OPEN ACCESS Freely available online

Advances in dairy Research

Review Article

Recent Advances in Dairy Animal Nutrition, Health, and Management: A Review

Muhammed Nurye*

Department of Food Science and Post-Harvest Technology, Oda Bultum University College of Agriculture, Chiro, Ethiopia

ABSTRACT

The application of biotechnology improves animal production and productivity performance through nutritional improvement in different feedstuffs such as enzymes, and probiotics increase the availability of nutrients from feedstuffs, lower feed costs, and reduce waste output into the environment. Digital technologies like wireless, mobile technologies and block chain have a remarkable role in animal health monitoring and management. While a significant potential for biotechnologies is invented and used as a bio-engineered input covering the entire food production chain from animal feed to product processing, including animal health and management, the application is limited only in the developed world.

Keywords: Animal health; Biotechnology; Innovation; Management; Nutrition

INTRODUCTION

The estimated global human population will be beyond 9 billion in 2050, and the growth rate is higher in developing countries, especially in sub-Saharan Africa. This leads to an increase in demand for animal products. To meet this continuously growing demand, farm owners, policymakers, and researchers seek a sustainable solution through increased animal productivity, growth, carcass quality, reproduction, nutrition, feed utilization, feed quality, safety, improved animal health and welfare, and reduced waste through more efficient resource utilization [1]. However, poor roughage, hay, and natural pasture are the main sources of feed in developing countries, and poor animal health facilities and infrastructure also have a significant impact on animal production and productivity in these countries. Therefore, innovative feeding technologies are being introduced by scientists and nutritionists to solve problems and deliver proper nutrition. These technologies include amino acids, vitamins, enzymes, macro and microelements, and other biologically active supplements. The application of advanced biotechnology is a critical factor for balancing animal nutrition, optimizing conditions for animal management, improving animal health through real-time diagnosis, and rearing productive breeds of young animals [2]. Many researchers point to the modernization of the material and technical base as a priority area for the development of the dairy sector through updating the fleets of machinery and technological equipment, introducing innovative methods of managing production processes, and the use of modern technologies. According to OECD-FAO, improvements in feed conversion efficiency couldn't address the worldwide demand for grain and other crop products for animal feeding (and biofuel production) because the demand would continue to rise and livestock feed costs would rise consequently. Therefore, the goal of this review is to provide a unique outlook on recent technologies and their role in animal management, nutrition, and health [3].

LITERATURE REVIEW

Advances in animal nutrition

A consistent supply of high quality feed and fodder ensures increased productivity, due to the fact that feeding accounts for roughly 60%-70% of the total cost of milk production on dairy farms. Thus, feeding management is critical in unlocking the true potential of dairy animals; a well-balanced feed (green and dry fodder, as well as a concentrate ration) is beneficial to the farm's sustainability and profitability; and a slight improvement in animal nutritional status through additional supplementation can improve animal productivity with a minimal cost increase. Therefore, scientists discover different types of animal feed

Correspondence to: Muhammed Nurye, Department of Food Science and Post-Harvest Technology, Oda Bultum University, College of Agriculture, Chiro, Ethiopia, Tel: 251964213195; E-mail: muhammednurye86@gmail.com

Received: 16-Nov-2022, Manuscript No. ADR-22-20169; **Editor assigned:** 18-Nov-2022, PreQC No. ADR-22-20169 (PQ); **Reviewed:** 02-Dec-2022, QC No. ADR-22-20169; **Revised:** 13-Jan-2023, Manuscript No. ADR-22-20169 (R); **Published:** 20-Jan-2023, DOI: 10.35248/2329-888X.23.11.613

Citation: Nurye M (2023) Recent Advances in Dairy Animal Nutrition, Health, and Management: A Review. J Adv Dairy Res. 11:613.

innovations that are easily applicable at every farm where they are available, to assist the dairy farmer's farm sustainability as well as feed the world [4].

