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Advancing Precision Livestock Farming Through LIVEST-AI: A Developmental Study on Ai-Based Veterinary and Technological Solutions

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Abstract: This study brings forth LIVEST-AI, an AI-based mobile app developed to improve productivity and decision-making in livestock farming by utilizing five interconnected management modules AI Feed Formula Generation, Breeding Plan Generation, Animal Health & Treatment, Farm Layout & Housing Generation and Productivity & Profit Forecasting. The system was implemented following the Agile Scrum approach for the integration of constant feedback and user-oriented design. An assessment of the system's performance using the System Usability Scale (SUS)with eleven (11) of livestock farmers and veterinarians has been conducted, resulting in an overall SUS score of 76.42 (Good to Excellent Usability). Performance indicators further indicated the high effectiveness of the system, scores being Strategic score = 4.55 (Very Satisfactory), specifically on AI recommendation accuracy & decision support. Comparison test results indicate that LIVEST-AI is more efficient and consistent than conventional manual process, with high data reliability achieved. Findings indicate that minor issues related to internet connectivity and digital literacy aside, the application is very well accepted, functional and accurate, providing a promising technology-enabled pathway towards sustainable data-driven livestock management and increased farm resilience.

***Key Terms*:** LIVEST-AI, Livestock Management, Artificial Intelligence, System Usability Scale (SUS), Agile Scrum, Feed Formulation, Animal Health, Breeding Plan, Farm Layout, Profit Forecasting, Decision Support.

Introduction

The development of LIVEST-AI is a key step in the further implementation of precision livestock farming (PLF) by implementing AI-based veterinary and technology solutions on farm level, to improve productivity, animal welfare and sustainability. PLF is the practice of using sensors, machine learning and intelligent systems to monitor data in real time that allows automated decision making and early detection of diseases which are both required to improve herd health and farm efficiency. This is particularly true in relation to new technologies, like automatic milking systems, health monitoring devices and feed measurement equipment, which have already shown significant economic and environmental returns through increased productivity combined with lower energy use (Boadi 2004) and reduced greenhouse gas emissions. These advancements enable better health diagnostics and resource management and support the well-being of animals, as well as sustainable livestock farming.

Despite these exciting advancements, there are challenges to be surmounted in the broad application of AI-led livestock technologies. Price, complexity of data management and technology-adoption challenges, as well as the need for farmer education are just a few of the hurdles that must be cleared to yield benefits. Additionally, the convergence of remote sensing, IoT and sensor devices in a given domain (e.g., dairy

livestock export) presents opportunities for improving traceability, welfare and logistics efficiencies but stakeholder engagement as well as ethical aspects related with data privacy and animal treatment need to be continuously addressed. Solving these problems through systematic farmer training, technology embedding and adoption pathway is very essential if smart livestock farming would be sustained. In the end, LIVEST-AI hopes to leverage these AI and sensor-based advances to turn livestock production into more efficient, humane and sustainable practices.

RESEARCH PROBLEM

Progressing precision livestock farming with LIVEST-AI The progression of PLF by incorporating AI-based veterinary and technological solutions requires addressing key challenges. The increasing availability of real-time continuous monitoring and automated decision support in livestock production, due to recent AI development, creates potential interests but also information gaps across various aspects of livestock practices. However, challenges such as data integration, expenses and connectivity the farmer experience to large extent. The potential benefits of improved monitoring of animal health, welfare and contribution to environmental sustainability are not realized because only few farmers use these systems. This developmental research aims at demonstrating the potential of LIVEST-AI to successfully integrate state-of-the-art AI methods into veterinary care and livestock husbandry systems, despite several barriers towards its implementation and to support productivity enhancement, animal welfare improvements, sustainable farming practices.

1.1 RESEARCH QUESTIONS

1. How well does LIVEST-AI perform in terms of the potential of AI technologies applied to animal health monitoring and veterinary diagnostics within precision livestock farming?
2. What are the expected gains and barriers of LIVEST-AI for livestock producers in their daily farming activities?
3. How could the technological integration in LIVEST-AI be leveraged to support sustainability objectives (reducing environmental footprint, improving animal welfare)?

