EFFECT OF CLIMATE CHANGE AND ADAPTATION MEASURES IN DAIRY INDUSTRY OF KERALA

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I. INTRODUCTION TO DAIRY SECTOR IN KERALA

Kerala, the god’s own state is located as the southern end of India, an agrarian economy predominantly rural population and two-third of the overall work force depending on agriculture, animal husbandry and allied activities, about 17% of state GDP is being contributed from this sector. Amongst the various professions of socio-economic importance, animal husbandry deserves a high priority sector in the state as it plays an important role in the economic upliftment of the weaker section of the society engaged in agriculture, livestock rearing and processing of animal products. The livestock wealth is an asset to the farmers and provides nutrition, draught power transportation employment and economic support. Over 80 percent of the rural households in the state own livestock and earn supplementary income from them. Livestock production in Kerala is predominantly the endeavor of the small producers. Most of them are small and marginal farmers own nearly 85 percent of cross bred cattle, indigenous goats, cross bred pigs, poultry and duck, practicing mixed crop-livestock farming system, earning substantial incomes and enriching family diets with nutrient rich animal products. As per 18th Livestock census 2007, the livestock population in Kerala is as follows (in lakhs): Cattle-21.22, Buffalo-0.65, Goat-12.13, Pig-0.76, Poultry-131.89 and Duck 6.61. The main livestock products in Kerala is milk, beef, egg, meat and manure.

Kerala is geographically comprised of three belts- the high interior range of archaic hills, which lie in the east, the low to medium elevation lateritic plateaus and the coastal plain. The eastern mountain region, which is covered by valuable forest. The state lies in the path of both the south-west and the north-east monsoons, thus getting exposed to two raining seasons, the first being the long and steady one and the second, called "thulavarsha", the short and heavy one. The average annual rainfall ranges from 97 to 101 inches, a much higher rate in comparison to the north and the Deccan Plateau provides different climatic condition. In plain and costal region the dairy herds are maintained by stall-fed method but in the hilly region and forest herds are maintained generally by semi-intensive system of feeding. The eastern mountain region, which is covered by valuable forest, is gradually giving way to the enrichment of man leads to deforestation is the main cause for the climatic change in the state.

Malabar Regional Co-operative Milk Producer’s Union (MRCMPU)

Malabar Regional Co-operative Milk Producer’s Union (MRCMPU) Limited is a Union of more than 1000 village level dairy co-operative societies located in the six northern districts of Kerala State in South India and it is owned by the dairy farmers who are members of each affiliated society and who live in the area of operation of these societies. The societies function on the pattern of the societies affiliated to the world famous Anand Milk Union Ltd. (AMUL) at Anand (Gujarat), India and hence are also known as Anand Pattern Co-op Societies or “APCOS”. The area of operation of MRCMPU Ltd. comprises of the six revenue districts of North Kerala, viz Kasaragod, Kannur, Wayanad, Kozhikode,
Malapuram and Palakkad. The Union is affiliated to the state level apex body-Kerala Co-operative Milk Marketing Federation Ltd (Operating under the trade name MILMA) along with its sister Unions at Ernakulam and Thriruvananthapuram. The number of farmers supplying milk to the Union is 92,846 (2015-2016) and average daily procurement of raw milk is (2015-2016) about 5,66,268 Liters and average daily sale of processed liquid milk is around 4,75,528 liters. This is in addition to farmers own consumption and local sale of milk and milk products, additionally farmers also get the benefit from sale of manure and calf. The primary role of the MILMA is to provide remunerative market for milk producers in the far-flung remote villages and make hygienic milk and milk products available to the urban consumers at reasonable rates.

