Short Research Article

Dairy Cattle Mechanized Farming Equipment Applications and Future Development Trends

ABSTRACT

With the rapid development of China's dairy industry and the continuous increase in the number of dairy cows, mechanized dairy farming equipment has been widely used. Therefore, mechanized dairy farming equipment in China has entered a new stage of development. From the current development of the dairy farming industry, mechanized farming has made outstanding contributions to improving the output of a single cow, ensuring the production safety of milk products, and improving the level of feeding management technology. Therefore, the implementation of mechanized dairy farming is the key to the development of China's dairy industry, and the R & D of standardization, finalization, serialization, and the complete set is also its future development direction.

Keywords: dairy farming, mechanization, intelligence, trend

1. INTRODUCTION

The shiitake mushroom, because of its tender taste, and delicious flavor with rich nutrition has become an essential dish on people's dinner tables and is one of the most produced edible mushrooms in the world [1]. Meanwhile, China is also a big consumer of beef. In 2019, China's beef output was 6.67 million tons, an increase of 230,000 tons or 3.6% [2], ranking steadily as the third largest beef producer in the world. Our country's cow feeding develops rapidly, but compared with the developed countries, there are certain gaps. With the technology of animal breeding, feeding, and epidemic prevention close to the level of developed countries, the fundamental way to improve the benefit of dairy farming is to reduce the cost of breeding, reduce labor and improve the mechanization level of dairy cows. Shaanxi Qianyang County Agricultural machinery management service station undertook the construction project of the Shaanxi dairy farming mechanization demonstration park. Given the current situation and mechanization development level of the dairy cattle industry in our country, centering on the demand for equipment and development trend of key weak links of dairy cattle farming, the whole mechanization farming mode process of a large-scale dairy farm is created, namely: whole corn silage mechanization → dairy concentrate feed processing, mixing mechanization → Total Mixed Rations (TMR) feeding mechanization → milking mechanization → epidemic prevention and health disinfection mechanization → manure collection and processing mechanization, etc. 6 key aspects of farming mechanization.

Comment [S1]: Remove with reference

2. APPLICATION OF MECHANIZED DAIRY FARMING EQUIPMENT IN CHINA

China's dairy mechanized breeding started in the early days of the founding of the country when the main development of dairy feed processing. With the introduction of some foreign forage, feed machinery, and milking machinery and equipment, coupled with the strong support of national policies, the development of China's dairy farming mechanization has also opened the curtain. In the process of standardization and specialization of dairy farming technology, advanced cattle breeding equipment and the welfare of healthy breeding process technology have formed the characteristics of China's facilities for breeding engineering technology.

In a broad sense, dairy mechanized breeding equipment includes daily breeding link equipment, milking, milk transportation, and storage equipment, manure treatment system equipment, feeding machinery and equipment and manure throwing equipment, new energy utilization equipment, etc.

2.1 Daily breeding link equipment

It is mainly dedicated to improving the living environment of cows, improving their rest quality, creating a clean and comfortable living environment, improving their welfare, reducing their sickness rate, and increasing their milk production. Daily breeding equipment is divided into the following categories:

2.1.1 Feeding equipment

Cow neck shackles. The cow neck shackle is installed between the cow's living area and the feeding channel (Figure 1). Through the unique device of the cow neck shackle, the cow can control the fixed feeding head, and the cow can feed independently it is convenient for the staff to conduct a routine physical examination, immunization, artificial insemination, pregnancy check, treatment, dehorning, calving and other veterinary treatment activities. The application of this equipment greatly reduces manual labor intensity and improves overall dairy farming management.

Fig. 1. Cow neck shackles

Drinking water tank. The water tank is designed according to the cow's drinking needs, automatically controls the water level, and has the functions of automatic water in and out, cleaning, heating, heat preservation, etc. It ensures the cow's drinking water safety, provides convenience for the cow to take in enough water after eating, promotes the digestion of food and the absorption of marketing, and plays an active role in the improvement of milk production. The precision feeding system can automatically run and identify cows according to the manually set program, and deliver precise feed for each cow separately, realizing regular scientific feeding in small batches of multiple batches [3].

