'Development of Spatial Decision Support System (SDDSS) for Dairy Management and Planning in Pune District'

Synopsis Submitted to Symbiosis International University, Pune

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1. Introduction:

Dairy sector plays an important role in sustaining rural economy and livelihood, a sector in which poor contribute directly to the economic growth. For a more balanced development of the rural economy and reduction of poverty, a remarkable progress in this sector is a national requirement. The nature of Indian Dairy Sector is, up to some extent, unique. Its developments in India have been significantly influenced by religious and cultural factors. There is change in the consumption pattern of milk and milk products like ice-creams, cheese, paneer, etc. has been increased drastically in last two decades. This demand-driven growth has shown a massive increase in demand for milk and milk products. As we all agree that milk is the most perfect food. It provides nutrients like proteins, calcium, etc. especially for vegetarians. Clearly, this increased demand will drastically stretch the existing production and distribution systems in near future. Since productivity is the key to growth, animal productivity will have to be raised through better breeding, feeding, management and health care practices. The scenario calls for formulation of long-term policies by the government and significant investments in this sector. Technologies like IT and GIS are rarely used in dairy sector in the past. Objective of this research is to develop a spatial decision support system for dairy planning and management in Pune District.

2. Review of Literature

2.1 Status of IT application in Indian dairy sector:

Indian dairy sector can be divided into two parts - organized and unorganized dairy sectors. Organized dairy sector includes private dairies and milk cooperatives which procures milk from small dairy farmers' in particular geographical areas. Most of the dairy farmers in India have less than five animals. Unorganized sector handles around 75% of India's total milk production. This includes selling of milk and milk products either by farmers directly or by traders.

According to National dairy development board, the total milk production of India was 121.8 MMT (2010-11). Out of this, only 30 MMT i.e. about 25% of milk is processed and marketed by dairy milk cooperatives and private dairies which come under organized dairy sector. In last few years, many organized dairy farms have come up in different parts of India. These farms have 50 to 2,000 medium/high yielding cows/buffaloes with modern facilities like milking parlors, silage making and TMR wagons. The challenges of managing such dairy farms are increasing with the increasing demand for high quality products. Official testing records, daily observations, animal history are the important information for dairy producers, which are used to provide milk quality solutions.

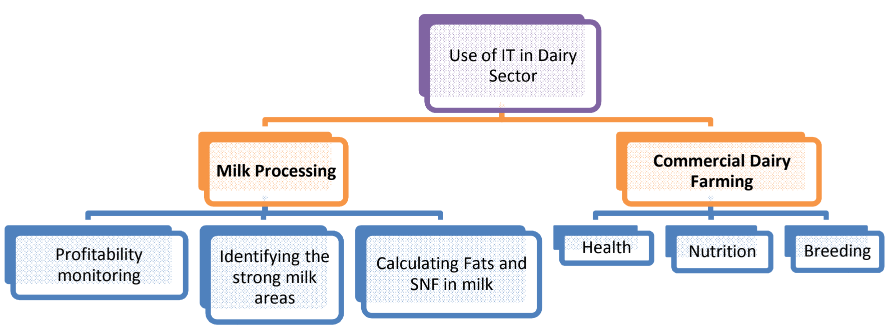

Figure 1: Use of IT in Dairy Sector

IT is used by milk processing plants (as shown in Figure 1) for profitability monitoring, calculating fats and SNF and payments to be given to the farmers. Commercial dairy farming, which is an emerging sector, is also using IT in health, nutrition and breeding management.

IT can help in creating database of milch animals and it can be used while selling/purchase of animals. It's a well known fact that there is a scarcity of green fodder, dry fodder and concentrates for feeding of dairy animals. There is a need to create a database of district-wise availability of these feed resources for judicious use to improve productivity of animals (Bhosale, 2010).

Companies like IBM and Microsoft have developed ERP systems which can be used in dairy milk cooperatives and private dairies which help in milk processing (Bowonder, 2005, Cecchini, 2002).

There are many steps involved in herd health management for high quality milk production. Monitoring and measuring each step is very important but it is complicated task. To solve this problem, there are many automated and web-based dairy technologies and tools available to dairy producers and consultants for monitoring and measuring milk quality. These tools are automated systems that allow producers to track the daily results from individual cows, milk quality testing and uploaded data from herd observations. These can be used to communicate problems with employees, nutritionists, veterinarians and dairy consultants (Schuring, 2010).