**Direct effect of climate on Dairy Animals**

- Dairy animals are homeotherms, which means, that they must regulate their body temperature within a relatively narrow range to remain healthy and productive.
- The ambient temperature below or above the thermoneutral range creates stress conditions in animals.
- The approximate thermal-comfort zone for optimum performance of adult cattle is reported to be 5–15°C (Hahn, 1999). However, significant changes in feed intake or in numerous physiological processes will not occur within the range of 5–25°C.
- The upper critical temperature of dairy cattle is lower than other livestock species. Hot and humid environmental conditions cause heat stress in cows.
- For air temperature below skin surface temperature of an animal, increasing ambient temperature decreases the gradients driving convective, radiation and conductive heat loss and consequently increases reliance on evaporative cooling (sweating and panting) to dissipate body heat.
- However, high relative humidity reduces the effectiveness of evaporative cooling and during hot, humid summer weather the animal cannot eliminate sufficient body heat and body temperature rises.
- Heat stress induces behavioral and metabolic changes, which include reduced feed intake and metabolic activity and thereby a decline in their productivity.
- Short-term extreme events (e.g., summer heat waves, winter storms) can result in the death of vulnerable animals (Hahn and Mader 1997), which can have substantial financial impacts on livestock producers.

**Milk production level in Kerala (tonnes)**

<table>
<thead>
<tr>
<th>State</th>
<th>09-10</th>
<th>10-11</th>
<th>11-12</th>
<th>12-13</th>
<th>13-14</th>
<th>14-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>All India</td>
<td>116425</td>
<td>121848</td>
<td>127904</td>
<td>132431</td>
<td>137685</td>
<td>146314</td>
</tr>
<tr>
<td>Kerala</td>
<td>2509</td>
<td>2645</td>
<td>2716</td>
<td>2791</td>
<td>2655</td>
<td>2711</td>
</tr>
</tbody>
</table>

The milk production level in the state during the year 2014–2015 has been increased due to the concerted efforts of the government and milk cooperative societies.

**II. EFFECT OF CLIMATE CHANGE IN DAIRY SECTOR**

**High Summer Temperature and Torrential Rains**

Milk is being a very good nutritious medium for growth of almost all kinds of microorganism there by it gets spoiled very quickly when it is exposed to outside environment with great variation in temperature. Even thou the dairy farmers in Kerala are educated to adopt recent clean milk production technologies and maintaining the quality but the quantity of sour milk is increasing every year in spite of various efforts to reduce it. In summer, temperature is reaching higher levels than before and such
upward trend is felt year after year is a lead to rapid multiplication of bacteria results in quality deterioration of milk is a great challenge. Similarly torrential rains, road block by tree falling and land slide cause road blocks during the monsoons, which result in delay in transportation of milk. Both the factors contribute to spoilage of milk. It is apparent that milk getting spoiled is directly related to summer and rainy season. State is also known for their torrential rain which is mainly due to climate change.

The curdling of milk can be prevented by improving the quality of milk, by chilling it below 5°C within 3 hours of milking and also by quickly transporting the milk to the processing centers. As a result of unexpected torrential and erratic rains, there are frequent landslides and falling of trees leads to road blocks and it becomes extremely difficult for the collection vans to reach designated collection centers in time. This delay in transportation results in rapid multiplication of bacteria and thus results in increasing acidity and spoilage of milk. So, in case of landslides, the milk need to be quickly trans-shifted and transported with the help of suitable vehicles to chilling centers. Therefore in recent years bulk cooling system of various capacity were installed in APCOS with the financial assistance from National Dairy Development Board (NDDP) and this milk were transported to central processing unit by insulated tanker lorry.

### Climatic change effect on the quality of Milk

The above mentioned climate change related factors pose threat to the dairy industry in the Kerala State. To overcome these threats, it is essential that the following steps be taken:

Regular education to farmers regarding clean milk production practice at

- Animal and Milker’s level hygiene,
- Utensil and equipment hygiene
- Hygiene during Milking process and
- Environment of cow shed and ventilation.
- Timely payment programme

This will leads to

- Minimize bacterial load and contamination in raw milk while milking cows.
- Milking of cow with clean, dry teats and in clean shed
- Use of clean, sanitary milking machines and milk handling equipments.

It is critical to use well cleaned, sanitized buckets, closed milk cans and equipment to handle raw milk to minimize the initial bacterial count in raw milk and helps to limit the total number of bacteria that may grow after harvest. Once milking is completed, the milk should be transferred to the milk society’s bulk cooling tank as soon as possible. They should use only clean, sanitized equipments and keep milk as cold as possible. Bacterial growth in raw milk produces different forms of spoilage depending on the type of bacteria involved. Many milk spoilage bacteria produce enzymes that damage the milk fat or proteins. This damage results in yield inferior quality of milk and milk products.