2.1.2 Sleep devices

Cow lying pen. According to the cow's body type and combined with the cow's lying action design of the bed mainly standardized the cow rest position, to provide a special place for cows to rest, not interfere with each other, to prevent cows from standing on the bed mat randomly discharged feces, to facilitate the centralized treatment of cow feces, to provide a clean and comfortable living environment for cows, maintain the health of cows, improve the milk production of

Comment [S3]: Remove full point; put :

Comment [S2]: Remove full point; put :

cows; cow mattress. The new cow mattress is composed of a rubber pad on the upper layer, a sponge on the lower layer, and a high-strength nylon net in the middle. And in the upper layer of the mattress is designed with countless massage dots, to promote the blood circulation of cows, prevent the occurrence of diseases such as mastitis, and reduce the culling rate of cows [4]. The overall anti-slip, anti-static, heat insulation and coolness, easy to wash, easy to change, no odor, changing the poor environment of cows in the past on the concrete and muddy ground, improving the resting comfort of cows, improving the bed rate of cows, and increasing the milk production of cows.

2.1.3 Welfare equipment

Cow body brush (Figure 2). It is made of special material and is durable. The use of a unique induction device, so that when the cow's body passes through the cow body brush automatically rotates work, when not in use can also automatically stop, easy to use, energy saving, and safe, greatly reducing the breeding of dirt and parasites on the cow's body, reducing the spread of germs and infection rate of cows, promote blood circulation, to ensure the health of cows, to protect the high yield of milk; bail frame. The new holding frame is now mainly divided into fixed, mobile, multi-functional, and other kinds. Its main purpose is to fix the cow, convenient for veterinarians and breeders for breeding, hoof trimming, treatment, immunization, expectation testing, embryo transfer, and other work.

Fig. 2. Cow body brush

2.1.4 Ventilation, cooling, and ventilation equipment

Rolling curtain. A rolling curtain is installed in the side wall of the barn, using the role of the film rollers, film roll cloth, and other components to automatically open up and down, with wind, rain, air, ventilation, cooling, lighting, sun, and other functions. Provide a comfortable living environment for cows; fans and wet curtains, etc. The equipment mainly reflects the application of cooling and ventilation technology. Low-pressure high flow type fan and evaporative cooling wet curtain, has become new technology for cattle barn ventilation, solving the dead end of livestock and poultry barn ventilation and summer high-temperature stress problems. The application of this technology can make the barn environment improved as a whole, to ensure the comfort and safety of the cattle [7].

Sliding cattle barn roof. This equipment mainly uses the motor, sliding track, and sliding wheel to finally achieve the function of opening or closing the barn roof. The application of this technology mainly provides a dry, comfortable, ventilated, and well-lit living environment for the cattle barn, so that the cattle can achieve the effect of free movement indoors.

2.1.5 Cross-contamination prevention system

Hydraulic flap. The hydraulic flap is installed at the intersection of the feeding channel and the milking channel. When the cows need to pass for milking, the hydraulic flap opens and the cows pass under the flap, and when all the cows pass or the feeding truck passes, the hydraulic flap is lowered to ensure that the stains and other debris carried by the cows' bodies or hooves do not pollute the feeding channel and prevent the cows from entering the feeding channel. The application of this technology mainly solves the cross-pollution of feeding

Comment [S5]: Remove full point; put :

Comment [S4]: Remove full point; put :

Comment [S6]: Remove full point; put :

Comment [S7]: Remove full point; put :

trucks and milking channels, ensures the cleanliness of dairy farm feeding roads, guarantees the cleanliness of farm roads, and improves the overall farm road hygiene and environmental conditions [7-8].

2.1.6 Cattle catcher

The application of the cowcatcher equipment is mainly reflected in the role of driving the cows to be milked when they pass through the milking channel, to facilitate management, the use of this technology has greatly improved the efficiency of the staff [13-14].

3. WHOIE-PLANT CORN SILAGE MECHANIZATION

The main model: silage special maize continuous order mechanical narrow rows of dense planting + silage crop combine harvester harvesting shredding + special transport vehicles with self-unloading function transport + heavy machinery heap high-pressure solid sealing cellar. The introduction of screening and promotion of special silage corn varieties Ya Yu 8, An Yu 2166, Aoyu 5102, Yao Qing 2, Qin Long silage 1, and Yu silage 23 varieties, and farmers signed an order, a thousand dairy farms need about 1500 acres of orders. Planting to take mechanized precision seeder, small row spacing 40 cm, plant spacing 13-15 cm, 3 kg of seed per mu, mu application of 40 kg of corn-specific compound fertilizer, the density of about 6000 plants per mu, each mu can be harvested 4-5 tons of the whole plant with stick silage corn [11].