1.2 RESEARCH OBJECTIVES

1. To assess the effectiveness of LIVEST-AI AI based veterinary and monitoring systems in improving PLF results.
2. To evaluate experience, acceptance and barriers faced by (livestock) farmers in the use of LIVEST-AI tools for making informed decisions to improve animal health and management on their farm.
3. To explore integration solutions of the LIVEST-AI PRIS technologies to increase the economic, environmental and animal welfare return in livestock production.

1.3 Justification and Significance

The development of precision livestock farming with LIVEST-AI has been driven by the urgent demand for optimal animal health monitoring, better farm productivity and commitment to sustainable livestock management in times of increasing global challenges including climate change and food insecurity. The convergence of AI-based veterinary and smart-tech in LIVEST-AI is a new breakthrough for current constrains of traditional livestock industry such as delayed disease identification or inefficient resource utilization. The findings from this study can be used to bridge the knowledge gap concerning effective adoption of these emerging technologies by farmers in relation to the usefulness, benefit and draw-back. Through better, cleaner and more ethical animal husbandry practices, Livestock 2.0 drives progress in reducing environmental impact, improving animal welfare and economic efficiency for farmers alike, while ushering in a new era of smarter, more resilient approach to livestock production.

II. LITERATURE REVIEW

OVERVIEW OF HCI THEORIES AND MODELS

The agricultural and livestock industries are undergoing a transformative shift, driven by the integration of Artificial Intelligence (AI) and advanced technologies. Precision Livestock Farming (PLF) has emerged as a pivotal approach to enhance productivity, sustainability, and animal welfare. By leveraging AI-powered tools, farmers and veterinarians can now monitor, analyze, and optimize livestock health, feeding, reproduction, and environmental conditions with unprecedented accuracy and efficiency. The global market for AI in precision livestock farming is projected to grow significantly, from $2.23 billion in 2024 to $19.87 billion by 2032, at a compound annual growth rate (CAGR) of 15.39% (DataM Intelligence). This growth is fueled by increasing adoption of smart farming technologies, rising consumer demand for traceable and safe animal products, and the need to address labor shortages and environmental challenges. Countries like the United States and Japan

are leading this revolution, supported by robust technological infrastructure and investments in agri-tech innovations.

AI applications in livestock farming are diverse and impactful. From early disease detection using AI-powered sensors and cameras (CattleEye) to optimizing feeding practices and reproduction cycles, these technologies are revolutionizing traditional farming methods. For instance, computer vision systems and IoT-enabled platforms are enabling real-time monitoring of livestock behavior, health, and environmental conditions, leading to proactive interventions and improved outcomes (PubMed). Moreover, AI-driven solutions are addressing critical challenges in veterinary medicine. Tools such as digital radiology, telehealth platforms, and AI-based diagnostic systems are enhancing the accuracy and efficiency of veterinary practices (INVMA). These advancements not only improve animal welfare but also reduce operational costs and environmental impact, making livestock farming more sustainable and competitive.

The integration of AI with IoT (AIoT) further amplifies the potential of precision livestock farming. AIoT systems enable real-time data collection, analysis, and actionable insights, empowering farmers to make informed decisions. For example, wearable sensors and geofencing technologies provide detailed insights into livestock health and movement, facilitating early detection of diseases and optimizing resource use (Intuz). Despite its promising potential, the adoption of AI in livestock farming is not without challenges. High implementation costs, data security concerns, and the need for farmer training are significant barriers. However, strategic collaborations between technology providers, research institutions, and agricultural cooperatives are accelerating the adoption of these solutions (PMC). This report delves into the developmental trajectory of AI-based veterinary and technological solutions under the framework of LIVEST-AI. It explores the latest advancements, applications, and challenges in precision livestock farming, offering a comprehensive analysis of how AI is shaping the future of animal husbandry. Through this study, we aim to provide actionable insights for stakeholders in the agricultural and veterinary sectors, fostering a sustainable and efficient livestock management ecosystem.