In recent years, different software has been created by computer programmers in order to provide the best option for farmers in ration formulation. Advanced options such as live weight, racing, lactation period, and animal feedstock information can be used to create optimal feeding programs. The automated feeding systems include each stage of feeding: Feed preparation, mixing equipment, and feed distribution installations. The systems will load, mix, and deliver feed components such as grass and maize/corn silage, as well as mineral feed and feed concentrate, to the feed table [5]. Automation systems, in their most basic form, consist of a control panel, a programmable command manager, a scale, a communication interface, and finally all of the necessary equipment to organize the feeding process and provide feed to animals of various ages. Calf feeders controlled by a computer have numerous advantages over traditional calf feeding methods. Calves are fitted with a transponder, allowing the daily intake of individual calves to be tracked. Calves quickly learn to use the computer controlled milk feeding system, and this technology offers significant labor cost savings (73%) [6].

Moreover, literature revealed that the electronic concentrate feeding system ensures that each cow receives the correct ration of feed at the correct time. The belt feeder feed distributor is an excellent starting point for learning about automatic feed supply systems. The combination of a conveyor belt and a sliding scraper is small, flexible, and cost effective. According to Grothmann, et al., the various technical approaches to automation. Stationary systems such as conveyor belts are reported, as are mobile systems such as self-propelled or rail-guided feeder wagons. Rumen activity sensors, in addition to feeding system automation approaches, are very popular innovative techniques for cattle farmers to reduce metabolic disorders. When sensitive cows exhibit increasing acidosis, a farmer can adjust feeding to avoid major problems [7].

Furthermore, many electronic sensors are available for measuring rumen pH and temperature, motility, pressure, redox potential, ammonia and ammonium, dissolved oxygen, conductivity, and a variety of mineral ions in cattle. Rumen sensors are expected to be improved in order to measure rumen Volatile Fatty Acids (VFA) and gases such as methane. The rumen bolus, in particular, can work continuously for 100 days and store data every 15 minutes for future evaluation [8].

Rumination activity is a good indicator of the health of cattle and it needs a certain level of well-being. Excitation and stress, anxiety states, and various diseases can inhibit rumination. Another sensor was used to gather data on cow jaw movement to estimate chewing activity. This sensor operates on the premise that the changing pressure of the animal's mouth is not detected during opening and closing. Generally, the use of biosensors in the livestock industry is becoming increasingly important, and biosensors have the potential to measure physiological, immunological, behavioral, and other variables [9].

Feeding innovations and biotechnology: The primary role of biotechnology in livestock production is to increase livestock feeds by improving nutrient content/value as well as the digestibility of low quality feeds such as roughage through the use of various chemicals and by protecting protein, amino acids, and fat. The use of biotechnology in animal nutrition is accomplished by, improving the gut ecosystem and encouraging the growth of beneficial bacteria/microbes, improving the ability to perform specific functions, and introducing new microbe species or strains of GMOs into the gut. Some microbes, including cellulose enzymes from anaerobic bacteria and white-rot fungi (*Pleurotus ostreatus*), have been shown to degrade lignin in fibrous feed cell walls. White rot fungi have been reported to be more suitable for the treatment of fibrous feed than others species of fungi. White rot fungi can attack lignin polymers, open aromatic rings, and release low molecular weight fragments. Besides, live microbial feed supplements, like probiotics, benefit the host by improving the intestinal microbial balance [10].

Bypass protein and fat: Rumen enzymes degrade the protein to produce ammonia, which the ruminal microbes then use to synthesize the microbial protein. So, degradable protein should be protected from ruminal degradation through chemical treatments such as formaldehyde and physical treatments such as heat treatment and extrusion cooking to increase utilization. The treated protein is not degraded in the rumen, so it can be used more efficiently in the small intestine. This rumen inert or bypass protein provides more essential amino acids at the intestinal level, which can result in a 10 percent-15 percent increase in milk yield and a 20 percent-25 percent increase in growth rate. Some researchers claim that the formaldehyde treatment of groundnut cake reduces protein degradability by 33% [11].

