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Review Article

Automation of Poultry Farms: A review

Sadiya Sajad*and Hafsa Imtiyaz Chisti
Division of Livestock Products Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology- Kashmir, Shuhama, Kashmir -190 006, India
Corresponding Author: sadiyasajad2024@gmail.com
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Abstract

Automation has revolutionized various industries to increase efficiency, reduce costs, and improve overall production. In the agriculture sector, one industry that has witnessed major advancements in automation technology is poultry. With the rise of innovative technologies such as sensors, robotics, artificial intelligence, automated poultry farms have become a reality. Automation makes it possible for large number of birds to be handled in the operation, saves time, labour, improves safety, provides higher efficiency and removes the risk of possible human error.

Key words: Agriculture, artificial intelligence, automation, robotics, sensor.

Automation or labour-saving technology is the technology by which a process or procedure is performed with minimal human assistance. Various commonly used automated equipments in the poultry (broiler) farming include mechanized cage systems, mechanical cleaning equipment, mechanical debeakers, automatic and semiautomatic feeding, watering and medicating equipments, etc (Chinaeke-Ogbuka et al., 2021).

Cage systems: The mechanized cage systems may be classified by the number of levels of cages and the method by which manure is eliminated from cages. With the advent of controlled environment housing, cage designs continued to be improved. Earlier three- tier, four-tier and five-tier systems became popular providing significant increases in bird density within a house. Six tiers required special elevated people-movers to manage the top levels. Nowadays, broiler battery cage system is

being used by broiler farms. Manure elimination is performed using slanted manure collection boards between levels to prevent manure from entering lower cages causing dirty eggs. Manure is scraped from manure boards from the aisle on a hanging system or with mechanical scraper on floor stand systems (www.gartech.co.in/broiler battery cage.aspx, 2014).

Advantages of battery system:

1. Broiler battery system gives better productivity due to better livability, feed conversion ratio and more flocks per year.
2. 10000 birds per hour can be harvested with minimal damage with the mechanized system in the broiler cages.
3. Birds are kept away from manure in broiler battery which improves bird health and overall performance.
4. A marked difference in FCR is certainly a great economical advantage.
5. Overall, less production cost in broiler battery cage.
6. Mechanized handling of manure and its daily removal helps maintain better farm hygiene.

Mechanical debeakers: The mechanical debeaker is a machine that cuts off and cauterizes a portion of the beak. The aim of debeaking is to prevent cannibalism among the birds. Enough of the beak must be removed to prevent regrowth to its normal length during the lifetime of the bird (Ren *et al.,* 2020).

Mechanised poultry feeding systems: Automatic or mechanical feeders are standard equipments on large poultry farms. They save a great deal of labour and keep fresh feed available to the fowls at all times. The design of feeding equipment varies considerably on different farms but no matter what style of construction is used, the feeding devices should be easy to fill, easy to clean, built to avoid waste, so arranged that the fowls cannot roost on them, and constructed in such a manner that as long as they contain any feed at all the fowls will be able to reach it. They save a great deal of labour and keep fresh feed available to the fowls at all times (Suma *et al.,* 2023).

Mechanized feeding of caged birds: The following mechanized feeding systems are used in multi-tier cage laying systems (Natho *et al.,* 2023).

1. Travelling hoopers: Feed is stored in one or more metal feed bins outside the building from where it is automatically carried by conveyor to the feed hoppers at the end of each cage row. Traveling hoppers ride on a track located above the cages or on the floor and dispense feed directly into the trough. These require enough capacity to dispense feed the entire length of the cage row. Long rows make it increasingly difficult to either carry enough feed or spread it thinly enough to uniformly feed

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the entire row. Traveling hoppers are easily automated to operate at desired intervals with timers and automatically refilled between feedings.

2. Conveyor Feeder: Conveyor feeders are also called automated closed loop mechanical feeders which can be used in any of the cage systems. Conveyor systems are quick and efficient. Conveyor feeders are further categorized into:

- Button type
- Auger type
- Chain type

3. High quality broiler feeding systems: Clean in place 'CIP' pan feeding system for broilers and pullets. For over 20 years, the strong and ergonomic CIP pan has proved to be a top-quality product in the broiler feeding area. Its design allows the animals an easy access to feed since their first day of life. The original Sperotto Feeding System has the unique innovative FLD (feed level device) a patented system which guaranteed the simultaneous distribution of feed in each pan. The pan feeder is made of special non-toxic, shockproof and acid-resistant material (Donnelly, 2024). Its advantages are:

- No more feed waste.
- Outstanding feed conversion ratios.
- Uniform distribution of fresh feed.

Watering Equipment: Water is critical to egg production and bird comfort. The water system in each house must be adequate, reliable, and free of contamination from feed, manure, and bacterial growth. It should be within easy reach for the birds. Even the medication system allows for medicines to be administered through the water lines (Olaniyi *et al.*, 2014).

1. **Dripping systems** (pipette) fixed on a feeding pipe and hanging inside the building, supplied through gravity, or round drinkers can be used. Height above floor level depends on the size of the fowls and on the period [either starting or breeding].

2. **Nipple drinkers**: In modern broiler farming, nipple drinkers have proven to be a reliable and hygienic solution for the supply of water. It has a pressure regulator with rinsing system and an indicator of water column height. Water supply through nipple drinkers is free from sedimentation because of zero stagnation.

