Why Do Small Holders Leave Dairy Industry in Sri Lanka: A Bayesian Belief Network (BBN) Approach

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ABSTRACT

Dairy farming in Sri Lanka is predominantly a small holder mixed crop livestock farming operation and provides them with a source of regular daily income. Though, Dairy sector contributes to the national economy the profit margin to the farmers is at very low levels. Therefore, there is a risk of farmers moving out of the dairy sector seeking more profitable alternatives.

The decision of the farmers to leave the industry or not depends on multitude of factors. Nevertheless, conventional analytical tools such as multiple regressions are capable of capturing the impacts of these factors on the farmers ultimate decision, most of these methods are analyzed the effects of the factors in isolation. Further, identifying indirect effects of some of the variables may necessitate more advanced methods as simultaneous equation methods. Hence, Bayesian Belief Network (BBN) is employed in this study to make inferences and analyze those factors in a quantitative manner. The study revealed that there is a 17.5% risk of abandoning dairy farming by small holders with under prevailing conditions. The network is in turn used to evaluate the impact of different changes on the farmers' decision. The results highlighted that many of these changes have a significant impact on their decision with respect to continuing in the dairy farming rather than moving to other alternatives.

KEYWORDS: Bayesian Belief Network (BBN), Dairy industry, Decision making, Livestock, Small holder.

INTRODUCTION

Ruminant livestock are a major component of agricultural systems in tropical countries. In Sri Lanka, rearing cattle and buffaloes by the rural poor has a long history which dates back to the tribal era of the country. It has evolved today to heterogeneous systems while crop livestock integration is a major activity by small holders.

Livestock industry in Sri Lanka contributes 8 percent to the agricultural Gross Domestic Product (GDP) and out of that, the formal dairy sector contributed 11 percent while beef production contributed 15 percent (Anon, 2000). In addition, milk plays a key role in infant feeding and alleviating nutritional poverty in all age groups. Further, this sector makes a major contribution to the economy by utilizing large areas of marginal lands and substantial amounts of crop residues which would have little alternative use. Also, dairy industry plays a vital role in the lives of rural base farm families in providing regular cash income and gainful employments.

At present, the current milk supply is adequate to meet only about 15 percent of the country's requirement (Anon, 2003). The balance is imported mostly in the form of powdered milk. It is evident that milk production in Sri Lanka contributes only marginally to the national economy relative to other industries. Pricing system prevailing in the country is biased towards satisfying millions of consumers rather than the producers. Comparatively, the high opportunity cost of labour relative to the farm gate price of milk discourages farmers from being involved with intensive dairy (Ibrahim *et al.*, 1999). In the meantime, low productivity of milking cows may become a serious constraint for future dairy development. It has been reported that low productivity, lack of basic supporting infrastructures, lack of quality veterinary services, small and scattered holdings are major weaknesses in the dairy industry (Anon, 2000).

As profit margin is very low, producers are unwilling to invest in dairy herds. Perhaps, adequate recognition has not been given in the past to the small holders despite the difficulties they experience in operating dairy. Since, they have very limited economic opportunities; many of them are unable to continue dairy farming for many more years to come (Bandara, 2000).

Even though many have identified these factors that inhibit the smallholder dairy sector, none have analyzed how the changes in these variables may affect the farmers' decision on continuing in dairy farming. Therefore, this study was carried out with the objective of identifying socio economic factors that have an impact on the farmers' decision to remain in the dairy sector. Further, to evaluate how these factors actually impact farmers' decision in a direct as well as indirect manner with the view of developing policy measures for a sustainable dairy industry in Sri Lanka. A Bayesian Belief Network (BN) has been employed for this purpose.

METHODOLOGY

1. Data Collection

The study was carried out with collaboration of MILCO (Pvt.) Ltd. from June to August 2006. Primary data were collected from small holders from 8 regions in Sri Lanka viz. Kandy, Kurunegala, Anuradhapura, Uva, Monaragala, Nuwara-Eliya, Colombo and Southern using a pre-tested questionnaire.

2. Sample Selection

A multistage sampling scheme was used in the study. The total sample size was 365 and it was divided among 8 regions studied on the basis of number of small holders in each area.

3. Analytical Method
Theoretical Framework (Bayes rule)

A particular decision made by farmers is influenced by a set of factors. Each of these factors is in turn affected by multitude of other factors. For instance, a farmer may decide to move out from dairy industry due to low income. But the income may in turn be affected by low yield levels. The yield may in turn be affected by herd size, extension, veterinary services etc. Thus, probability of an event occurring is dependent upon probability of occurrence of other events. Bayes theorem provides a rule to analyze such events where conditional probabilities are being involved.

$$P(A/B) = \frac{P(B/A)P(A)}{P(B)}$$

Where,

P (A) = prior /marginal probability of A
P (B) = prior/marginal probability of B
P (A/B) = conditional probability of A, given B
P (B/A) = conditional probability of B given A

Analysis of problems of this nature is termed as "problem tree" or a "causal map" which is a directed graph that represents the cause-effect relations. Hence, analyzing this kind of situation cannot be effectively done through conventional analytical tools (Wasana et al., 2004). However, analytical tools such as Bayesian Networks (BNs) are available at present to analyze causal maps in a quantitative way. This can be used as a graphical decision support tool, which allows interactive investigation of different causes affecting a decision and their relative impact on the system as a whole.

