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

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ABSTRACT

Background: The Indian dairy industry has progress 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 one (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 ($P \leq 0.05$) 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 compare to conventional rearing system. A significant ($P \leq 0.01$) 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 progress 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

to higher milking frequency than conventional milking parlour (CMP) (Klei *et al.,* 1997). Milk yield increases from 2 per cent to 8 per cent (Millogo *et al.,* 2008) and labour decreases by about 18 per cent. Automatic milking systems (AMS) present an opportunity for dairy farmers to not only improve their lifestyle and conditions of work, but also save on labour costs and/or increase the time available to focus on overall farm management (Clark *et al*., 2016). Carolan, (2020) conceptualize 'automation' and 'skill' provide sufficient analytic and conceptual clarity to critically engage the dairy works. However, there is no published scientific data on the merits of using automation over conventional system of rearing and hence the present study will be taken up to compare the automation and conventional systems on production performance in poultry and dairy farms.

MATERIALS AND METHODS

A study was conducted in collaboration with Department of Livestock production and Management, Veterinary College Hebbal, Bangalore 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 one (n=10 dairy cattle) utilized automatic rearing systems (the ARS farms), while the second group (n=10) had conventional rearing systems (the CRS farms). The Farms were designated as ARS-1 Dairy Farm, ARS-2 Dairy Farm, CRS-1 Dairy farm and CRS-2 Dairy farm. Each visit focused on general management practices. During the visit, the following information was obtained (Table 1) i) Farm characteristics ii) Feeding systems iii) Feeding strategies iv) Age at first calving v) Persistency in milk production vi) Lactation length vi) Types of automated milking system vii) Service period viii) Farm economics and ix) Working time measurement.

Statistical analysis method

The descriptive statistics for productive traits were analyzed using SPSS version 16.0. Student T-test was carried out to compare the effect of automation and conventional system on productive performance of poultry and dairy farms.

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 feed with 34% protein containing Distilled Dry Grain Soluble (DDGS) offered 3 kg per animal per day and Tapioca, GNC and Bengal gram based total mixed ration offered 3.5 kg per animal per day. Water is provided *adlibitum* which is automatically controlled by ball valve. There is intense labour saving with most of machine operations. In ARS Dairy Farm-2, the animals are fed with maize silage grown on 25 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 popkhoend 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 in 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 per cent 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 (Veysset *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 (Pichler *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 fore quarters. This configuration makes the walking distance shorter than in herringbone parlour. The cow platform is wider than a herringbone parlour to

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

1.	Farm characteristics	No. of Dairy cows maintained, Breed of cattle, Design and Layout of the barn, Methods of disposal of waste, Sexed semen A.I practice and Summer management and Other practices observe related to animal welfare measures.
2.	Feeding strategies for calf, heifer, pregnant and lactating cow	a) Green fodder (TMR) b) Dry fodder c) Silage d) Concentrates e) Feed additives
3.	Feeding systems adapted	a) Physical means-Manual feedingb Mechanical means-using Vehicle/Mechanized trolley
4.	Persistency of milk production	Recorded up to four lactation of an individual cow (Herd average).
5.	Age at first calving	Recorded in person from each farm
6.	Lactation length	Recorded in person from each farm
7.	Types of automated milking system adapted	Side Opening (Tandem) Parlour, Herringbone (Fishbone) Parlour, Parallel (Side by Side) Parlour, Swing (Swing-over) Parlour
8.	Service period	Recorded in person from each farm
9.	Farm economics	Recorded in person from each farm
10.	Working time measurement	Recorded in person from each farm

Table 2: Farm characteristics of the identified 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+ 01 calf shed	02 Adult shed+ 01 calf shed	03 Adult shed+ 02 calf 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 manoeuvre-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 foggers, Aluminium insulation roof sheet	Sprinklers and foggers, Aluminium insulation roof sheet	Sprinklers and foggers, Aluminium insulation roof sheet	Sprinklers and foggers

accommodate 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 ($P \leq 0.05$) 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. Total mixed ration feeding strategies strive to maintain a constant nutrient composition to encourage milk production and a more accurate understanding of nutrient consumption (Coppock, 1977). However there was no significant ($P \leq 0.05$) influence recorded in persistency of milk production (Table 3)

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
		Lactation yield (Kg)		
Automation	5203.5±159.44	6403.2±131.63	5467.35±152.18	6115.45^{A}±133.65
Conventional	4837.35±159.47	6204.4±107.14	4941.2±129.87	5785.20^{B}±106.25
P value	0.113	0.252	0.107	0.004
		Persistency (%) of milk production		
Automation	4.89±0.66	3.27±0.61	3.31±0.50	4.09±0.51
Conventional	3.86±0.44	2.71±0.31	3.36±0.48	4.33±0.50
P value	0.274	0.292	0.354	0.361

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^{A}±5.64	305±0.00	122.15^{A}±3.54
Conventional	903.05^{B}±8.18	305±0.00	142.55^{B}±1.54
P value	0.001	-	0.001
	Working time measurement for 60 dairy cattles (Manpower Minutes/day)		
	Feeding	**Watering**	**Milking**
Automation	71.6^{A}±1.32	15.4^{A}±1.74	8.5^{A}±1.57
Conventional	81.1^{B}±0.95	35.2^{B}±1.82	15.2^{B}±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 (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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