Comparative Study of Automation and Conventional System on Production Performance in Dairy Farms

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ABSTRACT

Background: The Indian dairy industry has progressed consistently ever since the White revolution of the 1970s, making India, the world’s largest and fastest producer of milk with 17 per cent global share. The Indian dairy market is expected to double within the next 10 years, primarily driven by over 16-20 per cent growth in value added dairy segment. To catch this high growth potential and to meet the rising demand, a sustainable and strong dairy production system will be critical.

Methods: A study was conducted between December 2018 and February 2019 at four different dairy farms. The farms were identified based on rearing systems practiced. The farms were divided into two groups where the first (n=10 dairy cattle) utilized automatic rearing systems (the ARS farms), while the second group (n=10) had conventional rearing systems (the CRS farms).

Result: Based on the results, the effect of different rearing systems on the average lactation yield in the fourth lactation was significantly higher (P<0.05) in automatic rearing system. The lactation yield of both the treatment groups was not significant till third lactation. There was no significant difference observed in persistency of milk production in both the rearing systems. Reproductive performance of the ARS houses had better age at first calving and service period as compared to conventional house type with significant difference. By using an ARS it is possible to save time and achieve greater flexibility. The experiment indicates less man power minutes required for routine daily work like feeding, watering and milking in automatic rearing system as compared to conventional rearing system. A significant (P<0.01) reduction in working time by comparison with a different feeding, watering and management system however can only be expected in the case of sizeable herds. It appears that not much time can be saved with herds numbering 60 animals, but flexibility for the farm manager becomes significantly greater. In view of the relatively high amount invested in ARS, the profitability of such a system must be decided on a farm by farm basis. In principle an ARS can be a good opportunity for optimizing working time and workload in dairy farming.

Key words: Automatic rearing system, Conventional rearing system, Persistency, Lactation yield, Working time measurements.

INTRODUCTION

The Indian dairy industry has progressed consistently ever since the White revolution of the 1970s, making India, the world’s largest and fastest producer of milk with 17 per cent global share. According to (BAHS, 2019;20th Livestock census, 2019), India ranks first in Milk production with 187.7 MT/year with a growth rate of 6.5 per cent. The Indian dairy market is expected to double within the next 10 years, primarily driven by over 16-20 per cent growth in value added dairy segment. To catch this high growth potential and to meet the rising demand, a sustainable and strong dairy farming base will be critical. For achieving this, it becomes critical to address key problems or challenges faced by the industry such as, low milk yield, improper breeding, improper nutrition, deficient veterinary care, poor farm management and inadequate financial inclusion among others. With dairy farming in India dominated by smallholder marginal farmers, with an average herd size of less than 2 or 3, it becomes all the more challenging to address these problems, in the specific context of making small holder dairy farming globally competitive. Dairy farmers are increasingly modernizing their farms: automatic concentrate dispensers and automatic milking systems (AMS) have been utilized for years and several manufacturers have introduced automatic feeding systems (AFS) during the past decade (Belle et al., 2012).

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Automatic milking systems (AMS) have been available in India since the beginning of 1998. The major advantages of AMS are the reduction of labor for milking (Dijkhuizen and Morris 1997) and the enhanced production per cow due
RESULTS AND DISCUSSION

Feeding strategies

In ARS Dairy Farm-1, the animals are fed with maize silage grown on 17 acre land. Silage making is carried out on land with Bunker silo method above the ground level using tractor driven harvester cum chopper. To meet concentrate feed requirements they procure the compounded feed from Charoen pokhoend feed pvt.ltd. containing maize, soybean meal, wheat bran as major component, offered 3 kg per animal per day. Watering system is similar to ARS Dairy farm-1. Concentrate feeding schedule to calves up to six months for 10 kg body weight.

In CRS Dairy Farm-1 and Farm-2, Calf was fed first four days on colostrums, later on milk was fed based on 10 per cent of body weight CRS Dairy Farm-1 and soya milk was fed based on 10% of body weight CRS Dairy Farm-2. Calf rations starts from thirty days and ends up to 180 days in both conventional dairy farms. Calf ration is a mixture of greens and concentrates and Guinea grass, Rhodes grass are primarily used as green feeding and concentrate fed based on 12% of body weight in CRS Dairy Farm-1 where as Calf ration is a mixture of green, concentrates and sprouted maize fodder and Napier and sprouted green fodder are primarily used as green feeding and concentrate fed based on 12% of body weight in CRS Dairy Farm-2. In both the conventional dairy farms, heifer was fed greens @22.5 kg per animal and concentrates was fed for maintenance@ 3kg per animal. Dry fodder fed @10 per cent of green fodder i.e. 2.25 kgs. Lactating cow was fed greens@45kg per animal and concentrates was fed for maintenance and production@ 3 kg per animal and 40 per cent of milk production, respectively. Dry fodder was fed @ 10 per cent of green fodder. However, the leftover residue after soya milk production will be fed to dairy cow by replacing 20% of total concentrates feeding.