In this study, first various factors that may affect a farmers' decision to continue in dairy farming were identified through focus group discussions. Then, a causal map was established. Each node in the causal map consisted of a true or false situations which are known as prior probabilities. These were gathered using a questionnaire survey. Later, each node was treated as a pay off table and conditional probabilities were developed using information in the pay off tables. The probabilities thus developed were used in the analysis by the computer software "Netica version 1.12" (Anon, 2006).

RESULTS AND DISCUSSION
1. Present Situation

The information which gathered from survey was used to develop belief networks. The diagram below (fig.1) was produced from information gathered from a group of 365 farmers, which represent a simple

conceptual model depicting the main factors affecting the farmers' decision on continuing in dairy farming. The factor that directly influences this decision is "Profit". Further, profit is in turn affected by "Price", "Milk yield" and "Feed cost". Milk yield is again determined by "adequate extension", "Herd size" and "animal health and productivity". The herd size is in turn affected by "Adequate land". In addition, "Adequate veterinary services" have an impact on animal health and productivity.

Figure 1 lays out the present situation. 82.5% of the farmers have indicated that they are willing to continue in the dairy farming even though 59.5% of those interviewed had less than average profits. Thus, 17.5% of the dairy farmers would leave the industry under present scenario.
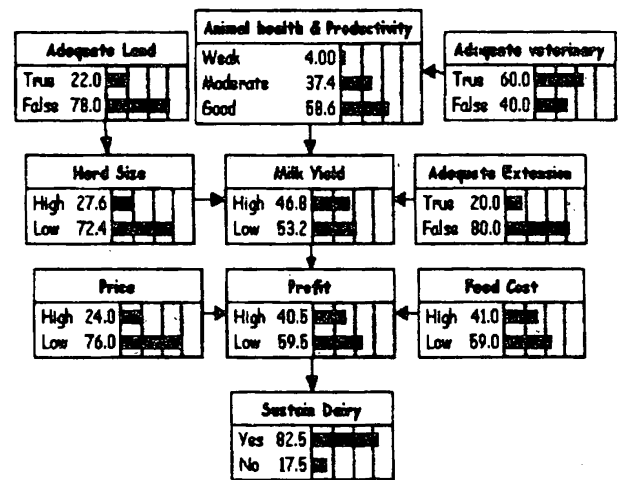

Figure 1 - 'Causal map' showing the decision on giving up dairy farming (Percentage values)

2. Inference Under Different Situations

Once the Conditional Probability Tables (CPTs) are completed, the BNs can be compiled and used to analysis. This is performed by altering the states of some nodes while observing the effect of this on other nodes. The impact of changing any variable is transmitted through the network in accordance with the relationships expressed by the CPTs. Every time the state of a node changes, the joint probability distribution is updated through the iterative application of Bayes theorem. As well as, the inferences on network can be easily made by changing the probabilities of nodes, which are of interest.

From time to time governments as well as milk producing companies try to motivate dairy farmers through manipulation of prices. The effect of this on the decision under consideration can be studied by altering the probability of the node, "milk price". This is shown in figure 2. Increased milk prices have an impact on profit; the "High" probability of profit increased from 40.5% to 68.8%, and ultimately it increases the probability of sustaining in dairy from 82.5% to 85.6%. Similarly, the network developed

can be used to study the impact of all other nodes independently or simultaneously.
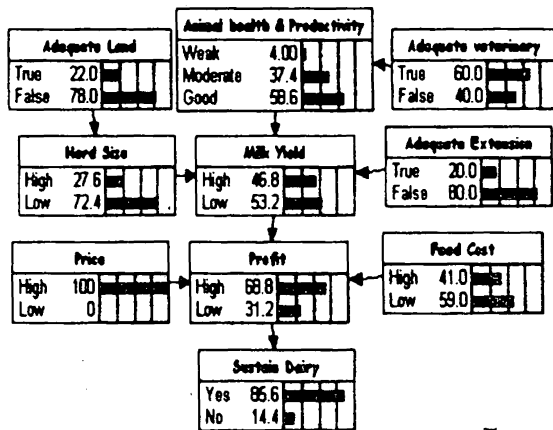

Figure 2 - Effect of increased milk prices on the decision of sustain dairy farming (values given are percentages)

Thus, Bayesian networks allow us to study the impact in possible areas of interventions and study the consequent change in the ultimate decision node. This is very much important in deciding on policy measures. Accordingly, the network is further used to make possible changes towards ultimate decision making of small holder dairy farmers.

Hence, interested nodes were treated 100% of positive situation and then observe the percentage changes of farmers remaining in the industry. According to the analysis milk price, feed cost, adequate land, adequate veterinary services and adequate extension services have significant impact on ultimate decision of dairy farmers in surveyed area. Further, the percentage difference was calculated with respect to present situation (Table 1).