Whole corn silage harvesting in the corn seed waxing pre-mature, the whole plant's lower 4 to 5 leaves become brown when the best use of corn silage harvester mowing. Maize silage mowing height is usually better than 15 cm. The cutting length should be controlled at 1.5 to 2 cm. Field harvesting cutting at the same time, with a special transport vehicle with self-unloading function synchronized pick-up (Figure 3), filled with fast transport to the silage cellar, and finally with heavy machinery loader using progressive wedge silage, each filled 20 ~ 30 cm, with heavy machinery pile high pressure solid. After the silage raw materials are filled, it is necessary to continue loading until the raw materials are about 60 cm above the edge of the cellar, then covered with plastic film, and then compacted with soil or tires, soil thickness 30 ~ 40 cm, so that the top of the cellar rises. After heavy machinery compaction and sealing, a density of 750 kg/m3 can be achieved. In general, cows need an average of 25 kg of corn silage per head per day; breeding cows need an average of 15 kg of corn silage per head per day. That is, according to the average 305 days of milk production of 7000 kg, the daily consumption of corn silage needs 19.65 tons, a thousand cattle farms need at least 10,000 cubic meters of silage cellar and the annual storage of at least 7000 ~ 8000 tons of whole plant silage corn.

Fig. 3. Specialized transport vehicles with self-unloading function

4. DAIRY CATTLE CONCENTRATE FEED PROCESSING, MIXING MECHANIZATION

Main mode: mechanical crushing of raw materials + mixing according to recipe requirements + bagging and sealing for storage. Dairy cattle concentrate feed mainly has grain solid feed and cake meal feed. The processing methods of grain feed include crushing, grinding, puffing, pelleting, roasting, steam pressing, and pressurized cooking. Mechanical crushing is the most common processing method of seed feeds and the cheapest. Cake

meal feed is the residual part of the seeds of oil crops after extraction of oil, the crude protein content of roughly 30% to 45%, cake meal is rich in protein, oil, starch, vitamins and minerals, good palatability, easy to digest, and abundant resources is currently the most commonly used plant protein feed materials. The commonly used cake meal feeds are soybean cake (meal), rapeseed cake (meal), cottonseed cake (meal), peanut cake (meal), and so on. But this kind of feed contains a variety of anti-nutritional factors, improper use is likely to cause livestock and poultry poisoning should be limited feeding. Various raw materials after the necessary crushing, according to the formula for adequate mixing, are bagged and ready to use. Crushed particles should be coarse rather than fine, such as crushed corn, the particle diameter of 2 to 4 mm is appropriate. In addition to 1 kg of concentrate feed for adult cows at 2.5 to 4 kg of milk, each head needs to add 3 kg of basic feed per day; pregnant young heifers average 2.5 to 3 kg of concentrate feed per head per day; 2 kg for breeding cows; 1.5 kg for calves.

5. TOTAL MIXED RATION (TMR) FEEDING MECHANIZATION

Main mode: Silage special (electric) picker cutting and loading silage + mechanical feeding of green hay + TMR special mixer truck mixing and feeding according to recipe + mechanical pushing and sweeping truck pushing the material.

TMR is an advanced feeding process in which all the materials and grasses in the formula are measured and put together according to the diet formula of the nutritionist and then fed to the cows after kneading, stirring, and mixing thoroughly in a special mixing truck, so that the cows can get balanced nutrition in every bite they take [5]. The implementation of TMR has a good effect on improving the feed conversion rate, ensuring the health of the rumen and the body, and improving milk production and quality. In modern-scale farms, feeding labor productivity can be increased by more than 10 times compared to traditional farms [9].

Adopt silage special (electric) reclaimer, high efficacy, reclaiming material at the same time with again shredding function, neat and smooth cutting surface, no secondary fermentation, no loss caused by rainwater soaking in the open air, and can finish loading at the same time. According to the size of the cattle herd, the mobile TMR mixer can be selected to feed 3 times a day, and the total feeding work of the feeder is 6 hours, which is 12 cubic meters for 1000 heads. The mobile TMR mixer can walk to the silage cellar, hay storage, and concentrate storage for loading and transport directly to the barn for feeding cows, which is highly efficient and saves labor costs. The full mixed ration pushing and sweeping truck can push the feed to the cow's mouth in the process of cleaning the feeding trough and mixing the feed at the same time (Figure 4). During the feed pushing and brushing process, the feed is also mixed evenly and the same moisture level is maintained.