Moreover, bypass fat (rumen-protected fat) is a dietary fat that resists lipolysis and biohydrogenation by rumen microorganisms in the rumen however; it is digested in the small intestine. Fat can be protected by saponification with calcium salts. Feeding calcium soaps of rumen-inert fatty acids to negative energy balance animals increases dietary energy density and thus energy intake without interfering with rumen microflora activity. As a result, the negative energy balance effect on animals can be mitigated [12].

Furthermore, ration for high producing animals should contain 4 percent-6 percent fat, with equal parts fat from natural feed, oilseed fat, and bypass fat. Bypass fat supplementation has been shown to be beneficial with no negative effects on rumen fermentation, feed intake, nutrient digestibility, and various blood parameters in dairy animals. Milk prices have risen by 5.5 percent-24.0 percent. This innovation has the added benefit of improving postpartum recovery and reproductive performance in dairy animals [13].

Metabolic modifiers: Recombinant bovine somatotropin is an example of a compound that modifies animal metabolism in a specific and directed manner. Overall, they improve productive efficiency (weight gain or milk yield per feed unit), carcass composition (lean-to-fat ratio) in growing animals, milk yield in lactating animals, and animal waste per production unit [14].

Probiotics (prebiotics/synbiotics): Probiotics are live microorganisms that can be added to farm animals' existing diets to improve intestinal microbial balance. *Lactobacillus* spp., also known as lactic acid producing bacteria, is the most common probiotic bacteria (LAB). The technology control diarrhea in calves' increased milk production, and composition controls ruminal acidosis, controls pathogen growth in the rumen, and reduced pathogen load. A daily dose of 20 g of probiotics per animal has been found to be effective. However, the effectiveness has been depending on whether the animals are in poor health, and also it is also difficult to predict which bacterial species would be advantageous in any given situation. The majority of non-digestible oligosaccharides are common prebiotics carbohydrates (such as Fructooligosaccharides (FOS), Mannan Oligosaccharides (MOS)), and others that are used to boost the population of already present good bacteria, whereas synbiotics are a combination of pre and probiotics [15].

Several studies have found that yeasts found in adult ruminants can be used as probiotics to improve rumen fermentation or environment and microbial activities. The growth of beneficial microorganisms in the rumen is imitated by yeast supplements. Yeast culture, for example, has been shown to increase the number of total ruminal anaerobes and cellulolytic bacteria. In this way, they influence the rate of volatile fatty acid production, increasing the stability of the rumen environment and improving digestion intensity [16].

Synthetic feed

Novel feed: Alternative animal feed, such as insect based protein and seaweeds are enabling precision nutrition. Feeding animals based on their life stage, gut health, and environmental factors have advantages in terms of health and welfare, sustainability, and traceability. New products are being tested for palatability as well as their impact on animal sourced food [17].

ALFRA box dosing system: Automates the preparation of micro ingredients for animal feed production. It is accurate, reliable, and fast micro dosing and eliminates prone-to-error manual additions and health and safety risks for employees [18].

Nova Pro: It is a high-energy, hot-pressed rumen-protected rapeseed expeller product that delivers excellent performance and improves amino acid balance when compared to soy. Reduces the cost of the crude protein content of the diet required for the cow [19].

LACTOLAC 35: It is a traditional milk replacer for calves, 22% proteins and 21% fat, with 35% skim milk powder, rich in dairy proteins allowing high digestibility. It also contains probiotics which act as an intestinal flora barrier and a guarantee of optimal growth [20].

Optimilk: Essentials was created with sound nutrition principles and moderate production expectations. Custom additives are not permitted in this diet in order to maintain milling efficiencies. It is used to increase milk production by +1.8 kg/cow/day while maintaining quality.

SRC nutritionals: It offers the *Bacillus* strain of probiotics to support healthy digestion while enhancing immune function.