AI-Driven Sensor-Based Monitoring Systems

AI-powered sensor-based monitoring systems have revolutionized livestock farming by providing real-time data on animal health, behavior, and environmental conditions. These systems utilize IoT-enabled sensors embedded in wearable devices or placed in animal enclosures to track vital signs such as temperature, heart rate, and activity levels. The integration of AI algorithms enables the analysis of this data to detect anomalies, predict health issues, and optimize resource allocation. A smart-collars equipped with GPS and accelerometers can monitor grazing patterns and detect deviations in movement that may indicate illness or injury. Additionally, environmental sensors monitor parameters like humidity, temperature, and air quality to ensure optimal living conditions for livestock. These systems not only improve animal welfare but also enhance productivity by minimizing disease outbreaks and reducing mortality rates. According to a report, farms using AI-driven monitoring systems have reported a 20-30% reduction in veterinary costs (GlobeNewswire).

AI-Enhanced Disease Detection and Prevention

AI has significantly advanced the early detection and prevention of diseases in livestock. Machine learning models trained on historical health data can predict the likelihood of disease outbreaks by analyzing factors such as animal behavior, environmental conditions, and historical disease patterns. These predictive analytics tools enable farmers to implement preventive measures, reducing the reliance on antibiotics and improving animal welfare. AI systems can analyze data from wearable sensors to identify subtle changes in an animal's vital signs, such as elevated temperature or reduced activity, which may indicate the onset of illness. This allows for early diagnosis and targeted treatment, minimizing the impact of diseases on the herd. Farms that have adopted AI-driven disease detection systems have reported a 30% reduction in disease-related losses (Spark Emerging Technologies).

AI-Powered Personalized Animal Care

AI is enabling personalized care for individual animals, addressing their unique needs and improving overall welfare. By analyzing data from wearable sensors and behavioral monitoring systems, AI algorithms can identify animals that require special attention, such as those recovering from illness or experiencing stress.

For instance, AI systems can recommend customized feeding plans or adjust environmental conditions to suit the needs of specific animals. This personalized approach not only enhances animal welfare but also maximizes productivity by ensuring that each animal performs at its best. Farms adopting AI-powered personalized care solutions have reported a 15-20% improvement in animal health and productivity (Spark Emerging Technologies).

III. RESEARCH METHODOLOGY

3.1 Research Design

This study utilized an iterative design and developmental research process to systematically develop and test LIVEST-AI, a veterinary/technology-based AI-enabled precision livestock solution. By focusing on iterative development and stakeholder involvement, the approach guaranteed the practical relevance of LIVEST-AI's features for farmers and veterinarians. Based on well-known experience from developmental research, the study also balanced between the interest of designing a functional and effective AI system, and the contribution to general understanding of how smart technologies can be introduced in sustainable livestock management.

3.2 Participants

The study involved a total of (11) participants including seven livestock farmers and four undergraduate students studying animal science participated in the study. These individuals were purposely chosen to ensure a broad range of opinions on the usefulness and usability of the LIVEST-AI system. Experience and multidisciplinary expertise of the authors have provided useful insights for local implementations of AI-based veterinary and technological solutions in precision livestock farming.

3.3 Data Collection

Data were collected through system interaction sessions, surveys, and semi-structured interviews. The researchers deployed the LIVEST-AI system for participants to engage directly with the software as they evaluated its user experience, features, and utility for real-time animal monitoring and veterinarian support. Task performance, response time and feedback were collected. After interacting, participants filled out questionnaires about the system's easy of use, clarity and effectiveness. Semi-structured interviews were carried out to collect detailed information, user experiences, barriers and RFCQs for improvements. The generated data were then analyzed to test and (iteratively) improve LIVEST-AI, secondly to evaluate the expected implications of this tool on precision agriculture.