### Microbial Quality of Milk

Milk is a highly perishable food item containing water, fat, protein and minerals –essential components of human diet. These components also promote rapid bacterial growth. In warm climate, bacteria numbers in milk may double for every 20 to 30 minutes in logarithmic manner leading to very high bacteria counts in a few hours (Yadev et.al, 1993).

<table>
<thead>
<tr>
<th>Time (in min)</th>
<th>Starting No of bacteria per ml – situation 1</th>
<th>Starting No of bacteria per ml – situation 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td>2000</td>
</tr>
</tbody>
</table>
For example 1000 bacteria in the milk will become 40,96,000 bacteria within a period of six hours and will become 1,04,85,76,000 in 10 hours. It shows the importance to maintain low microbial count in milk at all levels of its production, transportation, processing and storage.

III. CLIMATE CHANGE ADAPATION STRATEGY IN THE DAIRY SECTOR

1. Establishment of Milk collection centers with required technical infrastructure
   The Milk Collection Centers at the required locations need to be established and also the existing collection centers need to be strengthened on scientific lines to provide sufficient infrastructure facilities in village level milk society itself. Most of the village Milk Cooperative Societies have their own buildings to carry out their day today affairs but many of their collection centers run in rented house or in open premises or with charity support in the houses of some generous villagers and also most of the societies maintaining the mobile collection unit to increase the milk collection and reduce the time delay in transport of milk. It is therefore proposed to provide proper shelter to the milk collection centers.
   Every Milk Cooperative societies need to be strengthened with infrastructure like for milk testing equipments like lactometer, milko scan and regular management needs to be provided according to their production capacities.

2. Use Of Bulk Cooler Systems To Check Bacterial Growth
   Cooling of milk to below 5°C within 3 hours of milking will arrest the growth of bacteria to greater extent. Therefore it is advisable to install bulk coolers at required locations, will enable societies to go for morning and evening collection separately and to chill the milk as soon as it is received. There by avoid multiplication of microbes to large extent and prevent souring of milk due to higher fluctuating temperature. One bulk cooler unit can take care of five or ten societies located near to each other.

3. Quality Assessment through Laboratory Facilities
   Dairy product quality assurance begins at the farm and ends in the hands of the consumer. In this regard, raw milk quality is essential and is monitored closely. Raw milk must also meet other
quality standards; it should be free of added water, free of sediment, contaminants, free of drug residues, less in total bacterial count and other abnormalities. Milk is synthesized in specialized cells of the mammary gland and is virtually sterile when secreted into the alveoli of the udder (Tolle, 1980). Beyond this stage of milk production, microbial contamination can generally occur from three main sources (Bramley and McKinnon, 1990); within the udder, from the exterior of the udder and from the surface of milk handling and storage equipment.

The key factors in influencing the level of microbial contamination of raw milk is the health and hygiene of the cow, the environment in which the cow is housed and how it is milked and the procedures used in cleaning and sanitizing the milking and storage equipment are all. The temperature and time of storage are equally important because which allow microbial contaminants to multiply and increase in numbers. All these factors will influence the total bacteria count (SPC: Standard Plate Count) and the types of bacteria present in bulk raw milk. Other than the SPC, a number of testing procedures may be used to evaluate the quality of raw milk, including the methylene blue reduction test, the Resazurin reduction dye test and/or the Coliform Count. These tests generally carried out to find the extent of contamination of milk that occur through contaminants and that are not considered to be the natural flora of the cow.

4. Scientific Dairy Cow Management

Scientific management of dairy animals is the base for quality milk production. Training to farmers is needed for various issues associated with dairy cow rearing from the selection of breeds, feeding, vaccination, health issues, reproductive management to calving and calf management. Scientific feeding is an essential component for improving the milk production and reduces the cost of production. It would be advisable to provide chaff cutters for feeding grass and fodder scientifically and avoid wastage of fodders. All the scientific management techniques have to be taught to the farmers through various health camp and education programme.

