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Employing Precision Livestock Production to Strengthen Dairy animal Management

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Abstract

This research offers a comprehensive analysis of modern dairy production that takes two important factors. We investigate the complex interactions that exist between people and dairy animals, with a particular emphasis on small ruminants, buffaloes, and dairy cattle. By bringing attention to the intricacies of these relationships, we can get important knowledge that will help to increase productivity and improve animal welfare. This research explores the field of Accurate Livestock Farming (ALF) and how it has changed the dairy industry. An examination of methods for assessing health, such as detecting lameness and mastitis, is provided in relation to dairy cattle. The definition of ALF technologies is expanded by including tiny ruminants in the discussion. Therefore, to increase the effectiveness and efficiency of handling, tiny ruminants, tailored intervention training programs are also required. With its emphasis on the critical interactions between the animal and human elements and its demonstration of the critical role that accuracy technology will play in influencing the direction of the dairy industry, this synthesis advances our comprehension of the dynamic field of dairy farming.

Keywords: Dairy production, accurate livestock farming (ALF), ruminants, animals, human

INTRODUCTION

Increased productivity and wellbeing of dairy cattle are the main goals of ALF, an innovative approach to controlling and improving livestock agricultural systems. To assist dairy farmers in making more accurate and informed decisions in a variety of dairy farming-related areas, the innovativeapproach combines data analytics, real-time monitoring, and modern technology (1).

ALF uses a range of technology, including automation, data analytics, and sensors, to transform conventional dairy cow management methods. With unattainable accuracy and regularity, farmers may monitor vital parameters like as nutrition, reproductive health, environmental conditions, and nutritional status. To provide targeted treatments and improved general management, a deeper comprehension of individual animals as well as the entire herd is stressed (2, 3).

One of the pillars of ALF in dairy management is the use of data-driven insights. By collecting and analysing data from a variety of sources, including automated systems, wearable sensors, and smart devices, farmers are able to gain a comprehensive understanding of the health and behaviour of their dairy cows. Better reproductive control, optimal feeding habits, and early health issue detection are aided by the data (4, 5).

ALF also assists dairy farmers in using their resources sustainably and effectively. Carefully managing inputs, such as feed, water, and medications, can reduce farmer waste and environmental harm. Beyond that, monitoring and improving production parameters contributes to enhanced productivity and long-term economic viability (6).

A step toward a reactive and specialized agricultural approach to the management of dairy cattle was ALF. This might benefit farmers in terms of overall dairy animal health and performance, as well as production, resource management, and financial sustainability. As technology advances, the integration of ALF will have a significant impact on the future of profitable and sustainable dairy farming operations (7, 8).

Using accuracy technology benefits the individual animal but also the overall farm environment. More sustainable and farming practices can arise from more effective use of resources like energy, feed, and water. Intelligent agricultural methods enable these data analytics may also provide useful information on the overall performance of farms, which would aid in continuous growth and strategic planning (9).

ALF has changed the rules in dairy animal management by using data and technology to promote output and sustainability, farmers may improve overall welfare, reproductive efficiency, and health monitoring. As the agricultural environment continues to develop, ALF is set to have a major role in shaping the future of dairy farming by striking a balance between animal husbandry ethics and economic viability (10).

Interaction between Humans and Dairy Animals

Due to the impact on milk production and welfare, the relationship between humans and dairy cattle has drawn a lot of attention in (11). Negative handling techniques and harsh, unfavourable tactile interactions with dairy cows were frequently leads to anxiety, fear, balking, aversion to approaching the milking parlor, increased vocalizations or steps, a lower chance of conception after the first fertilization, a drop milk production, and a decline in quality of milk.Simultaneously, cows treated with unpleasant treatment demonstrate increased fear of humans and more challenging to control. This is due to elevated catecholamines and cortisol levels caused by increased hypothalamic-pituitary-adrenal and sympathetic nervous function. The increasing frequency of flinch, stride, and kick reactions throughout the milking process indicates greater agitation. How humans interact with cows influences the comfort of handling, and this reaction may extend to other individuals via stimulus generalization.

At a modest level, the flight distance (the amount of space required for an animal to feel comfortable between them), demonstrates a positive link with unfavourable interactions. Cows quickly learn to stay away from milker's associated with unpleasant handling, though this deception reaction does not always represent a degree of panic that impairs milk supply. It's worth mentioning that, flight or approach distance minimal bearing on milk production. Yelling and using electric pokes appear to possess the utmost substantial unpleasant impacts on dairy cow behaviour. This increases the time and power for cows to undergo an experimental race.

