ICT Based Cattle Heat Period, Insemination and Fertility Management Model

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Abstract— Reproductive efficiency of the dairy herd is important for the economic success of the cattle owners and dairy operations in rural India. Artificial insemination is a scientific reproductive technology that is popular in the dairy industry. Efficient heat detection management and correct insemination timing are crucial issues that play pivotal roles in reproduction. The timing of insemination must ensure that the fertile life of sperms and eggs are synchronized. There are many reasons for the failure of artificial insemination or natural service. A sample survey of cattle owners shows that large percentage of the owners miss heat period and except some kind of arrangement that intimates them regarding heat period. Challenge is to intimate the concerned persons on time regarding the heat period. This paper focuses on the information and communication technology can be helpful to intimate concerned people about heat period and status of the cattle. Based on facts of the survey we proposed the information and communication based model to manage heat period, insemination and fertility. We have developed software as a part of the model. This low cost solution can be helpful to improve the fertility of the dairy herd and economy of owners.

Keywords- rural; cattle; cattle-reproduction; insemination; ICT; SOA; IVR. RFID, web services.

I. INTRODUCTION

The Livestock Sector has been making rapid strides and spectacular growth in the recent times. The livestock population of India is huge and animals as a whole play an important role in the agricultural economy [1]. This sector also contributes a good amount of supplementary income to the economically weaker sections of society, small farmers, marginal farmers and agricultural laborers. As a result, their standards of living can be raised considerably. In addition to this it also offers a good opportunity for employment generation, if adopted on a large commercial basis [7]. A large number of rural women find good opportunities to work in several operations of livestock production. According to the livestock census -2007, the total breedable population of cows and buffaloes in the state of Gujarat (India) was 3.755 million and 5.141 million respectively [2]. During the academic year 2009-2010, we had conducted a survey of more than 350 cattle owners from different villages of Mehsana district, situated in the northern part of the state of Gujarat, which is situated in the western part of India. The Main objective of the survey was to study the knowledge and awareness in cattle owners regarding heat period and the reproductive life cycle of the cattle that constitutes cows and buffaloes. The reproductive efficiency of the cattle is one of the most important factors for the success of this sector. The Government spends a huge amount of money to improve the reproductive efficiency in the dairy herd. Heat detection management and insemination in a scientific way at a proper time is the most important criteria to increase fertility, productivity and quality of dairy herd. The timing of artificial insemination (AI) or natural service must ensure that the fertile life of sperms and eggs co-ordinates. There are many reasons for failure of insemination and one of the reasons is missing or neglecting the ‘heat period’ by cattle owners even though they are aware about its resultant economical loss. The analysis of this sample survey shows that most of the cattle owners missed the ‘heat period’ due to:

- Social engagement of the cattle owners.
- Inability to detect heat period.
- Inability to recognize or calculate proper ‘heat’ date.
- Habituated carelessness.
- Unavailability of Bull or AI experts due to lack of proper information.
- Inability to detect heat period.

Calculation of ‘heat period’ is very critical as it is of very short duration. If timely and well in advance information is provided to cattle owner(s) as well as doctor or AI expert then the situation can be improved.

In this paper, we have tried to assess the potentiality of Information and communication technology (ICT) as a tool to solve the time management problem for the heat period. ICT has played a significant role to change the fabrics of the society. Here we propose a technologically advanced model for the identification of the heat period, methods of insemination and fertility management of the cattle. We have also developed a software as a part of the implementation of our proposed model, which keeps a track of heat period as well as the entire reproductive life cycle of the cattle. Milk collection centres or co-operative societies at a village play the role of a dairy extension services provider. The software keeps track of the parent information of a particular cattle
and it generates family history and many other reports. The proposed model is based on Service Oriented Architecture (SOA). Here it is assumed that each cattle has Unique Cattle Identification Number (UCIN).

Mobile phones, computers and internet are most important for the proposed model. The model helps to manage the reproductive efficiency of dairy herd. It will eventually improve the fertility of cattle, uplift the lifestyle of cattle owners and boost up the rural economy, too.