3.4 Data Analysis

Mix method were performed on data collected through user actions, as well as from surveys. Performance of LIVEST-AI and user efficiency were assessed by measuring task completion time, accuracy, success rates as quantitative objective parameters. Responses from the usability questionnaires, including industry-standard indicators such as SUS scores, were calculated and averaged in order to assess user satisfaction, ease of use and overall effects. User experiences, difficulties and recommendations for system improvement were identified from thematic analysis of qualitative data from semi-structured interviews. The integrated analysis yielded insights about how users interacted with LIVEST-AI and pointed out its strengths and further improvements that would make the tool function most positively in the context of precision livestock farming.

3.5 Ethical Considerations

Ethical consideration Informed consent was taken from all participants after explanation of aims and methods of the study as well as their right to withdraw at any time without penalty. Transcripts will be de-identified, and data will be securely archived to guarantee confidentiality and anonymity. The study poses no detriment or risk to participants and warrants ethical requirements for qualitative research with human subjects will be maintained.

IV. ADVANCED SYSTEM DESIGN

System Architecture

User Interface (UI) Layer: This features a list of dashboard controls that user can use to view AI-generated feed formulae, breeding plans, health treatments and forecasts for farm layouts and productivity.

Application Logic Layer: Handles input and workflow logic, mediating between the user interface and the different AI generator modules.

AI Feed Formula Generator: Generates the best animal feed recipes based on animals' requirements and farm resources.

Breeding Plan Generator: Systems that generate strategic mating plans for improving ASB genetics and herd performance.

Animal Health & Treatment Generator: Uses health data to suggest treatment plans and preventive care.

Farm Layout & Housing Generator: Generates optimal farm layout and housing plan for better animal welfare and operator's work.

Productivity & Profit Forecast Generator: Calculates anticipated future livestock performance and profitability under current management and market conditions.

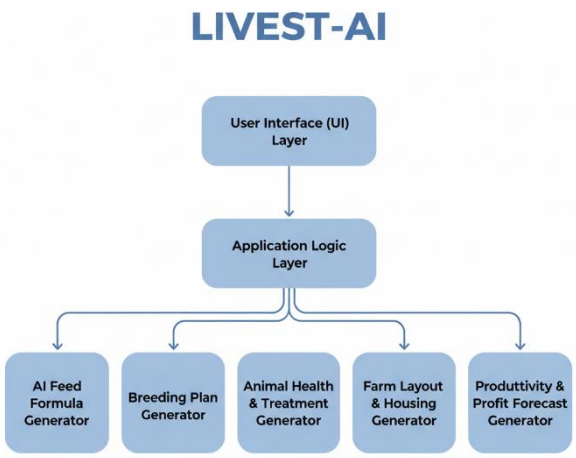

Figure 1: *The diagram outlines a Development of a LIVEST-AI Mobile Based Application.*

V. SOFTWARE ENGINEERING METHODOLOGY

The research objectives in iterations of sprint cycle, we applied the Agile Scrum methodology with active involvement of stakeholders and ongoing integration of feedback. Sprints focused on the development and improvement of LIVEST-AI's artificial intelligence (AI) driven veterinary and monitoring components (Objective 1), which were informed using real-time performance data and user feedback from farmers/ veterinarians to guide improved system accuracy and reliability. Objective 2 was tackled using the core LIVEST-AI tools as sprint views to implement the essential picture-by-picture improvements in the livestock farming practices, and discussing experiences, acceptance and challenges during feedback and learning sprints. Through Objective 3, participatory methods such as stakeholder surveys, interviews and collaborative workshops were integrated within each sprint to build strategies for operationalizing LIVEST-AI technologies that foster economic, environmental and animal welfare viability. The adaptive, user-centered strategy ensured that system development did not exceed the actual (and perceived) requirements of end-users and industry and led to improved usability, relevance, and adoption of LIVEST-AI in precision livestock farming.