Farm Characteristics (Table 2)

Feeding System

ARS Farm-1, ARS Farm-2 and CRS Farm-1 used feed mixer wagon alley without robotic pusher with the help of tractor whereas CRS Farm-2 done manual conventional feeding. The feeding of cows was done twice a day in all the studied farms.

Types of milking system

ARS Dairy Farm-1 has Herringbone (Fishbone) milk Parlour where 12 cows can be milked at one time. Cows stand on an elevated platform in a 45° angled or herringbone manner with their back to the centre of milking area (Veyssset et al., 2001). This exposes enough of the back half of the cow to access to milk her from the side. The milking cup was attached from the sides (Fichler et al., 1998). There was a single entry and exit point for this milking parlour. ARS Dairy Farm-2 was equipped with Parallel (Side by side) milk parlour for the lactating cow. Cows stand on an elevated platform at a 90° facing away from the operator area (Axelsson et al., 2012). Access to the udder between the rear legs, reduces the visibility of front quarters. This configuration makes the walking distance shorter than in herringbone parlour. The cow platform is wider than a herringbone parlour to
comprise the length of the cow. To assure that each position is filled in order, a series of interlocking fronts prevent a position from being used until the one next to it has been occupied. Most parallel parlours use rapid exit stall fronts and use dual return lanes. Both CRS Dairy Farm-1 and CRS Dairy Farm-2 equipped with Bucket automatic milk parlour for the lactating cow. The simplest autonomous machine milking included vacuum pump, single or dual buckets and pulsator for milking one or two animals simultaneously.

**Lactation yield and persistency of milk production**

There was significant difference (P<0.05) in lactation yield of animals in automation over conventional system. The average lactation yield at fourth lactation (Table 3) for dairy cattle rear in automatic rearing system recorded 6115.45 litres as compare to 5785.20 litres of milk production of dairy cattle rear in conventional rearing system. In the present study increased in Automation occurred at all four lactation stages. AMS feeding programs involves concentrates that completing the nutrient to meet the requirements of animal and increased the production. The findings of current study were in agreement with those of de Koning (2010), Jacobs and Siegford, (2012), Prescott et al, (1998), Rodenburg, (2011) who reported increase in milk yield due to AM system.

**Table 1:** Questionnaire format used for data in different dairy farms.

| Questionnaire format used for data in different dairy farms. | ARS-1 Dairy farm | ARS-2 Dairy farm | CRS-1 Dairy farm | CRS-2 Dairy farm |
|-------------------------------------------------------------|------------------|------------------|------------------|------------------|
| Breeds                                                      | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) |
| Number of dairy cows in the house visited                   | 55 (50-80)       | 95 (90-120)      | 105              | 200              |
| Number of shed per farm                                     | 01               | 01 Adult shed+   | 02 Adult shed+   | 03 Adult shed+   |
| Drinker type                                                | Automatic Stainless-steel drinking trough | Automatic Stainless-steel drinking trough | Cement concrete drinkers | Cement concrete drinkers |
| Enrichment related to welfare of the animal                 | Sensor driven automatic grooming brushes | Usage of pedometer for checking the health status of the animal | Large open paddock area | Manual grooming |
| Methods of disposal of waste                                | Farm yard manure, Biogas plant | Farm yard maneuvre-composting and Biogas plant | Farm yard manure | Farm yard manure, Vermi-compost, Biogas |
| Sexed Semen AI Practice                                     | Yes              | No               | No               | No               |
| Summer management                                           | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers |

**Table 2:** Farm characteristics of the identified farms.

| Breeds                                                      | ARS-1 Dairy farm | ARS-2 Dairy farm | CRS-1 Dairy farm | CRS-2 Dairy farm |
|-------------------------------------------------------------|------------------|------------------|------------------|------------------|
| Breeds                                                      | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) | Holstein-Friesian cross bred (n=10) |
| Number of dairy cows in the house visited                   | 55 (50-80)       | 95 (90-120)      | 105              | 200              |
| Number of shed per farm                                     | 01               | 01 Adult shed+   | 02 Adult shed+   | 03 Adult shed+   |
| Drinker type                                                | Automatic Stainless-steel drinking trough | Automatic Stainless-steel drinking trough | Cement concrete drinkers | Cement concrete drinkers |
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| Sexed Semen AI Practice                                     | Yes              | No               | No               | No               |
| Summer management                                           | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers, Aluminium insulation roof sheet | Sprinklers and floggers |
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Table 3: Effect of rearing systems on lactation yield (kg) and persistency (%) in milk production up to four lactation of ARS and CRS dairy farms.