5. Method of Milking and utensils quality

Milking is an important event in the milk production process that has a very critical role to play in reducing microbial contamination. Using of milking machines to reduce the microbial load to greater extent. From cleaning of udder, drying of it, time taken for milking, use of disinfectants need to be carefully examined and an appropriate practical solution should be provided to the farmers. Use of unclean vessel can be a source of bacteria, which multiplies rapidly in the milk, thus spoiling it early. The farmers need to have through understanding on scientific methods of milking and clean milk collection and storage vessels to improve the hygiene.

6. Effective transportation of Milk

Quick transportation of milk is very essential to retain the milk quality. Care and vigil must be taken to societies those are suffering from poor microbial quality and suggest a suitable option. To speed up the transportation of milk from collection centers to the societies and bulk cooling centres by medium sized vehicles and insulated milk tanker lorries were used to transport the milk from societies to central processing plant.

7. Educational programme to farmers and society employees

Various training programmes need to be organized in each of the milk societies to explain to the farmers and employees about the importance of clean milk production techniques, microbial quality of milk, scientific management and breeding practices. The simple techniques of clean and quality milk production such as clean milking procedures, storage techniques, use of clean utensils with lid has to be demonstrated and explained with the use of appropriate tools. The rate at which the microorganism multiply in milk has to be shown to the farmers through microscope and methylene blue dye reduction test and the acidity changes explained through a hands on exercise. The results of the efforts of scientific
management of dairy cows and clean milk production on the economic benefits have to be extended to the farmers in practice.

8. Training to farmers on climate change adaptation

The experts from the Animal Husbandry Department, Veterinary College and Dairy Development Department were utilized to demonstrate and explain the protocol of practices for quality milk production, scientific dairy cow management and clean milk production technologies to all the farmers of the milk cooperative societies and all other interested farmers in the village as a measure to adapt to climate change.

IV. ADAPTATION STRATEGY FOR THE YEARS TO COME

1. As the effect of climate change on dairying is expected to rise in the years to come, the adaptation strategy explained above needs to be included in the standard operating procedure in the production, collection, processing and marketing of milk in order to minimize the climate change impacts on the milk production system and quality of milk.
2. Farmers also need to be equipped with management practices suitable to the changing climate conditions.
3. There is need to provide proper cow shed according to geographical condition, prevailing temperature and rainfall intensity and frequency. The sheds for the cows need to be designed by the experts accordingly.
4. Feeding pattern, water and fodder requirement needs to be provided accordingly.
5. As the change in climate will also affect fertility of animals, scientific breeding practices need to be adopted and there is a need to ensure availability of such services.

V. STRENGTHENING EXISTING PROGRAMMES

1. The existing milk collection centers need to be strengthened with appropriate infrastructure including local bulk cooling facilities as discussed above to adapt to climate change. Similarly the numbers and size of such centers also need to expand as per the requirements.
2. The milk collection-transportation system has to be designed in such a way that the transportation time for the milk to reach processing centers is minimal.
3. Provision of milking machines can help to reduce the work load, wastage and contamination of milk.
4. The MILMA and Animal Husbandry department is extending the breeding services through artificial insemination and embryo transfer technology and health cover to the animals and farmers, free vaccination camp, and infertility camp, providing dry fodders in summer season at subsidized rate. The network of such centers also needs to be strengthened.
5. The fodder species in the state of Kerala need to be scientifically assessed in order to adapt a changing climate.

Additional Interventions

In the climate change scenario a scientific study is required to assess the suitable breed option for dairying for the state of Kerala.

There is a need for land use planning to ensure adequate feed and fodder availability to the dairy animals throughout the year because farmers always depending on the nearby states for raw materials, concentrates and dry fodders.

Provide more number of bulk milk cooler to centers having higher milk collection and far away from processing dairy.

The option of processing milk at the local level and selling them in a decentralized manner may be assessed for its feasibility.
Product diversification also needs to be studied and the new products were produced according to the requirement of consumers so as to sustain the marketing linkages to the farmers.

Education and training to dairy farmers to give knowledge in all the above issues is also needed.

V. CONCLUSION

Dairy industry in the state of Kerala is a well-known traditional livelihood activity. It is evident that this sector is being affected by the climate change drastically. The measures suggested above may need to be implemented to sustain the livelihood of the people dependent on the dairy sector.

BIBLIOGRAPHY

Figure 1