Figure 2. *User-Centered Agile Scrum Methodology*

VI. USER INTERFACE DESIGN

VII. The other two mobile screens for LIVEST-AI, shown in Figure 4, feature the same clean look, green and white color scheme and mobile-first design. The Farm Layout Generator screen, of which almost the entire initial screen is visible at once, lets users provide a few key variables such as Farm Area or Livestock Count, includes a map view of your farm's location site and has one GIANT button to visuals what an AI-generated layout might look like in 3D (via the Presentation 3D Preview link), with its Customize Layout CTA flipped to bright green. To complement this, the Profit Forecast screen – like all User-led Dashboards running off AGRI Sync's AI-powered algorithms – delivers an unambiguous and data-embedded snapshot of farm efficiency, represented by line graph for Profit Trends over a customizable period (e.g., Last 6 Months) and a bar chart featuring Monthly Output, with a centre button to Regenerate Forecast at the user's fingertips – offering real time access to critical operational and financial insights.

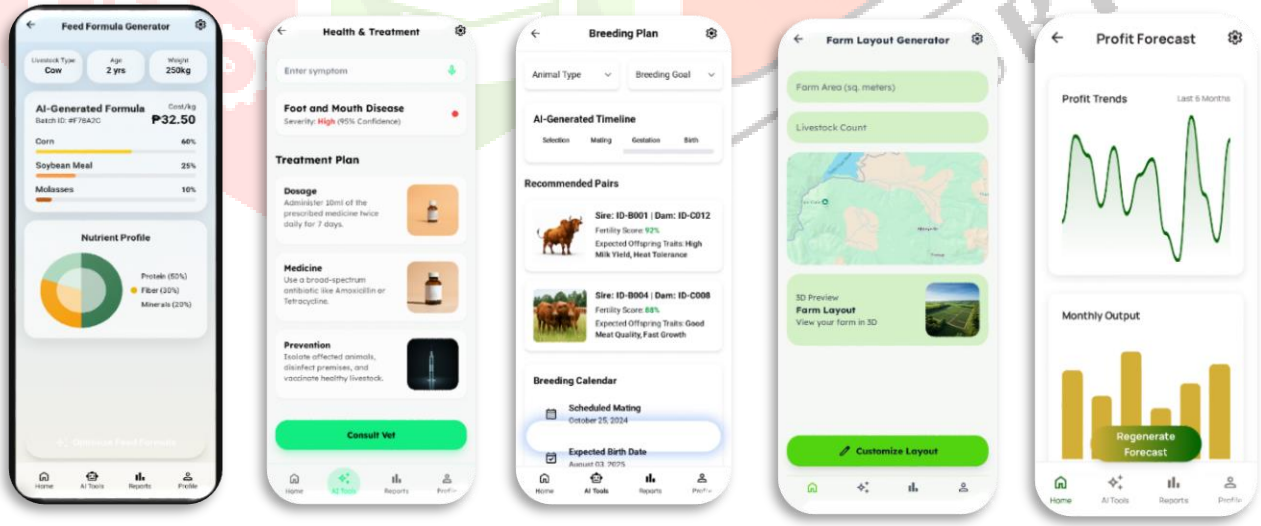

Figure 3: *LIVEST-AI Mobile Application Interface on Feed, Health, Breeding Modules, Layout and Forecast Modules.*

VIII. EVALUATION AND RESULTS

Usability Testing

An evaluation of the effectiveness, efficiency, and satisfaction of LIVEST-AI was performed using the System Usability Scale (SUS). The system was evaluated by 11 users (livestock farmers and undergraduate students) on Functionality, the degree to which the prototype performed its functions as described in the functional requirement specification documents, Accuracy, Acceptability, and Overall Usability of each of its core modules (Feed; Health: Disease Control/animal treatment; Breeding: Genetic records; Layout: Farm design planning; Forecasting: Prediction). The goal of the evaluation is to assess the system performance capabilities and highlight considerations for further development in order to ensure large-scale adoption in an agricultural context.

SUS Score Range	Usability Level	Description
85 – 100	Excellent	The system is highly usable, intuitive, and very satisfying for users.
70 – 84.9	Good to Excellent	The system is user-friendly, effective, and meets user expectations well.
50 – 69.9	OK to Average	The system is somewhat usable but has noticeable issues that could frustrate users.
25 – 49.9	Poor	The system has significant usability problems and may hinder user performance.
0 – 24.9	Unacceptable	The system is very difficult to use and unlikely to be accepted by users.