In contrast, when animals were handled gently, there is a noticeable decrease in their avoidance of humans, and there were observed improvements in fertility rates and the state of the udder.Positive relationships between dairy cattle and milkers, such as gentle stroking, calm speaking, and caressing, also reduce kicking and stepping. These actions have been connected to improved handling, reduced heart rates,reduced cortisol levels in milk and more milk production. Implementing prepartum techniques that entail familiarizing animals with the milking parlor has been demonstrated to improve dairy cow welfareby (12).

Apart from animal-human interactions, genetic variables like breed temperament may impact the physiological state of cows and behaviouralresponse to milking. This can lead to variationsamong different breeds in(13). However, exposing fearful cows to good experiences like gentle petting and brushing from a young age can reduce stress reactions noticed during milking. This, may contribute to a reduction in the time spent milking and an increase in the milk flow rate.

Furthermore, dairy cows with less human involvement had greater "flinch, step, kick" rates reactions, indicating a tense milking temperament, and they both challenging to manage than cows with frequent human interaction in (14). Even small or unnoticeable stresses, such as a new setting, can cause increased heart rate, cortisol levels, and vocalizations in dairy cows.

The capacity of a stressor to effect buffaloes during milking is greater than that of dairy cows because buffaloes have been less chosen and controlled. Even modest environmental changes might impact their behaviourand

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efficacy despite their constant milking pattern. Stress causes adrenaline release, which reduces oxytocin supply due to narrowing the veinsor the obstruction on the oxytocin receptors udder alveolar cells called myoepithelial. The drop in oxytocin was significantly linked to decreased milk production. Positive interactions, result in increased milk production in dairy buffaloes. Buffaloes' anxious temperament during milking may also lead a reduction in milk production and fat content.

Small Ruminants

More information about the influence of interactions between humans and animals on production and well-being of goat and sheep needs to be available. Negative handling behaviours, including slapping, pushing, and screaming, have been connected to decreased milk supply and increased kick responses during dairy sheep milking by (15). However,the milk flow rate was unaltered, goats subjected to unpleasant treatment had higher cortisol levels in saliva. Conversely, though fostering a healthy calmer interaction between humans and animals and less reactiveness to the tradition of milking, leading to enhanced well-being, more efficient milk excretion, and increased output. Based on findings, good tactile engagement improves dairy's heart girth, health, and decreases their stress levels.

Accurate Livestock Farming (ALF) Techniques for Dairy Production

Dairy cattle

ALF systems were created to speed the evaluation of dairy animals' well-being and health state, eliminating the manual work requirement. These systems were designed to monitor individual ruminants in an automated and continuous manner, bringing technical and computer improvements into manufacturing. Sensing devices include many sensors that may be used at many manufacturing phases, such as imagine and sound, blood and urine tests, and temperature and pressure. ALFsystem's principal role in (16) was to monitor activities like feeding, drinking, and laying and identify behavioural changes caused by external variables such as housing circumstances or biological changes that influence the animal'shealth and well-being.When these kinds of changes in behaviour were observed in (17) the framework sends analert signal, allowing the cultivator to react and solve the issue quickly. Their results in early problem identification and resolution or an instantaneous assessment of housing methods. Farmers may monitor the daily activities of animals, regardless of herd size, possibly boosting animal well-being and health, increasing both the final product's quality and quantity output, and reinforcing the operation's economic sustainability.

Health Status Evaluation

Mastitis and lameness were the most typical health problems in the dairy sector, and they considerably influence everyday operations in a unit. These infections threaten the health and well-being of the animals, but they also severely impact production quality and quantity, resulting in a negative economic impact on the entire unit. The economic consequences include decreased milk yields, poorer reproductive performance, and an increased risk of culling. To address these concernsin (18), different ALFtechnology has been devised for timely observing and early identification of such issues.

Stress-related cues affect buffaloes during milking compared to dairy cows by(19), which can be related to their less extensive selection and domestication processes. Despite their constant milking pattern, even modest changes in their behaviour and milking performance might have an influence. Stress causes adrenaline to be released, which reduces oxytocin delivery owing to vasoconstriction or blocking of myoepithelial cells' oxytocin receptors alveoli in the udder. Their occurrence was directly related to a decrease in milk yielding.Conversely, positive interactions have increased production of milk in dairy buffaloes in (20). The buffaloes'anxious attitude when being milked may contribute to a decrease in milk supply and fat percentage. It was important to note that exposing buffalo calves to the milking procedure before parturition reduces restlessness. There was demonstrated by fewer kicks and steps reported while milking than control animals.