Generally, the application of biotechnological innovations like bypass protein and fat, mix ration, probiotics and prebiotics, yeast, synthetic feed, and automatic feeding ration formulation systems have a significant role in animal production and productivity improvement. Rumen bypass protein and fat improves milk production as well as composition while other synthetic animal feeds, probiotics, prebiotics, and metabolic modifiers enhance the health of the animal.

DISCUSSION

Animal health and diagnosis

Between 2000 and 2016, nearly 360 animal disease outbreaks were reported in 116 countries, causing massive economic losses, disrupting trade, and jeopardizing global food security. Two-thirds of these outbreaks were caused by just five diseases, including avian influenza, foot and mouth disease, and African Swine Fever (ASF), highlighting the opportunities for better identifying and managing livestock diseases. Appropriate objective measuring systems are required to quickly and safely recognize illness, normal estrus cycle, quiet heat, or stress in animals. Thus, veterinarians and engineers discover from artificial intelligence to stem cell therapy and new generations of vaccines. These scientific advances and emerging technologies have increased the ability to predict, prevent, diagnose, and treat animal illness more quickly, accurately, and safely. Veterinary researchers and developers are constantly breaking new ground in terms of reducing disease spread and impact.

Over the last century, science and technological advances have been major drivers of change in the livestock farming and animal health industries. Livestock technologies and processes such as breed selection, feeding and milking automation, as well as modern housing and environmental management, have led to the intensification of farming systems and the production of more food for the growing population as they have become integrated into farming practices and animal husbandry. Advances in animal health biotechnologies such as vaccines, antimicrobials, and diagnostic tools have been critical in supporting the intensification of farming systems and the expansion of the livestock sector by lowering disease burdens and raising standards of animal health, welfare, and product quality.

Nowadays, animal health is supported by advanced technologies and innovations such as cutting-edge biotechnologies, nutritional technologies, and other digital technologies. Among these, digital technologies are the most rapidly evolving technologies, drastically altering how people live in modern society, and have received a lot of attention in recent years as part of the fourth industrial revolution (industry 4.0). This revolution is driving disruptive digital technologies and innovations that are transforming almost every sector, including food and agriculture. Mobile applications, the Internet of Things (IoT), cloud computing, big data analytics, artificial intelligence, blockchain, and other advancements are all contributing to these developments.

Sensors are mounted on the cows to monitor their health conditions. Sensor networks are logically self-organizing ad hoc systems made up of several tiny, low-cost devices. The sensor network's role is to monitor the health parameters of animals, collect data, and transmit it to other sink nodes. Sensors that collect data such as temperature, pH, and so on receive a large amount of data, allowing data to be transmitted at regular intervals. Many new sensor technologies for animal health and behavior are being developed.

Potentiometric chemical sensors were used in the electronic tongue. Sensors with plasticized PVC membranes with cross-sensitivity to inorganic and organic cations and anions, chalcogenide glass sensors, chloride, potassium, and sodium selective electrodes, and a glass pH electrode were part of an array. Automatic milking systems that use newly developed sensors (NIR, SCC, and LDH, for example) produce much faster and more effective results. Many biosensor research studies for mastitis diagnosis are still ongoing. Generally, there is enormous potential to improve animal welfare, protect livelihoods, increase efficiency; make livestock production more sustainable; and provide longer, healthier lives for pets on our farms.

According to the Animal Health Institute (AHI), digital technology allows veterinary medicine to become more efficient and precise, allowing for the provision of individualized veterinary care to large groups of animals. Automation, increased connectivity, and more health data can lead to earlier diagnosis and more accurate treatment, but they also necessitate infrastructure and expertise. Moreover, digital monitoring and surveillance advancements are rapidly transforming the animal health landscape, bringing improvements in speed and efficiency that allow for individual level treatment even in groups of hundreds or thousands of animals. Among the digital technology innovations are:

Smart tags and sensors: New technology can enable farmers and veterinarians to treat herds on an individual level on a scale that was previously impossible with only farm staff. Cattle sensors or smart tags, for example, detect health problems in a single animal before they spread to the rest of the herd. Thermal cameras detect the first elevated temperature in a herd of cattle. These advancements enable earlier diagnosis and targeted treatments, resulting in improved animal health and lower costs.