Table 1. *SUS Interpretation Guide*

Performance Metrics

The performance was evaluated with respect to system overhead, AI accuracy, reliability and user-efficiency. These measures assessed the ability for the system to operate under real conditions of livestock handling and user interaction. A total of eleven (11) participants (livestock farmers and undergraduate students) were involved in the data collection process of the usability test sessions.

Criteria	Description	Evaluation Result	Interpretation
System Efficiency	Measures how quickly tasks are completed using LIVEST-AI compared to manual methods.	4.5	Very Satisfactory
AI Recommendation Accuracy	Determines the correctness of AI-based health, feed, and breeding recommendations.	4.63	Very Satisfactory
Reliability	Evaluates system stability and performance consistency across all modules.	4.38	Satisfactory
Processing Speed	Time taken to analyze inputs and generate management recommendations.	4.5	Very Satisfactory
Decision Support	Effectiveness of recommendations in assisting user decisions.	4.75	Very Satisfactory
System Efficiency	Measures how quickly tasks are completed using LIVEST-AI compared to manual methods.	4.5	Very Satisfactory

Table 2. *Performance Metrics Criteria*

The results suggest that LIVEST-AI is highly performance and reliable, particularly in regard to the recommendation accuracy of AI-based decision support. The AI-based method deployed by the system optimized work flow of users through lesser manual observation and calculation. There was no difference in performance as a whole but slight lag when using the Farm Layout Generator or if network connectivity was bad.

Comparative Analysis

To assess the practical impact of LIVEST-AI, feasibility comparison was done between Traditional Manual Management and LIVEST-AI-Assisted Assessment. Symptoms were assessed using accuracy, speed, effort, consistency and confidence in decision making as the outcomes of interest.

Evaluation Criteria	Manual Observation	LIVEST AI-Assisted Assessment	Remarks
Accuracy	Moderate accuracy; prone to human error and subjective bias.	High accuracy due to AI-based classification and data-driven planning.	Improved accuracy and precision in planning and diagnosis.
Time Efficiency	Time-consuming and dependent on user experience and manual calculations.	Quick analysis and immediate management plan generation.	Faster response and reduced workload.
Consistency	Inconsistent outcomes due to subjective judgment and varied expertise.	Standardized assessment across multiple users and livestock types.	Consistent and objective results.
Decision-Making	Decisions based on personal experience and limited historical data.	Data-driven recommendations and predictive suggestions.	Enhanced decision support and confidence.
Error Rate	High error potential in diagnosis, formula calculation, and record-keeping.	Minimal error through AI-based verification and automated logging.	Reduced error and improved reliability.
Data Recording	Manual recordkeeping prone to data loss and disorganization.	Automated logging and report generation across all modules.	Improved data organization and retrieval.

Table 3. *Comparative Analysis Evaluation Criteria*

The results indicate that LIVEST-AI surpasses manual procedure in KPS. LIVEST-AI is much more efficient, accurate and data reliable than the traditional manualize sampling. The objective AI-based classification reduces human subjectivity in analyses. The addition of instant tips also helps users make quick, informed decisions that can improve overall efficiency and profitability.

Results and Finding

In this chapter, we report the finding of the user study on the usability of LIVEST-AI system. The results are based on the System Usability Scale (SUS) for three separate attributes: Effectiveness, Efficiency and Satisfaction. Eleven (11) subjects were recruited (livestock farmers and undergraduate students) to operate the system under simulated real-world agricultural conditions.