Table1 - Effect of possible changes in factors related to the decision on continuing in dairy farming:

Inference	Sustain dairy (%)	Change with respect to present situation*(%)
1. Milk price being "High"	85.6	3.1
2. Feed cost being "Low"	82.8	0.3
3. Adequate land being "True"	82.7	0.2
4. Adequate veterinary being "True"	82.5	0
5. Adequate extension being "True"	82.9	0.4
6. All 5 above	86.2	3.7

*present situation of continuing in dairy is 82.5%

As indicated in Table 1, highest reduction in risk (3.1%) of abandoning dairy was observed for the increase of milk price. Milk price is usually

determined according to the SNF and FAT ratios. Hence, low quality of milk lead to low price to the farmer. Thus, farmers should be motivated to produce quality milk for which necessary knowledge (extension) and inputs should be available to them. In addition, since price is the main factor that motivates milk producers, a sound pricing policy is also essential where farmers get most of the consumers' expenditure on milk. The results show (figure2) that the price increment 'higher' levels would lead to increase farmers who are in 'high profit' category by 28.3 percent.

High cost of feed is another issue faced by most of the farmers. Feed cost is incurred due to concentrates, vitamin and antibiotics that have to be provided to maintain animal health. Provision of concentrate is necessary to maintain productive and healthy animals in order to get a high milk yield. Though it is the case, ultimate profit is decreased in considerable amount due to high feed cost. Therefore, institutions involved in livestock industry should come up with ideas of providing animal feed at low price or subsidized form to make the farmer more profitable. The results revealed that increased profit will lead to the farmers' decision to continue in the dairy industry.

The size of land owned by the farmers has become a constraint to increase the herd size and the intensification of the management of the surveyed area. Government intervention is important on that issue to provide adequate land through proper policy measures as most of the farmers are willing to expand their herd size and make year around production.

Low quality of milk and low milk yield are major constrains faced by majority of farmers in the studied area. This is mainly due to low productivity and poor animal health conditions. Improving quality veterinary and extension services are the possible remedial measure for those problems. Thus, with all possible changes the high profit category can be increased by 34%. As depicted in figure 3. Farmers' decision on sustaining dairy industry was increased by 3.7%.
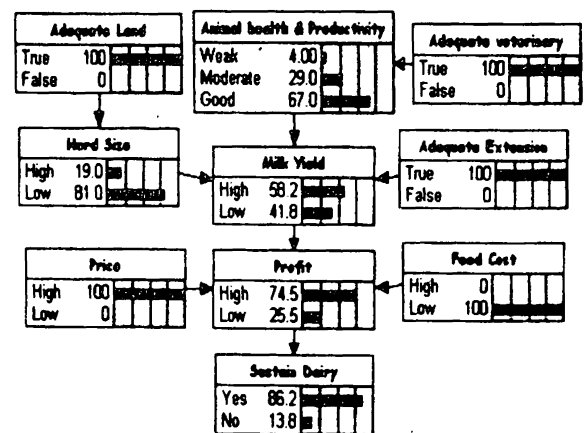

Figure 3 - Effect of all possible changes of giving up dairy (values given are percentages)

CONCLUSIONS

The results of the study revealed that the farmers were basically involved in dairy as mixed crop livestock farming operation while most are engaged in semi intensive and tethering systems. Herd size was limited to 3 to 4 milking cows.

Low price is the major constraint faced by majority of farmers and ultimately it has lead to low profits. Lack of quality veterinary and extension services at required time, high cost of feed, low milk yield from local breeds, lack of adequate land are major weaknesses prevailing in the industry.

In addition to above issues, steeling of animals and difficulties in disposing old, diseased animals and bulls are minor constraints faced by farmers in rural areas.

It is evident that government intervention is required to resolve these issues. In addition, younger generation should be motivated to engage with dairy farming activities for sustainable development of dairy industry in Sri Lanka.

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REFERENCES

Anon, (2000). *Policy Strategy for dairy Industry*, Annual report, Ministry of Livestock Development and Estate infrastructure (MLDEI), Colombo, Sri Lanka

Anon, (2003). Central bank annual report pp.89

Anon, (2006). "Netica" version 1.12 software, Online. Available at http://www.norsys.com/ [Retrieved February 2006]

Bandara, B.H.W.M.U.S (2000). "Current status of buffalo production in Sri Lanka". Online. Availableat. http://www.ilri.cgiar.org/infoServ/W ebpub/Fulldocs/South_South/ch07.htm.[Retrieve d July 2006]

Ibrahim, M.N.M.,S.J. Staal , S.L.A. Daniel and W. Thorpe (1999) "Appraisal of the Sri Lanka Dairy sector". Online Available at http://www.ilri.cgiar.org/InfoServ/Webpub/Fulld ocs/South_South/ch07.htm#P22_2583 [Retrived July2006]

Wasana, W, D.M.A.P.Dissanayake, M.Wijerathne, K.Herath and J.C.Edirisinghe (2004) "Reasons for abandoning Rubber cultivation: A case study using Bayesian Network (BN) Approach", Bulletin of the Rubber Research Institute of Sri Lanka pp.32-38