Surveillance *via* remote monitoring: Cameras, microphones, and sensors can generate precise, real time data demonstrating animals' happiness, productivity, and performance. Without the need for additional personnel, surveillance can be applied to anything from livestock pens to fish cages. Pet owners can use smart collars to continuously monitor key health data that can be used to optimize care.

Construction design: Animal housing, such as pens and barns, can be smartly designed to improve animal health while also incorporating monitoring and surveillance. High negative air pressure, similar to clean rooms in hospitals, can create a controlled environment, while heat and ventilation monitoring systems can also ensure optimal conditions. However, increased data volumes raise concerns about confidentiality, ownership, and the capacity for adequate analysis. Regulators and governments can help the digital health revolution by collaborating with developers to simplify regulations and consider appropriate incentives.

Diagnosis: Diagnostic innovation is taking place in the digital realm, where artificial intelligence and user-friendly tools have the potential to transform the animal health industry.

Artificial intelligence: AI has the potential to improve diagnostics by enabling more predictable, rapid analysis of samples, allowing for the rapid and accurate identification of disease. AI algorithms, for example, can detect parasitic eggs in fecal samples, reducing the workload of veterinarians who would otherwise have to compare sample slides for signs of parasites. This could provide greater accuracy than traditional, in-clinic analyses of samples subject to human error. This not only allows for faster or even real-time results but also allows for predictive diagnoses *via* algorithms that predict the likelihood of animal disease.

Microfluidics: These are tiny chips that can analyze extremely small volumes of fluids such as blood. This allows practitioners to bring diagnostic devices to the point of care, increasing user convenience and improving the chances of early disease detection. Microfluidic devices can test smaller sample volumes than conventional tests, which reduces costs and turnaround time.

Molecular diagnostics: This is a group of techniques for analyzing biological markers in an organism's genetic code and proteins. It is a promising and rapidly evolving field of veterinary medicine. While these technologies are already available in laboratories, many pharmaceutical companies are working to bring this high-precision method to the point-of-care in the livestock industry in order to improve diagnostic accuracy.

Vaccine innovation: Vaccines are one of the most reliable and effective ways to protect animals, food supplies, and livelihoods from deadly animal diseases. Vaccine development innovations can result in new vaccines against previously lethal and expensive diseases, as well as new ways to expand existing vaccinations to more regions and species.

More effective vaccines and delivery mechanisms can help protect more animals from diseases and improve production performance, which also means protecting the livelihoods of millions of people around the world who rely on livestock and reducing the use of antibiotics, which reduces the risk of antimicrobial resistance and contributes to the protection of public and environmental health. Therefore to achieve this, scientists develop new vaccines; mRNA vaccines, heat-resistant vaccines, precision systems for vaccine delivery, and custom vaccines.

Generally, the spread of animal diseases could have an impact on milk production. Treatments based on antimicrobials are commonly used to control many diseases, including mastitis. However, concerns have been raised about antimicrobial overuse and the development of antimicrobial resistance, which would reduce the effectiveness of existing treatments and necessitate the development of new ones. The evolution of this process

continues to be a source of concern for the next decade. Therefore, mRNA vaccines will solve this issue.

Dairy animal management

Automatic identification system: It is a special device for recognizing individual animals that can function and use various physical communication principles (radio engineering, optical, magnetic, and acoustic or induction). In most cases, the device is attached to the animal's neck and acts as a responder; the recognition system operates on the pulse code modulation principle. Following the reading, a specific individual's recognized unique number is transferred to a single database for registration. Handheld NIRS devices are easily used on the farm to perform quality control measures on incoming feed from suppliers, during feed preparation, milking, and processing of cheese, butter, and yogurt. Furthermore, special ear tags and bolus-shaped gastric capsules are used to generate a magnetic field and transmit data to the scanner, which then enters the computer *via* a wireless connection for further processing.