Lameness Finding

Lameness was one of the leading reasons behind economic losses in the dairy business, ranking among the top three health-related causes by(21). Affected animals have decreased mobility, lower milk output, poorer reproductive capacity, and a significant loss of physical condition, accompanied by acute discomfort. Various approaches for detecting lameness have been developed, focusing on animals'movements and walking patterns, proving to be particularly helpful in evaluating the condition. A probabilistic neural network modelin (22) with four-balance based on weekly leg load observations from 73 cows over five months. Their findings demonstrated a 100% validation score for lameness and a classification success rate of 96.2%.

Mastitis Diagnosis

Dairy cow milking has been practiced bovine mastitis sickness has existed since at least 3100 BCwas believed to have existed since that timeby (23).The incorporation of milking robots into farm management methods has resulted in the development of various automated mastitis early detection systems. These systems generally have two components:

- A setof data-collecting sensors and
- The construction of computerized models that evaluate the data and provide warnings via a decision support system.

Milk conductivity of electricity, milk's colour, milk output from lactate dehydrogenase, body weight, percentages of fat, protein, and lactose, blood, and somatic cell counts (SCC) in automatic milking were important variables for mastitis detection.Minimal farms raising ruminants in (24), located in rural and hilly areas with limited services and infrastructure, need help adopting ALF. High-end apparatus prices, absence of demonstration and specialist insufficient training and educational attainment all assist in ALF's slow acceptance in these locationsby (25). Furthermore, practical concerns the cycle of productivity in small ruminants operate as impediments to adopting ALF developments. For example, whereas oestrus identification was critical among dairy cattle and a key primaryALF treatmentfor calf, small ruminant producers place less emphasis on it.

Small ruminants

Small ruminants in (26) werekept in flocks or herds, restricting well-being assessments to average states. The novel technology gives a rare chance to enhance welfare management by shifting from traditional manual at the farm level procedures to partially or fully automated individual-level evaluations. The move could lower on-farm labor and veterinary care expenses along the value chain. ALF technology and applications in small ruminant farming were not extensively used despite the potential benefits. Many sheep and goat farmers' unwillingness to accept and adapt to new technology remains a substantial barrier, resulting in the primary usage of technologies for research reasons in (27).Farms with fewer ruminants were typically found in rural and hilly regions with limited infrastructure and services, confront difficulties adopting ALF.

High-tech apparatus prices, lack of evidence and low educational attainment and specialized training all assist in ALF's slow acceptance in these locations. Furthermore, practical concerns connected to small ruminants' production cycle operate as impediments to adopting ALF developmentsby (28). For example, whereas oestrus identification was critical in dairy cattle and a major ALF stimulator treatment for cows, small ruminant producers place less emphasis on it.A concentrated effort by researchers to demonstrate the positive effects of these systems on both welfare and efficiency could boost the appeal of ALF technologies among sheep and goat farmers. As a result, more sustainable and profitable agricultural units would be established. Figure (1) illustrate the Application of ALF used for reducingor resolving a wide range of issues in modern cows' farms.

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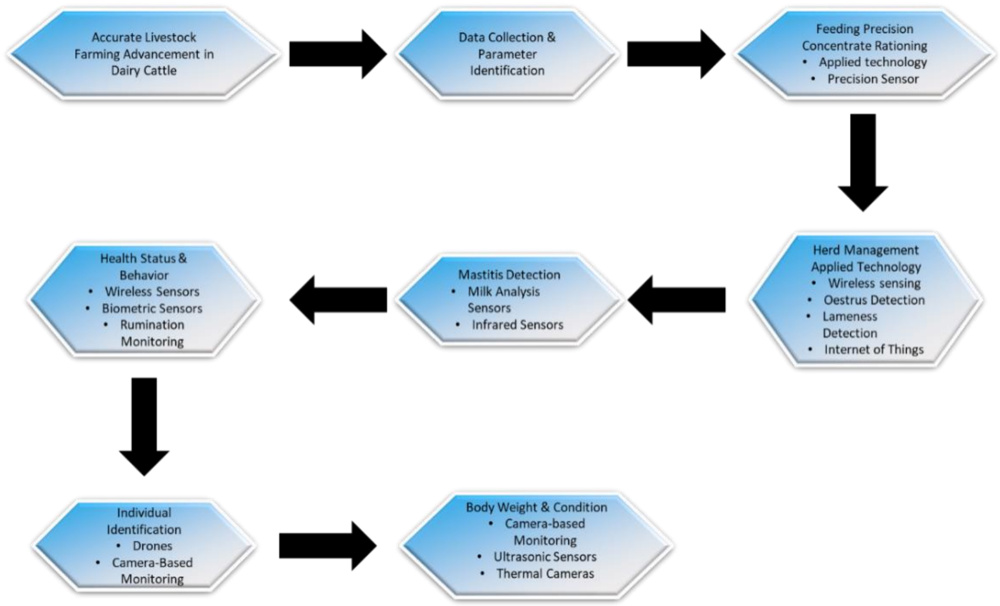