Comment [S8]: remove

Fig. 4. Full mixed ration push sweeper

6. MILKIG MECHANIZATION

Main model: mechanized milking for healthy herds + regular milk sample collection for DHI production performance measurement + online detection and metering system metering + dairy farm management information system to manage the herd. The centralized use of mechanized milking for healthy herds can

reduce human labor intensity (Figure 5), improve production efficiency, and reduce production costs [12-13]. Calculating the size of milking stalls, 480 milking cows, milking 3 times a day and 12 hours to complete milking, 1 set of 2×16 parallel milking stalls should be selected and equipped with a refrigeration system, hot and cold water supply, washing and disinfection solution, teat disinfection equipment, cow number display, automatic cup removal, milk yield display, and record. It is better to be equipped with measuring devices, which are not only beneficial to production statistics, and management, and closely related to breeding techniques, wages, and labor compensation distribution. To improve the overall quality and production level of the herd, milk samples can be collected periodically for DHI production performance measurement, which is a comprehensive physical examination of the cow, and the DHI measurement data gives parameters such as somatic cell count (SCC), milk composition, peak daily milk yield, lactation duration, average fetal spacing, and lactation loss, which can reflect problems in cow feeding, reproduction, and management and help It helps managers to evaluate the degree of harm of problems, find the causes of problems and improve them in time. At the same time, the dairy management information system can be used for intelligent early warning, decision support, herd management, reproduction management, milk production management, DHI analysis, veterinary care, feed formulation and nutrition, and material management. It completely realizes the standardization, science, and transparency of the whole life cycle of cow growth and breeding, the milk production cycle of the litter, and the daily production and operation management of dairy farming enterprises [6].

Fig. 5. Mechanized milking equipment

7. EPIDEMIC PREVENTION AND SANITATION DISINFECTION MECHANIZATION

Main model: disinfection of vehicle disinfection pool at the gate + mechanical fogging disinfection of personnel disinfection channel at the side gate + disinfection of the whole field epidemic prevention and disinfection vehicle + cattle body brush to clean cattle body + hoof trimming machine to trim hoof health. A disinfection pool is set up at the entrance of the gate and the entrance of the cattle barn, with the pool being as wide as the gate, 4 meters long, and 30 cm deep. Disinfection solution with 2% to 4% sodium hydroxide, to ensure the effectiveness of the solution, generally 15 days to replace the solution; around the field and the field cesspool, sewer outlet, disinfection with bleach once a month, each cubic meter of sewage can use 6 to 10 grams of bleach. Staff should enter the gate and production area through the disinfection channel, and the disinfection channel is equipped with a mechanical atomization disinfector. Foreign visitors entering the farm to visit should be thoroughly disinfected, change their farm work clothes and work shoes, and comply with the farm epidemic prevention system. The barn is regularly disinfected by washing the cattle bed with a high-pressure water gun and spraying; the sports field and its surroundings are disinfected once a week with 2% sodium hydroxide or sprinkled with quicklime. Feeding utensils, troughs, and feed carts

are disinfected regularly, once every two weeks in summer and once a month in winter. Daily utensils such as veterinary utensils, midwifery utensils, breeding utensils, milking equipment, and milk tankers should be thoroughly cleaned and disinfected before and after use. Regular disinfection of the environment with cattle, especially during the infectious disease season, is beneficial in reducing pathogenic microorganisms in the environment [10]. Disinfection of the environment with cows should avoid contamination of milk with disinfectants. Cow body brushing can easily enable cows to achieve self-cleaning and reduce dirt and parasites on their bodies. The cow body brush also promotes blood circulation in cows, keeps the cow's coat clean, and increases cow feed intake. It allows cows to comfortably clean their heads, backs, and tails and stop rubbing and scratching everywhere, thus saving money and preventing accidents.

Hoof trimmers make hoof trimming easy, allowing hoof trimmers to work standing up, freeing them from heavy physical labor and treating wounds accurately; greatly reducing abortions that occur due to hoof trimming, allowing for extremely easy trimming of the front hooves, and a variety of uses such as surgery, breeding, cesarean section, and rectal examination of cows.

8. MECHANIZATION OF MANURE COLLECTION AND PROCESSING

Main model: electric scraper for cattle barn to clean manure pit collection + sewage pump conveying + mechanical dry manure cleaning in sports field + solid-liquid separation mechanical separation + solid composting fermentation to produce organic fertilizer + liquid digester fermentation to produce biogas liquid.

At present, the manure-cleaning method of large-scale cattle farms in China is based on scrapers and tractor shovels, and the manure-cleaning method of smaller cattle farms is mainly manual [7]. The houses of cattle farms are mostly cemented and hardened, and to separate dry manure from urine and sewage, mechanical manure cleaning equipment needs to be equipped in cattle barns for harmless treatment to improve resource utilization and reduce labor costs. The manure of the sports field adopts a dry manure cleaning process, i.e. dry manure is cleaned or collected by hand or machinery, and then transported to the storage or processing place. The manure scraping board is used to clean the manure in the barn and lying pen, which can clean the manure at any time, with easy mechanical operation, safe and reliable work, moderate scraping board height and running speed, basically no noise, and no impact on the walking, feeding, and resting of the cattle. The manure collected and conveyed is firstly sieved once for solid-liquid, and the fibrous solids sieved out are fermented and used as cattle mattress material or organic fertilizer, and the solids after the second sieving can be made into high-grade organic fertilizer. The sieved sewage can be returned to the irrigation field after a biogas project or other harmless treatment according to the economic strength and industrial direction of the enterprise.