One of the Hi-Tech Milk cooperative in Gujarat has automated milk collection centers and dairy information system kiosk for supply chain. They are using GPRS for tracking milk collection tankers which brings milk from villages. National Dairy Development Board has developed Ration Balancing Software which can be used at farmer's level to design balanced feeding program of dairy animals. It helps to increase milk production, to reduce cost of milk production and to use available feed resources efficiently (Bowonder, 2005).

Kariuki et.al (2006) has developed Livestock Information Network and Knowledge System (LINKS) having collaboration with GL-CRSP (Global Livestock Collaborative Research Support Program). The LINKS is a livestock marketing information system based on ICT that has now been adopted as the basis for developing a national livestock marketing information system for Kenya. This has a positive effect on market transactions in terms of improving sales and identifying markets offering better prices. LINKS plays major role in improving connectivity among markets and this can help communities of livestock producers to identify markets for their livestock and improve their knowledge on prices in those markets. Livestock early warning system (LEWS) is SMS text message based reporting flow from various markets in Kenya, Ethiopia, and Tanzania. This system is used to inform rural communities on the availability of the water.

C Manivannanan, Hema Tripathi (2007), their study revealed that urban respondents were the better planners, decision makers, risk takers, coordinators besides skilled in rational marketing and adopted more number of dairy farming practices as compared to those came from rural and peri-urban areas.

2.2 Feeds and Fodders in India

The forage resources in India are mainly derived from crop residues, cultivated forage and grazing from pastures and grasslands. The crop residues mainly constitute the major feed material for the animals in most of the states in India. The country has about 4.9% of the total cropped area under cultivated forages. The requirement for fodder is mainly governed by the density of livestock in an area and secondly by management levels and climatic conditions. The fodder with the present productivity level is not sufficient to meet the demand of huge livestock population. It is difficult to find out fully reliable figures of fodder production in India. However working estimates are available. According to draft report on fodder during the 10th five year plan an estimate current fodder requirement is 1,057 and 588 million tons for green and dry fodder respectively. The present availability of green fodder from cultivated areas and pastures is 395 million tons which includes supplementation form sugarcane tops and seasonal weeds taken out from cultivated fields. Similarly, total availability of dry fodder is 453 million tons which constitutes stovers of cereal crops like paddy, wheat, barley, maize, sorghum, pearl millet and few legumes like pigeon pea and chick pea and dry grass from grazing lands and forests. It is clear from the projection of demand and supply of forages that deficit of green fodder and dry fodder will be more than 65% and 25% by 2025. In a span of next 15 years, picture of bridging the gap between demand and supply appears to be gloomy if appropriate measures are not taken such a situation calls from serious attempt to improve supply of green fodder in India for sustaining millions of livestock every year (Gupta, 2004).

There are several factors like genetic make-up, environmental conditions, breeds, health practices, nutrition and feeding are the important factors affecting on the productivity of the milk. One of the important factors among in this is nutrition and feeding. In India, most of the farmers have at least 3/5 milch animals at their door but they are very low productive as the farmer doesn't have sufficient resources to feed his animals. Livestock population in India is dependent upon the biomass residues in crop production for animal production and plays important role in the rural economy. Earlier, number of livestock holding was considered prestigious in society and was linked with status. This trend is still continuing in some parts of the country. The buffalo population is increasing with 1.7% annual growth rate, while in case of indigenous cattle the trend is negating (Gowda, 2009).

The total area under cultivated fodder is only 8.4 MHA on individual crop basis which is static since last three decades. The scope for further increase in area under forages seems to be very less due to demographic pressure of human population for food crops. The accurate figures of area and production of forage crops is very difficult to find because these crops are grown in small patches which finds less attention. No systematic efforts for collection of data on area of forage crops have been made so far. However provisional figures of area under important fodder crops have been reported under the aegis of AICRP on forage crops (Hazra, 1998).

There are three major sources of fodder supply viz: crop residues, cultivated fodder and fodder from common property resources like forests, permanent pastures and grazing lands. Maharashtra comes under southern region of India. The fodder used in Maharashtra is sorghum, pearl millet, coarse rice and other millets are used as straw for animals, there is need to promoting forages based agro forestry systems on arable lands (Gowda, 2009).

Thus it is apparent that forage demands can be adequately met by mobilizing the resources of climate, water, soil, species, varieties and the management. Fodder and its importance are realized only in the deficit zones and deficit rainfall years. Technological options are sufficient to meet these challenges. The potential areas requiring attention are as under: (Pathak, 2002)

1. Develop degraded lands under pasture.
2. Develop degraded forests under pastures through joint forest management.
3. Conserve extra fodder and crop residues by establishment of fodder banks.
4. Popularize chaff cutters in those areas where it is not used presently.
5. Use improved varieties of fodder crops.
6. Emphasize use of perennial crops in deficit zones along with crops.
7. Emphasize year-round fodder production and mix cropping of forages with crops to meet the demand of livestock.

