Conception rates of cows inseminated with frozen semen of Rural Development Academy, Bogura, Bangladesh. Bangladesh Journal of Veterinary Medicine (BJVM), 21(2), 71–78. http://www.bjvm.org/index.php/home/article/view/130
8. Helen Rayner. (2017). Self awareness | The Myers-Briggs Company. https://eu.themyersbriggs.com/en/Knowledge-centre/Blog/2017/September/Self-awareness
9. Khan Shahoria, R. (2023). Smallholder Dairy Farming Management in Netrakona District of Bangladesh. A production Report submitted in partial satisfaction of the requirements …. http://dspace.cvasu.ac.bd/handle/123456789/2302
10. Krell, N. T., Giroux, S. A., Guido, Z., Hannah, C., Lopus, S. E., Caylor, K. K., & Evans, T. P. (2021). Smallholder farmers' use of mobile phone services in central Kenya. Climate and Development, 13(3), 215–227. https://doi.org/10.1080/17565529.2020.1748847
11. Mavura, F. (2023). Mobile-based peer-to-peer learning prototype for smallholder dairy producers [PhD Thesis, NM-AIST]. http://dspace.nm-aist.ac.tz/handle/20.500.12479/2206
12. Mutuma, S. P., Ngare, W. L., Bett, E. K., & Kamau, C. N. (2023). Extent of adoption of mobile phone applications by smallholder dairy farmers in Tharaka Nithi County, Kenya. Cogent Food & Agriculture, 9(2), 2265225. https://doi.org/10.1080/23311932.2023.2265225
13. Pandey, H. O., & Upadhyay, D. (2022). Global livestock production systems: Classification, status, and future trends. Emerging Issues in Climate Smart Livestock Production, 47–70. https://www.sciencedirect.com/science/article/pii/B978012822265200017X
14. Rahman, M. S., Tambi, F., & Anny, N. Z. (2020). The importance of enhancing pedagogical skills through continuing professional development. International Journal of Research in Business and Social Science (2147- 4478), 9(4), Article 4. https://doi.org/10.20525/ijrbs.v9i4.757
15. Resti, Y., Reynoso, G. G., Probst, L., Indriasari, S., Mindara, G. P., Hakim, A., & Wurzinger, M. (2024). A review of on-farm recording tools for smallholder dairy farming in developing countries. Tropical Animal Health and Production, 56(5), 168. https://doi.org/10.1007/s11250-024-04024-9
16. SARAH, Y., TAKESHI, S., & YUKIO, I. (2021). Determination of factors related to adoption of modern dairy farming in selected areas of Mymensingh in Bangladesh. Journal of Sustainability Science and Management, 16(8), 218–228. https://jssm.umt.edu.my/wp-content/uploads/sites/51/2022/04/15.-DETERMINATION-OF-FACTORS-RELATED-TO-ADOPTION-OF-MODERN.pdf

17. Uddin, Md. E., Pervez, A. K. M. K., & Gao, Q. (2022). Effect of voluntary cooperativisation on livelihood capital of smallholder dairy farmers in the southwest of Bangladesh. GeoJournal, 87(1), 111–130. https://doi.org/10.1007/s10708-020-10218-z
18. Waiswa, D., Günlü, A., & Mat, B. (2021). Development opportunities for livestock and dairy cattle production in Uganda: A Review. Research Journal of Agriculture and Forestry Sciences, 9(1), 6063. https://www.academia.edu/download/98812622/4.ISCA_RJAFS_2020_029.pdf