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Harvesting systems: Earlier some of the non-commercialized mechanical harvesting systems were used for birds which included:

a. A built-in conveyor belt.

b. A collecting mat system.

c. A large foam rubber paddle loader with a self-propelled harvester.

d. A pneumatic vacuum system.

e. A second generation vacuum-based system.

f. A tined fork system.

There are two main mechanical catching systems used by the industry (Yang *et al.*, 2024). They include loaders that move towards the birds and either a) place them on **a moving belt**, or b) gather the birds with long rubber fingers while directing them onto **a conveyor belt .**

The Moving Belt System: A tractor equipped with the loading device is driven into the barn and birds are moved to one area. The bottom part of the device is slowly moved towards the birds and as they step on it a belt carries them towards the centre where a second inclined belt picks them up and moves them toward the crate system. The equipment is fitted with a scale system and/or a bird counter so each crate is filled with a predetermined weight/ number of birds. Once the module is full, it is automatically moved to the back and another module is filled. The manufacturer indicates that about 10,000 birds per hour can be loaded with this system (Astill *et al.*, 2020).

The rubber finger gathering system consists of a few soft, long, counter-rotating rubber-fingered cylinders that direct birds onto a conveyor belt. The long rubber fingers are soft to prevent injury but they are also stiff enough that the birds cannot escape or flap their wings (Ramasamy *et al*., 2004). Once captured, birds are lifted onto an inclined telescoping conveyor belt that carries them to a caging system designed to fill standard dump type cages at the back of the machine. The machine is designed to handle 8,000 to 12,000 broilers per hour with a crew of four people. As with other catching procedures, the operation is done at night or when the barn lights are very dim in order to prevent too much movement and/or excitement of the birds. The main benefits of using mechanical harvesters include improved working conditions for the catching crew, reduced labour costs, and reduced stress and injury to the birds.

Transportation: Transporting the birds on a truck to the processing plant is a significant part of the whole operation. As birds are exposed to new conditions (e.g., climate, vibrations, social order, feed restriction) special care should be taken to minimize potential damage. Minimizing stress during

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transport is an important issue from both an animal welfare and meat quality perspective. One of the major transportation stresses is environmental temperature. Relative humidity is also an important factor. Therefore, proper ventilation is an important criteria during transportation of birds. Today, more attention is paid to truck design factors such as air spaces in the middle of the truck, air movement from bottom to top. In some trucks the roof can be elevated to increase ventilation when the truck stops or while moving on very hot days. Roof height adjustment can also be used to facilitate loading and unloading of the module crates. In addition to it, special floor designs allows better air movement without causing problems with droppings from the upper cages (Park *et al.*, 2022).

Temperature monitoring system: Temperature monitoring indicated the potential for developing both hypo and hyperthermia, showing that cold stress can occur near air inlets and heat stress in poorly ventilated areas. Today some trucks used to transport animals have fans located at strategic points to direct air to certain areas, this can be combined with a monitoring system to reduce/eliminate microclimate problems (Mitchell and Kettlewell, 1998). Improved transport trucks are also becoming available that allow better control of the thermal environment during transit. These trucks incorporate forced ventilation as well as temperature and humidity censors in critical areas of the load that can alert the driver to conditions that are likely to result in heat stress, thereby allowing corrective action to be taken.

The industry uses three major types of containers to transport poultry to the plant (Barbut *et al.*, 1990):

a) Loose crates (plastic, wood, metal)

b) Fixed crates on a truck (usually metal) and

c) Large modular containers (plastic and/or metal) that are brought into the barn.

Control of Shrinkage

Pre-processing shrinkage: It is important that the intestines be fairly empty during processing to reduce the chance of faecal contamination (i.e., when the intestines are full there is a higher chance of rupture when using automated evisceration equipment as well as during manual evisceration). The recommended time for feed withdrawal is 8-12 hrs for broilers. On the other hand, too much time off feed (e.g., 14 hrs) is not recommended as this can result in a weakening of the intestine's strength. Also, broilers exposed to light and water empty 60-70% of their gut content after 6 hrs, 80% after 12 hrs, and 100% after 18 hrs whereas birds kept in the dark are slower at emptying their intestinal contents (Buhr *et al.*, 1998). So, automated lights are used in commercial broiler farms inorder to control shrinkage. Temperature also plays an important role in shrinkage. Hot temperature decreases

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feed intake but increases water consumption which effects the consistency of faecal material and increases the rate of Gastro intestinal tract (GIT) clearance. So, in hot weather feed withdrawl period is shorter than in cold weather. Stress (of any sort) to the broiler bird should also be avoided to control shrinkage.

Post-processing shrinkage: Shrinkage caused by heat during cooking called as meat cooking shrinkage (MCS). MCS is the difference between the raw and the cooked areas of meat sample, expressed as the percentage of raw area. The different methods of cooking leading to MCS are ohmic heating, high pressure processing, sous vide cooking (cook in bag system), frying, oven cooking which includes hot air oven and microwave oven cooking (Pathare and Roskilly, 2016).

Conclusion

Automation of poultry farms is rapidly evolving thus, revolutionizing the industry. Introducing various automated energy efficient systems has made the poultry farming promising and less cumbersome. However, certain constraints still persist which include initial implementation costs, reliability, maintenance, animal welfare and its impact on local communities. Therefore, an integrated approach that encompasses all aspects of automation is needed to ensure benefits are achieved and the potential negative impacts are minimized.

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