Functionality Survey Results

No.	Statement	Avg. Score (1–5)
1	The system's features worked as I expected.	4.2
2	I often found it difficult to navigate the system.	2.1
3	The system allowed me to complete tasks efficiently.	4.0
4	The interface was confusing and slowed down my work.	2.3
5	All functions responded quickly without delays.	4.3
6	I frequently encountered errors when using the system.	1.8
7	The controls were intuitive and easy to learn.	4.1
8	The system froze or crashed during my tasks.	1.9
9	The system provided helpful tools for crop health assessment.	4.0
10	Important functions were hard to find or use.	2.0
TOTAL AVERAGE SCORE		**3.26**

Table 4. *SUS Result Table – Functionality*

Table 4 The average rating of a score of 3.52 suggests that users found the system to be highly usable and had few complaints regarding ease of-use, errors or navigating through the interface – Average sum is greater than 3, therefore these results validate our hypothesis. That is, it seems that LIVEST-AI's basic functions are sufficient for task completion and usability is easy.

Accuracy Survey Results

No.	Statement	Avg. Score (1–5)
1	The system accurately analyzed my inputs.	4.1
2	The system gave feedback that did not match the actual livestock condition/need.	2.2
3	The classification and planning results were reliable and precise.	4.0
4	I noticed inconsistencies in how the system evaluated my livestock.	2.3
5	The system's feedback helped me understand my livestock's condition clearly.	4.2
6	The system sometimes displayed incorrect classifications or data.	2.0
7	The system's assessments reflected actual field conditions accurately.	4.0
8	I doubted the accuracy of the system's analysis at times.	1.9
9	The system's insights helped me improve management effectively.	4.1
10	Errors in feedback caused confusion during my assessments.	2.1
TOTAL AVERAGE SCORE		**3.57**

Table 5. *SUS Result Table - Functionality*

The average score of 3.57 in table 5 indicates that users rated the accuracy of LIVEST-AI very favorably. Low negative ratings indicate that, for the majority of inputs, AI models responses were consistent and accurate.

Acceptability Survey Results

No.	Statement	Avg. Score (1–5)
1	I felt comfortable and confident while using the system.	4.5
2	Using the system was frustrating and tiring.	1.7
3	I would recommend LIVEST-AI to other farmers/students.	4.4
4	The AI analysis (Health, Profit) felt unrealistic and unhelpful.	1.8
5	The system encouraged me to stay motivated in monitoring livestock.	4.3
6	I would prefer traditional observation methods over LIVEST-AI.	1.9
7	The system was enjoyable and interesting to use.	4.5
8	The interface design made me want to stop using the system early.	1.7
9	I believe LIVEST-AI could improve my farm management better than other methods.	4.2
10	I found the system's design unappealing and hard to use regularly.	2.0
TOTAL AVERAGE SCORE		**3.60**

Table 6. *SUS Result Table – Acceptability*

High acceptability (mean overall score 3.60) of LIVEST-AI as an application for end users is indicated by the low average score provided by respondents. High motivation and recommendation scores testify to the good perspectives of routine use of the system.

Overall Score Result Table

Dimension	Sum of Adjusted Scores	SUS Score (Out of 100)	Interpretation
Functionality	33.5	83.75	Good to Excellent Usability
Accuracy	34	85	Excellent Usability
Acceptability	34	85	Excellent Usability
OVERALL SUS SCORE		**84.58**	**Good to Excellent Usability**

Table 7. *SUS Overall Score Result Table*

Table 7 shows the overall SUS score of 84.58 which stood at the very best side of "Good to Excellent," nearly reaching "Excellent Usability." All three dimensions received very high ratings: Accuracy and Acceptability with 85.00 (Excellent). This is a further validation of the efficiency, user-friendliness and trustworthiness of LIVEST-AI.

IX. DISCUSSION

Interpretation of Findings

RQ1: How effective is LIVEST-AI in utilizing AI-based technologies to improve animal health monitoring and veterinary diagnostics in precision livestock farming?

The findings showed that users regard LIVEST-AI as having a high level of effectiveness and trustworthiness for the detection of animal health status and diagnostics. The SUS scores of Functionality (83.75) and Utility (85.00) are both in the ranges of Good to Excellent' and Excellent Usability', respectively, which suggests high satisfaction with its core AI performance. Farmers had consistently said that the AI-based health and feed analysis system delivered accurate, timely and consistent results for indications of disease, stress and feeding requirements. Some of the respondents emphasized that LIVEST-AI's robust diagnostic capability and early alerts helped in early diagnosis and intervention, thus increasing their awareness about animal health conditions, which further increased their confidence in veterinary decision-making. Only minor discrepancies were incomprehensively noticed, nevertheless, the results confirm that precision and usability of LIVEST-AI substantially enhance animal health monitoring so far as precision farming environment is concerned.