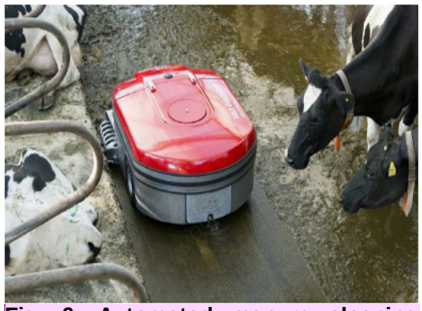

Fig. 6. Automated manure cleaning machines

9. CONCLUSION

Mechanization is an inherent requirement of large-scale dairy farming, advanced and applicable mechanical equipment is conducive to improving the production efficiency of large-scale farms,

Comment [S9]: All figures check for ethics

Comment [S10]: full point

Comment [S11]: Mechanical

automation, information technology, and intelligence is the development direction of feeding equipment, milking equipment, breeding monitoring equipment, through the collection and analysis of data in all aspects, to enhance the refinement of farm management, to achieve cost reduction and efficiency [15].

REFERENCES

1. China Milk Industry Analysis Report 2020 - Market Operation Trend and Development Prospect Forecast. [EB/OL].http://baogao.chinabaogao.com/rupin/417917417917.html,2020-08-08.
2. China Beef Industry Analysis Report 2020 - Market Operation Trends and Development Prospects [EB/OL]. (2020-02-21). http://market.chinabaogao.com/nonglinmuyu/02214P4462020.html.
3. Yang Cunzhi, Li Yanyuan, Yang Xu, et al. The development of FR-200 intelligent precise feeding robot [J]. Agricultural Mechanization Research ,2014,36(2):120-122,126.
4. Zheng Guosheng, Shi Zhengxiang, Teng Guanghui. Research on equipment technology of dairy farming facilities in China Progress [J]. Chinese Journal of Animal Husbandry,2019,55(7):169-174.
5. Jin Hongwei, et al. Full mixed ration preparation machine options and maintenance [M]. Beijing: China Agricultural Science and Technology Press,2014:3-12. Beijing: China Agricultural Science and Technology Press,2014:3-12.
6. Zhang Xiaoliang, Tian Jinming, Li Wei, et al . Analysis of the quality of milking machines in China [J]. China Dairy,2011(1):8-12.
7. Peng Xiaopei, Huang Kejing, Guo Yi, et al . Research on mechanical manure removal methods in domestic livestock farms [J]. Report [J]. Contemporary animal husbandry,2020(7):24-26.
8. He Dongjian, Liu Dong, Zhao Kaixuan. Research progress of animal information intelligent sensing and behavior detection in precision animal husbandry [J]. and behavior detection [J]. Journal of Agricultural Machinery,2016,47(5):231-244.
9. Shao Lin, Liu Shuxia, Huo Xiaojing, et al. Application of data fusion algorithm in the environmental monitoring system of livestock and poultry house[J]. Agricultural Mechanization Research,2013,35(8):162-165,169.
10. Hou Shizhong, Wu J, Song Lei, et al. The current situation of the application of livestock machinery and equipment in Shandong Province Survey and development measures [J]. Heilongjiang animal husbandry and veterinary medicine,2014(11):89-95.
11. Huang Wenyu. Research and design of a refined dairy farming management system based on data on animal husbandry [J].and design [J]. Journal of Yichun College,2017,39(3):46-49.
12. Department of Agricultural Mechanization Management, Ministry of Agriculture and Rural Affairs. 2019 National Agricultural Mechanization Statistics Annual Report [M].2020:14.
13. China Dairy Association, Institute of Agricultural Information, Chinese Academy of Agricultural Sciences. Automatic milking machine Weapon innovation technology analysis report [R].2021:4.
14. Ministry of Agriculture and Rural Affairs of the People's Republic of China. DG/T 219-2021 cow behavior monitoring equipment[S].2021:1.
15. Lv Zhanmin, Jin Hongwei, Liu Shengchun, et al. Analysis of the application of dairy cattle behavior monitoring equipment analysis[J]. Chinese dairy cattle,2021,06:51-54.

Comment [S12]: for

Comment [S13]: Remove space

Comment [S14]: and

Comment [S15]: remove