| Rearing system | First lactation | Second lactation | Third lactation | Fourth lactation |
|----------------|-----------------|------------------|-----------------|------------------|
| Automation     | 5203.5±159.44   | 6403.2±131.63    | 5467.35±152.18  | 6115.4±133.65    |
| Conventional   | 4837.35±159.47  | 6204.4±107.14    | 4941.2±129.87   | 5785.20±106.25   |
| P value        | 0.113           | 0.252            | 0.107           | 0.004            |

| Rearing system | Persistency (%) of milk production |
|----------------|-----------------------------------|
| Automation     | 4.89±0.66                         |
| Conventional   | 3.86±0.44                         |
| P value        | 0.274                             |

Table 4: Effect of rearing systems on age at first calving, lactation length, service period and working time measurement of ARS and CRS dairy farms.

| Rearing system | Age at first calving | Lactation length | Service period |
|----------------|----------------------|------------------|----------------|
| Automation     | 843.65±5.64          | 305±0.00         | 122.15±3.54    |
| Conventional   | 903.05±8.18          | 305±0.00         | 142.55±1.54    |
| P value        | 0.001                |                  | 0.001          |

Working time measurement for 60 dairy cattle (Manpower Minutes/day)

| Rearing system | Feeding | Watering | Milking |
|----------------|---------|----------|---------|
| Automation     | 71.6±1.32 | 15.4±1.74 | 8.5±1.57 |
| Conventional   | 81.1±0.95 | 35.2±1.82 | 15.2±1.25 |
| P value        | 0.01    | 0.001    | 0.001   |

among two rearing systems. A typical lactation curve can be described as increasing from initial yield at calving to maximum peak yield, a plateau maintaining peak yield and a decrease from peak yield to the end of the lactation (Grossman and Koops, 2003).

Age at first calving, lactation length and service period

The comparison between automation and conventional system of rearing showed in Table 4, that there was significant difference (P<0.01) in Age at first Calving and service period. The average age at first calving and service period in automatic rearing system was recorded 843.65 days and 122.15 days respectively where as average age at first calving and service period in conventional rearing system was recorded 903.05 days and 142.55 days. However, there was no significant difference in lactation length. These results will be in agreement of the findings of (Ali et al., 2015) who reported that location differences in reproductive performance are often results of difference in feed and feeding strategies, microclimatic conditions including temperature and humidity and management practices. As reported by (Obese et al., 1999; Domecq et al., 1997), cows reared under very limited resources and unfavourable climate of extensive management systems may fail to become pregnant. On contrary to these findings, (Carson et al., 2002) reported that effect of rearing regime does not influence on reproductive traits like age at first calving, fertility etc in Friesian cattle. However, reproductive performance, as indicated by the number of services per conception, was somewhat poorer than previous work with Friesian heifers (Leaver, 1977) but similar to that reported, more recently, by other workers using Holstein heifers (Pirlo et al., 2000; Lammers et al., 1999; Carson et al., 2000).

Working time measurement

The comparison between automation and conventional system of rearing showed in Table 4, that there was significant difference (P<0.01) in manpower minutes for feeding, watering and milking in automatic rearing system than conventional rearing system. Automatic feeding systems are relatively expensive and require a high initial investment. The reason is that if at all possible they should be used for all feeding groups, including dry cows and young animals. The storage containers for the various feed components, particularly roughage, account for a substantial proportion of the investment cost, so the number of basic ration components used has a major effect on investment cost. Working time measurement modelling showed a significantly lower time requirement for feeder-mixer wagon than for a conventional manual feeding system. This supports corresponding statements by farmers in the survey conducted previously. Bisaglia et al. (2012) arrived at a similar result in a simulated comparison of working times between automatic feeder-mixer wagons versus conventional feeding system. Working time measurement of feeder wagon was also studied by Grothmann et al. (2010) and reported the similar manpower minutes requirement in these system. However there should be extensive work and research required to understand the economics of modern dairy farming in India.
CONCLUSION
This study indicated the significant influence on lactation yield, age at first calving and working time measurement. However there was no significant difference in persistency of milk production in both rearing system. There was lot of dissimilarities’ in feeding strategies, feeding system, farm characteristics and types of milking system among the identified dairy farms. Thus, these results indicated that automation rearing system for commercial dairy farms is beneficial for eliciting optimum production performance in crossbred dairy cattle.

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