ISBC group companies are the world's leading manufacturers of technological equipment and robotic equipment for dairy cattle breeding offer their customers a package software product that includes not only information systems that ensure the implementation of individual production processes (milking, feeding, etc.), but also automated herd management systems.

ISBC group of companies has developed an identification system based on RFID tags, which allows receiving data from an animal throughout its life and creating an individual electronic passport. RFID (Radio Frequency Identification) technology is a type of radiofrequency identification that automatically identifies objects, including those at a distance, by tracking their movement with radio signals. The information will write on an RFID tag, save, and read it later. RFID tags are more reliable and durable than traditional methods of animal identification allowing the generation of more information and simplifying the reading process as this technology does not require its placement in close proximity to the scanner. The system's operating principle is to transfer information from the chip to a single base when animals cross the reading zone, which reduces processing time and increases their reliability, as well as reduces the likelihood of errors when entering data into the farm information system.

Biometric sensing: Biometric sensors monitor the behavioral and physiological parameters of livestock, allowing farmers to evaluate an animal's health and welfare over time. Today a wide variety of available biometric sensors are either non-invasive or invasive. Non-invasive sensors that can be deployed around the barn include surveillance cameras and sensors in the feeding systems to monitor animal weight and feed intake. Noninvasive sensors also include sensors easily attached to animals, such as pedometers, GPS (Global Positioning System), and MEMS (Micro-electromechanical Systems), that can be used to monitor behavior. Therefore, this technology makes it possible to organize a complete zootechnical and pedigree registration and form breeding groups of animals based on data on their productivity, origin, and breeding value.

CONCLUSION

Feeding accounts for roughly 70% of the total cost of milk production in dairy farms. The invention of automated feeding systems, feed preparation, mixing equipment, and feed distribution installations are important to reduce this cost loss and improve the nutritive value. There are also tools like electronic sensors that detect the rumination activity of cows which, is a good indicator of the health of cattle, and manipulate the feed based on the result.

Recent advance in biotechnology plays a significant role in livestock feeds production by improving nutrient content/value by producing genetically modified microbes, and enzymes from anaerobic bacteria and white rot fungi to degrade lignin in fibrous feed cell walls. Rumen bypass protein and fat also a significant role to improve milk yield by providing essential amino acids and fatty acids at the intestinal level for milk synthesis. Development of metabolic modifiers, such as prebiotics probiotics, synthetic feed, such as insect based protein and seaweeds, milk replacers, and automatic feeding and ration formulation systems play an important role in increasing animal productivity.

The innovations in animal health biotechnologies like artificial intelligence stem cell therapy and new generations of vaccines have increased the ability to predict, prevent, diagnose, and treat animal illness more quickly, accurately, and safely. Mobile applications, the Internet of Things (IoT), cloud computing, big data analytics, artificial intelligence, blockchain, and other advancements are all contributing to these developments, effective vaccines and delivery mechanisms can help protect more animals from diseases and improve production performance. Recent technologies in animal management tools have also a remarkable role in monitoring the behavioral and physiological parameters of livestock, allowing farmers to evaluate an animal's health and welfare over time. These innovations are also used to perform quality control measures on incoming feed from suppliers, during feed preparation, milking, and processing of cheese, butter, and yogurt.

To recap the use of modern biotechnology is essential for balancing animal nutrition, enhancing animal management aspects, improving animal health in real time diagnostics, and maintaining productive breeds of young animals. Therefore, developing countries must use these recent biotechnological tools to improve the livestock sector and to feed the fast growing human population.