II. ECONOMICS OF HEAT CYCLE

The oestrous cycle for cows is approximately 21 days in length (range 18 to 24 days) and for buffalo it is 21 to 29 days depending on the breed. There are a number of ovarian and hormonal changes that occur during this period. This is the period of the oestrous cycle in which the cow and buffalo will stand to be mounted by herd mate or artificial insemination. However, under continuous surveillance with the heat watch system, it was observed that cows are in heat for only 12 to 18 hours in some cases [8]. In buffaloes heat duration varies from 21-24 hours. As per AM-PM Rule for artificial insemination those cattle seen in heat in the evening are inseminated the following morning. Those cattle seen in heat in the morning are inseminated that evening. Many cows come in heat at night and may go off heat in the morning. If cattle owner fails to manage the short and critical period of ‘heat’, then they have to wait for the next oestrus cycle. At the same time faulty heat detection that results in failure to present the cattle for service at the correct time is the biggest single cause of low fertility in herds inseminated by AI. A missed heat period or untimely insemination results in economical losses to cattle owners due to

- Unexploited potentiality of milk and of calf production caused by prolonged calving intervals.
- Expenditure on excessive replacement of heifers and on infertile insemination.
- Reduced rate of genetic progress [6].
- Costs of semen.

In case of natural insemination cleaning the bull is required. A bull can be owned or taken on rent [3]. If cattle owners have people doing the work then the cost of oestrous management need to be considered in the cost analysis. Analyzing the additional cost the actual economical losses per cow or buffalo can be calculated. By multiplying these losses by number of cows or buffaloes, gives economical loss which can be a big number in long term projection.

III. SURVEY & ANALYSIS

The survey was carried out by the Department of Computer Science, Gujarat Vidyapith, Ahmedabad, during 28th September to 2nd October 2009. Nearly 90 students and 6 faculties interviewed more than 400 cattle owners. Over 25 villages of Bahucharaji taluka in the Mahesana district of Gujarat State were covered during survey. The main objective of the survey was to study the levels of awareness of cattle owners about cattle insemination, reproduction and healthcare. It was found that out of at least 400 questioners 367 were accurate for the analysis. Using SPSS tool, data it was analyzed that out of 367 respondents (cattle owners), 256 were male and 102 were female. Majority (258) respondents had ‘Maheshani’ buffaloes than cows. Interviewees were asked some questions regarding the reproduction of cattle.

Respondents were asked the age of the first conception for buffalo heifers. 202 respondents answered 30 to 36 months where as 43 respondents answered 24 to 29 months. In case of the cow heifers, 27 respondents answered 30 to 36 months and 29 answered 24 to 29 months.

Respondents were asked the average length of oestrus cycle in buffaloes and cows respectively. 180 respondents answered 20 to 24 days and 136 respondents answered 25 to 30 days for buffalo. For cows 44 respondents answered 20 to 24 days and 17 respondents answered 25 to 30 days.

Question regarding the optimum time of AI, natural service in buffaloes and cows were also asked. 225(61.3%) respondents answered it to be between 16 to 24 hours in buffaloes. 46 respondents had given the same answers for cows.

Figure.1 shows that the 236 (64%) of the respondents are missing the heat period.

There are multiple reasons behind it. It should be noted that it is one of the points in which respondent’s feedback is very important. This is very much related with economical and reproduction losses to cattle owners.

Five options were given to them and it was tried to find out the major reasons for missing heat period. Table -1 shows the response of the respondents.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Options</th>
<th>No of respondents</th>
<th>% of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Forgetting expected date of heat</td>
<td>105</td>
<td>18%</td>
</tr>
<tr>
<td>2</td>
<td>Work load</td>
<td>194</td>
<td>34%</td>
</tr>
</tbody>
</table>

Figure 1. Respondent feedback on missing heat

![Figure 1. Respondent feedback on missing heat](image-url)
### Sr. No | Options | No of Respondent | % of Respondent
--- | --- | --- | ---
3 | Negligence | 107 | 18%
4 | Difficulty in heat detection | 93 | 16%
5 | Unavailability of Bulls / AI | 44 | 8%
6 | Absence of Inseminator for AI | 36 | 6%

‘Work load’ (34%) is a bigger reason while ‘forgetting expected date of heat’ and ‘Negligence’ are next (18%).

Figure 2 shows that the 267 (71.1%) respondents believed that there should be some system that reminds the cattle heat period.

One more important result of the survey also shows that 278 (75.5%) respondents agreed that the heat missed is economical loss to the cattle owner. This shows that the feedback of respondents on reminder system and heat missed are co-related to each other.

### A. Conclusion of Survey

The survey shows that the knowledge of respondents regarding cattle reproduction and healthcare is up to the marks. However missing of heat period is the most common problem in the cattle owners. It is highly associated with cattle reproduction and owner’s economy. Therefore to overcome the same, a majority of cattle owners need a system to remind them for the cattle heat period.