Figure (1). ALF Application (Source: Author)

ALF was used on large-scale intensive farms than in other commercial applications. For ALF, several devices have been developed, including sensors, collars, pedometers, infrared cameras, injectable devices, ear tags, rumen boluses, and so on. However, in the case of sheep and goats in (29), the most common use was the installation of sensors in the milking parlor.

(a) A time or flow-based mechanism, automatic vacuum shut-off (AVSO) device designed to avoid excessive milking and reduce its unfavourable effects on animal health and well-being. It enhances the milking parlor's hygiene while also reducing labour needs. Flow-based AVSO outperforms manual milking by obtaining equal milk amounts at shorter intervals. They suggested ideal sheep combinations, such as a flow restriction of 150 g/min with a 20-second delay or 200 g/min with a 10-second delay. The perfect combinations for goats were 10-15 seconds and 100-150 g/min.

(b) Milk meters and meters of flow act as detectors to measure milk flow in each animal. Electronic milk meters use data from together with conductivity, infrared, and volume-measuring chamber sensors.Their information was evaluated and shown on a computer. Moreover, computerized milk meters may collect and analyse milk, providing information about animal health. As a result, milk and flow meter apps have become crucial decision-making tools for farmers.

(c) Electronic identification was evaluated using sensor-based technologies like injectable transponders, RFID, endoluminal Drones and Boluses. Specific information such as health status, age, gender, weight, and milk flow were stored in these systems for each animal. These technologies were useful for long-term decision-making since the producer may have an inventory of every animal in the flock. It should be noted that RFID technology was being used extensively, with transmitters connected to ear tags or feet being scanned by receivers put in milking parlors. Their configuration enables remote real-time access to the data flow.

(d) When integrated with flock management software, automated sorting gates and weighing scale systems quickly categorize animals or change current groups, isolating those in need of care. These methods considerably decreases the work and time spent on animal regrouping and relocation. These procedures, used to promote milk yield homogeneity among groups, were expedited by the smooth operation of these networked systems.

While small ruminant farmers recognize the benefits of ALFapproaches, broad adoption poses problems. Economic and cultural restrictions, insufficient technological infrastructure, and a lack of knowledge and competence all contribute to resistance. Furthermore, sensor manufacturers were interested in creating sensors for small ruminants as a result oftheir expensive devices, miniaturization problems, reduced production numbers, and relatively less individual profit in contrast to dairy cattle by (30). Nonetheless, developing European farming policies impacted by variables such as climate change, the green economy, animal welfare, and resistance to antibiotics may impact cultivating methods shortly, perhaps leading to wider adoption of ALF systems.

CONCLUSION

The discovered association between handling, production, and well-being in commercial dairy farms emphasizes the critical need for excellent farm management. ALF technologies emerge as a potential alternative, acting as useful decision-making tools for farmers. These systems can enhance the competitiveness and sustainability of dairy farms by lowering labour demands, animal disruptions, and environmental impacts through automated operations. Sensor application innovations will likely focus on size reduction, energy management, and data transmission methods.ALFsoftware should stress simplicity so farmers and workers can readily understand it. This user-friendly design is critical for anticipating short-term dangers and encouraging long-term cattle production and profitability advances. Despite technological advances that make automation and accurate farming, competent animal managing remains crucial to enhancing well-being, health, and total production advantages. The availability of ALF applications, particularly for small ruminants, is restricted, emphasizing the need for training programs to improve everyday behaviours. These measures are critical for maintaining high levels of welfare and production. The future holds enormous promise for the use of precise livestock farming technology to improve accuracy in dairy animal management, hence enhancing health, productivity, and sustainability in the dairy sector.

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