REFERENCES

1. Akinfemi A, Adu OA, Doherty F. Assessment of the nutritive value of fungi treated maize cob using *in vitro* gas production technique. Livestock Res Rural Develop. 2009;21(11):188-194.
2. Ali W, Ali M, Ahmad M, Dilawar S, Firdous A, Afzal A. Application of modern techniques in animal production sector for human and animal welfare. Turkish J Agri Food Sci Technol. 2020;8(2):457-463.
3. Bhakat C, Mohammad A, Mandal DK, Mandal A, Rai S, Chatterjee A, et al. Readily usable strategies to control mastitis for

production augmentation in dairy cattle: A review. Vet World. 2020;13(11):2364.

4. Asmare B. Biotechnological advances for animal nutrition and feed improvement. World J Agri Res. 2014;2(3):115-118.
5. Braun U, Trosch L, Nydegger F, Hassig M. Evaluation of eating and rumination behavior in cows using a noseband pressure sensor. BMC Vet Res. 2013;9:1-8.
6. Brito LF, Oliveira HR, Houlahan K, Fonseca PA, Lam S, Butty AM, et al. Genetic mechanisms underlying feed utilization and implementation of genomic selection for improved feed efficiency in dairy cattle. Canada J Anim Sci. 2020;100(4):587-604.
7. Brito LF, Oliveira HR, McConn BR, Schinckel AP, Arrazola A, Marchant-Forde JN, et al. Large scale phenotyping of livestock welfare in commercial production systems: A new frontier in animal breeding. Front Genet. 2020;11:793.
8. Byrne TJ, Santos BF, Amer PR, Martin-Collado D, Pryce JE, Axford M. New breeding objectives and selection indices for the Australian dairy industry. J Dairy Sci. 2016;99(10):8146-8167.
9. Capper JL, Cady RA, Bauman DE. The environmental impact of dairy production: 1944 compared with 2007. J Anim Sci. 2009;87(6): 2160-2167.
10. Clay N, Garnett T, Lorimer J. Dairy intensification: Drivers, impacts and alternatives. Ambio. 2020;49(1):35-48.
11. Colditz IG, Hine BC. Resilience in farm animals: Biology, management, breeding and implications for animal welfare. Anim Prod Sci. 2016;56(12):1961-1983.
12. Cole JB, VanRaden PM. Symposium review: Possibilities in an age of genomics: The future of selection indices. J Dairy Sci. 2018;101(4): 3686-7301.
13. Edwards JP, Kuhn-Sherlock B, Rue BD, Eastwood CR. Technologies and milking practices that reduce hours of work and increase flexibility through milking efficiency in pasture-based dairy farm systems. J Dairy Sci. 2020;103(8):7172-7179.
14. Faizah HM, Richard F, Meena P, Stanley KL, Amriana H, Alhassany A, et al. Multiple Ovulation Embryo Transfer (MOET) in dairy cattle in Gatton. Malaysian J Vet Res. 2018;9(2):109-116.
15. Fernando SC, Purvis HT, Najar FZ, Sukharnikov LO, Krehbiel CR, Nagaraja TG, et al. Rumen microbial population dynamics during adaptation to a high-grain diet. Appl Environ Microbiol. 2010;76(22):7482-7490.
16. Miglior F, Fleming A, Malchiodi F, Brito LF, Martin P, Baes CF. A year review: Identification and genetic selection of economically important traits in dairy cattle. J Dairy Sci. 2017;100(12): 10251-10271.
17. Friggens NC, Blanc F, Berry DP, Puillet L. Deciphering animal robustness. A synthesis to facilitate its use in livestock breeding and management. Animal. 2017;11(12):2237-2235.
18. Goncu S, Gungor C. The innovative techniques in animal husbandry. Anim Husb Nut. 2018;18;1.
19. Grothmann A, Nydegger F, Moritz C, Bisaglia C. Automatic feeding systems for dairy cattle potential for optimization in dairy farming, 2010.
20. Hansen BG, Straete EP. Dairy farmers' job satisfaction and the influence of automatic milking systems. NJAS: Wagen J Life Sci. 2020;92(1):1-3.