Use of GIS technology can help in assessing the fodder production in particular areas and can help farmers/milk cooperatives to decide feeding strategy for dairy animals in that particular area. Efficiency in the agricultural sector can be augmented effectively by using IT tools such as remote sensing and GIS.

The database for the agriculture sector can ensure greater reliability of estimates and forecasting that will help in the process of planning and policy making. Efforts to improve and harness latest remote sensing and IT techniques to capture, collate, add value and disseminate data into appropriate destinations will be helpful for managing risk and in accelerating the growth process (Mandal, 2003).

P Parthasarathy, A J Hall (2003) has done the survey based research. This study shows the mixed crop-livestock systems are the dominant form of agriculture production in India. Integrating crops and livestock on the same farms helps smallholder farmers to diversify the source of income and employment.

Abdur Rahman et al. (2008) has given comparative study of two transects that are Karakoram highway and Gilgit-Ghizer region. The sample regions has two geographical transect and three agro-ecological zones. This study was set up to identify transect & cropping zone effect.

2.3 Application of ANN and GIS in Dairy Sector:

According to Clarke (2001) accurate and timely information is necessary to evolve strategies for sustainable management of agricultural resources. Remote sensing (RS) and geographic information system (GIS) technologies if used with intelligent techniques, it can have a great use to planners in planning for efficient use of agricultural resources at national, state and district levels. Season-wise information on crops, their acreage, and production enables the country to adopt suitable measures to meet shortages if any, and implement proper support and procurement policies. In Ghana, the prediction of crop yield was done by using GIS/GPS integration.

Ingo Ackermann and Ralf Schlauderer (1997) developed decision support models for the design of animal husbandry and plant production procedures. The models dealt with the choice and design of plant and animal production procedures. A characteristic feature of these models is the simultaneous consideration of environmental substance flows and economic information.

Dunea and Moise (2007) presented several applications of the geospatial technology as a method to maximize the efficiency of the dairy farm management. The experiment was carried out at Negrasi dairy farm in targoviste plain. A functional farm production and mapping program for detailed farm management information system with several modules: mapping, forage stock, feed forecaster, individual cattle database, fuel consume for field operations and farm inputs database was developed for handheld computers with GPS navigation. Such portable information tools might help the decision making process, the development of ideo-types or in the exploration of land use options to support the policy makers at eco-regional level, the management staff at farm level and various other applications in dairy farms. Engineering technologies such as farm production and mapping program, GPS, variable rate application systems, close-range and remote sensing systems, and yield mapping systems will have a significant role in making the agronomic principles embodied in precision farming feasible. PDA handheld devices with dedicated software might provide useful features to optimize the farm management. Such instruments, designed for the realities of mobile fieldwork are suitable for agricultural, surveying, forestry, or other applications where portability, real-time data accessing and maximum operating time are crucial. The farm manager can connect seamlessly to a local network for easy and convenient data transfer updating farm information or using mobile Internet, he can access web-based agricultural map information systems, customers and suppliers.

Miah and Kerr (2006) have explained in his paper that significant numbers of decision support systems (DSS) are available for rural applications. However, many of these have low adoption rates because they have been developed with little end-user engagement, limited ease of use by farmers, and the identified gap in understanding significant problems between the DSS developers and the potential end-users in the development process. A useable development environment that priorities end-user engagement can be expected to reduce the known DSS development difficulties and to improve the development of appropriate decision support tools. To date however few significant attempts have been made to outline sophisticated models for a design environment that offers an adaptable and effective solution for end-user DSS development. This paper describes ongoing work in ontology construction and knowledge elicitation part of the development of an end-user enabled design environment (EUEDE). In general the EUEDE will assist rural business stakeholders to build their own target-relevant decision making tools. We describe in the first instance, the ontology for EUEDE that will allow dairy stakeholders to outline domain-specific decision making scenarios that will lead to the building of relevant DSS.

The work of Nejla Ben Arfa, Carmen Rodriguez is an insight in the spatial structure of the French dairy sector, allowing a better understanding of the agglomeration and dispersion forces that influence the location of dairy farms in France in 1995-2005

J Khazaei, M Nikosiar (2008), their Study focuses on the capability of ANN to predict the milk yield, fat and protein concentration of milk for each cow as affected by the lactation stage, number of milking day, and season of the year. The ability of ANN to predict simultaneously milk yield and concentration of fat and protein of milk could significantly reduce the computation time and the amount of practical work required to build the Wood models.