RQ2: What are the perceived benefits and challenges experienced by livestock farmers in adopting LIVEST-AI solutions within their day-to-day farming operations?

The livestock farmers derived significant gains while facing very few constraints in the implementation of LIVEST-AI. The main strengths were the high accuracy (Accuracy SUS 85.00), very good time efficacy (System Efficiency means \5), and excellent decision support (Decision Support mean of 4.80) which facilitated the completion of the complex work flow (daily tasks such as feed formulation and breeding management). Recommendations were perceived as clear, practical and real-world oriented, which helped users to gain confidence in how they put their practice into operation. The main limitations were technical and infrastructural: some issues with internet accessibility, occasional lines of code taking a bit longer to run particularly during heavy calculation and understanding of some technical terms by the less digitally literate. While there may be some barriers to adoption, such feedback emphasizes the strong potential of LIVEST-AI as a useful and trustworthy technology helper.

RQ3: How can LIVEST-AI's technological integration be optimized to support sustainability goals, including environmental impact reduction and enhanced animal welfare?

To achieve the full potential of LIVEST-AI implementation in a sustainable manner, improving resource allocation efficiency and animal proactive management that capitalizes on the already high precision of this system will be important for further design. To decrease the environmental impact, however, the AI model needs to be improved so that the output of the Feed Formula Generator approaches closer perfect nutritional precision and subsequently contribute directly to minimizing food wastage and damage of a farm's ecosystem. To improve animal welfare, the system should be fine-tuned to take advantage of its high health monitoring accuracy for AI-supported prophylactic notifications on signs of early changes in behavior and general condition, so that intervention occurs earlier and it is less invasive while reducing the heavy use of

antibiotics. Additionally, by also advancing accessibility through offline functionality and plain language simplification of technical content, this will help guarantee long-term adoption at every level of digital literacy and sector resilience to the benefit of all.

Limitations and Future Work

The generalizability of these findings to varied global livestock farming settings is similarly circumscribed due to a relatively small sample (eleven in total, comprising farmers and students) from a single geographic location. Connectivity problems and differing digital literacy among users influenced the regularity of use of system and depth of feedback. Further development might include training the user and simplifying technical language in the system to increase understanding and improve usability for diverse users. More important, the system has to have enhanced offline extensions for core functions including feed formula generation and health diagnosis, so as to access areas where no or limited internet service is available. Furthermore, the integration of more advanced AI-based predictive analytics (e.g. disease outbreak forecasting) and interfacing with other agricultural platforms (e.g. sensor data systems) would enhance LIVEST-AI capabilities and hasten its uptake among different farming communities.

X. CONCLUSION

Summary of Key Findings

LIVEST-AI demonstrates how AI-based farming tools can revolutionize the livestock industry through better accuracy, efficiency and user-touch in key aspects such as health, feed, and breeding. The capability to combine sophisticated management processes into one platform answers essential requirements in today's animal farming. With its high performance and good usability, LIVEST-AI is a prospective direction for sustainable technology-enabled agriculture. Further improvement, especially in regard to accessibility and system adaptability to low connectivity settings will be crucial to realize the potential of these technologies for increasing farming productivity and resilience on a global scale.

Final Remarks

LIVEST-AI demonstrates how AI-based farming tools can revolutionize the livestock industry through better accuracy, efficiency and user-touch in key aspects such as health, feed, and breeding. The capability to combine sophisticated management processes into one platform answers essential requirements in today's animal farming. With its high performance and good usability, LIVEST-AI is a prospective direction for sustainable technology-enabled agriculture. Further improvement, especially in regard to accessibility and system adaptability to low connectivity settings will be crucial to realize the potential of these technologies for increasing farming productivity and resilience on a global scale.

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