### IV. ICT BASED CATTLE HEAT PERIOD, INSEMINATION AND FERTILITY MANAGEMENT MODEL

The first major commercial AI program happened in Denmark in 1936 with more than 1,000 dairy cows and a success rate of 59%. In the 1940s the technique took off worldwide in most countries [4]. Government of India allocates huge amounts of fund for AI every year. One of the challenges for success of AI is heat detection management and correct insemination timing. Poor timing of insemination results in the waste of a large number of healthy sperm going waste otherwise; being available to fertilize the egg soon after its release. By very late insemination the egg ages or dies before the sperm reaches the site of fertilization [6]. Survey facts show that people prefer AI to natural service. In that case it is the responsibility of the cattle owners’ to manage heat detection and insemination timings. Sample study also showed that cattle owners need some kind of mechanism to manage all these issues in their busy schedule.

During the survey it was observed that each and every milk collection centre at a village level has computers and farmers or cattle owners use mobile phones having good network connectivity. Keeping these in mind a low cost ICT based model is proposed as a cattle heat period, Insemination and fertility management model to address the problems of the cattle owners. The entire solution is divided into two levels i.e. local and central level.

#### A. Local Level

In the first phase we have targeted the high priority issues like heat period management, timely intimation regarding cattle insemination, current status of reproduction etc. We developed software as a part of proposed model.

1) **Software System**

To provide the low cost solution we studied existing software and hardware infrastructure at milk collection centre for various activities. We then designed desktop based multi tier software which can be compatible with existing environment. Figure -3 shows the screen shot of Cattle Insemination and Family Management System. Software system generates the information regarding the probable heat period, pregnancy status, de-warmination time, delivery date and current status of the cattle in their reproductive life cycle. Through mobile phone, the Small Message System (SMS) technology timely intimates the cattle owners, doctors or concerned people regarding the heat date and any other critical situation of the cattle. User of the system generates the common reports regarding the reproductive life cycle status of the cattle and informs concerned cattle owners and doctors.

2) **Software Features**

- Maintain information of the cattle, owners, and doctors.
- Keep a track of cattle information from heat period to delivery.
- Generate and send SMS on various stages of reproduction cycle.
- Generate various analytical reports.
B. Central level

ICT based Cattle Heat period, Insemination and Fertility Management Model (CHIFMM) is proposed as an outcome of this study. CHIFMM is based on web services and Service Oriented Architecture. SOA is a paradigm of designing and developing IT solution which positions a service as the primary building block. A service is an autonomous and reusable unit of business logic. Rules and methods of accessing services are specified in service contract [5]. Figure-4 describes the high level architecture of CHIFMM. In the proposed system, data must be kept on a server. Here the Government or dairy is a service provider. The data available of the cattle owners and the cattle at a local level can be merged at a central level. They provide various services to their consumers. Consumers may be milk collection centre, registered cattle owners, ICDP and veterinary dispensary. They can consume the various web services. Consumer can update the information of cattle and cattle owners’ via web or mobile phones. It is assumed that each cattle can have Unique Cattle Identification Number (UCIN). Cattle owner can update the cattle reproduction cycle status using mobile phone.

Central database system will be connected with interactive voice response (IVR) system. Using this IVR system cattle owner can get the information like probable heat date, pregnancy status, probable delivery date and information regarding current location of the cattle, in a local language using UCIN. Similarly other consumers can also get the information of the cattle and cattle owners, using the IVR system. The proposed system has all features like the local system. In addition to this the system keeps a track of cattle family history and owner history.

V. SCOPE

The study includes only cows and buffaloes from the North Gujarat region. This system can be extended for the other animals and regions too. With the technological advancement there is a scope for radio frequency identification device (RFID) technology. RFID will helps to uniquely identify the cattle. Cloud computing is an emerging area; it is a business model of delivering IT resources and applications are services accessible remotely over the internet rather than locally. It can be useful for better service delivery and development of economy.

VI. CONCLUSION

It can be conclude that this solution may face challenges in its implementation stage. It is strongly believed that it is time to access the potentiality of ICT that is waiting to be explored. The power of ICT to uplift the life of common people, rural economy and create livelihood opportunities for people in the developing world should be explored. Today a considerable percentage of the Indian population depends on the agricultural sector. Hence, this technology that reaches the grassroots level will significantly contribute to the national development

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