Adesh Sharma et al. (2007), a multiple linear regression model is developed for the milk-yield prediction. The performances of ANN and MLR models are compared to assess the relative prediction capability of the former model. It emerges from this study that the performance of ANN model seems to be slightly superior to that of the conventional regression model. Hence, it is recommended that the ANNs can potentially be used as an alternative technique to predict FLMY305 in the KF cattle.

Wilhelm Grzesiak (2006) This study shows contrast methodological approaches followed in predicting dairy cows lactation yield, i.e. Wood's regression model and ANN. Within these two approaches they compared: (1) the quality of the neural network against that of Wood's model, (2) predictive capabilities of both models in terms of lactation yield based on daily yields, and (3) predictions by these models against those produced by an official milk recording system.

Louis Sanzogni, Don Kerr (2001) have used historical milk production data to derive models that are able to predict milk production from farm inputs, using a standard ffann, a ffann with polynomial post-processing and multiple linear regressions. Forecasts obtained from the models were then compared with each other. Within the scope of the available data, it was found that the standard ffann did not improve on the multiple regression technique, but the ffann with polynomial post processing did.

DM Njubi, Wakhungu, MS Badamana (2009), Investigates use of back-propagation ANN approach to model and predict the performance of daughter first lactation milk yield in recorded dairy cattle herds in Kenya. Such prediction is a prerequisite to selection which ultimately leads to optimal breeding strategies and increased annual genetic progress.

Mercedes Torres, Cesar Hervas (2005), the objective of this study is to predict the sheep's productive capacity and thus contribute to the elaboration of a selection program aimed at breed improvement.

3. Objectives:

- To create fodder and dairy cattle density map.
- To develop Spatial Decision Support System for Dairy Management.
- To predict the demand and supply of fodder and milk production using SDDSS.

Methodology:

Stratified random sampling will be used to select sample villages in Pune District. The strata will be formed on the basis of various parameters like agro-climatic zone, milk production per area, breed of milch animals, number of cows and buffaloes etc. The livestock census is done after every five years. The latest census was done in 2007. It shows the population of cows and buffaloes in Pune district. We will get population of cows and buffaloes of selected sample villages from Animal Husbandry Department of Government of Maharashtra.

The milk production data of selected sample villages will be collected from various sources like milk cooperative societies, government agencies, private companies, dairy experts, and dairy extension officers.

Crop residues and green fodders are used as fodder for the milking animals. There are variations in type of crop residues and green fodders available in the different talukas in Pune district. The crops and fodder production data will be collected from Agriculture Department (Zilla Parishad) and satellite images. From the satellite images, we can identify the type of different crops grown in the selected areas in Pune district. From the crop production numbers, we can calculate how much crop residues we can get for feeding of dairy animals.

We will correlate information received from agriculture department and information received from satellite images. Satellite data will be integrated with intelligent technique which will be useful for improved decision-making. Then we will develop an algorithm to predict milk production of sample villages with the help of data collected. This algorithm will be used as forecasting application for milk production and requirement of fodders (Figure 2).

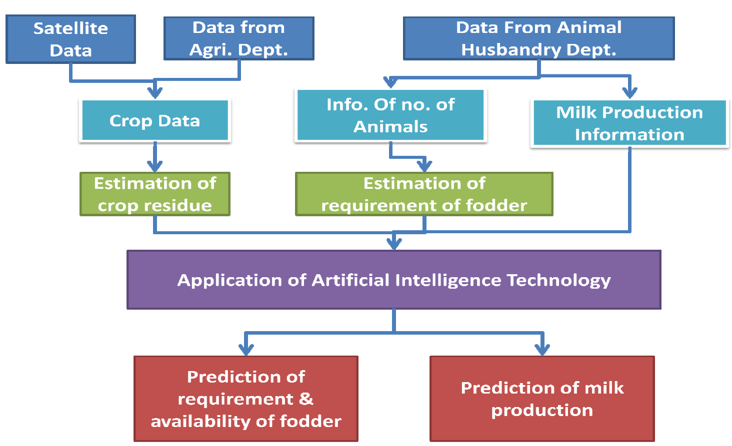

Figure 2: Architecture of SDDSS

Expected results:

- Development of an algorithm for assessment of milk production.
- Design and development of artificial intelligent system for dairy sector.
- Development of SDDSS.

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