

REASONS FOR ABANDONING RUBBER CULTIVATION: A CASE STUDY USING BAYESIAN NETWORK (BN) APPROACH

Wasana Wijesuriya, D M A P Dissanayake, Mahinda Wijeratne,
Keminda Herath and J C Edirisinghe

INTRODUCTION

Low rubber prices prevailed for a fairly long time have caused smallholder rubber farmers to move away from rubber cultivation towards more profitable crops such as tea or other forms of land use. The attitude of the farmers on this issue depends on many factors. These factors may directly or indirectly affect the farmer's attitude and are of importance in different magnitudes on the ultimate decision. Studying this kind of situation cannot be effectively done through conventional survey approach based on questionnaires. Participatory Rural Appraisal (PRA) is a family of approaches and methods, which are suitable to analyze such situations where the local people are given a chance to analyze their own living conditions, share outcomes and plan activities.

The ideal PRA tool for analysis of problems of this nature is termed as a 'problem tree' or a 'causal map', which is a directed graph that represents the cause-effect relations. A simple causal map is given in Fig. 1, which identifies reduced income and insufficient subsidies as the main causes affecting the decision of giving up rubber where as rubber prices and heavy rainfall are indirect causes.

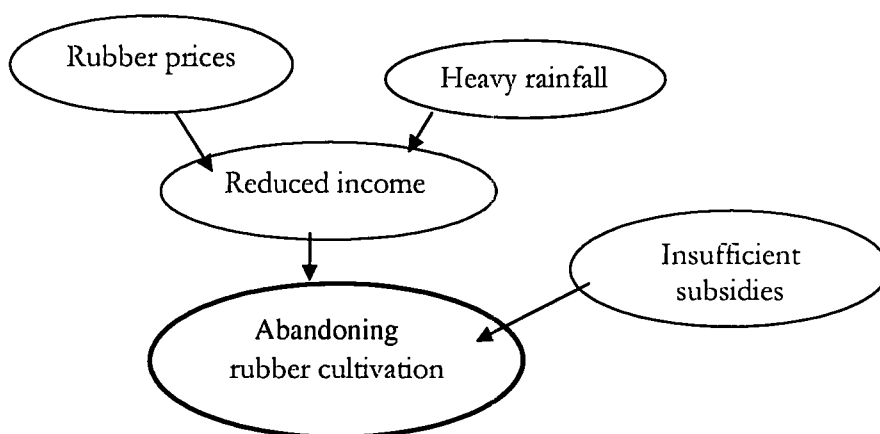


Fig. 1. A causal map representing reasons for evading from rubber cultivation

The traditional approach of interpretation of causal maps is by a diagram as shown in Fig. 1. However, analytical tools are available at present to analyze causal maps in a quantitative way. Recent advances in artificial intelligence such as Bayesian networks (BNs) allow the use of causal maps to make inferences for decision making. 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.

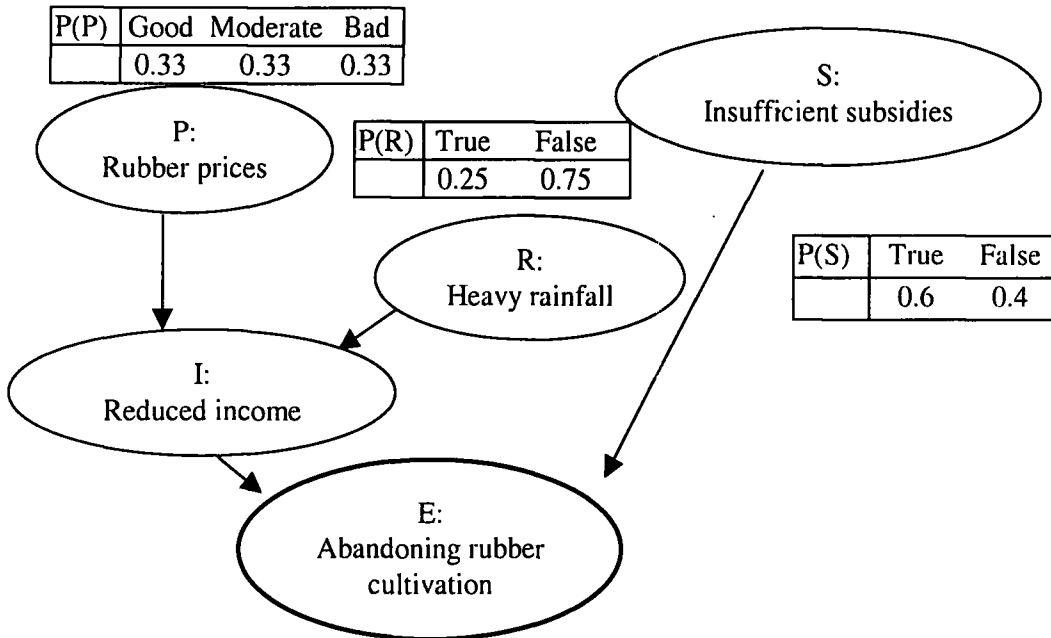
The objective of this article is to present the results of a participatory study done with smallholder farmers to identify the causes for abandoning rubber cultivation by the smallholder farmers. This case study employs Bayesian Network (BN) model, which is simple and appropriate as a decision-making tool.

METHODOLOGY

This study is one of the exercises done in the Pohorabawa village in the Ratnapura district during September 2002, in view of finding the interactions between the environment, society and technology in the smallholder rubber sector. The objective of this study was to identify the factors responsible for abandoning rubber cultivation as perceived by the smallholder rubber farmers.

A group of 21 smallholder rubber farmers were involved in this exercise. This exercise was initiated with a short discussion with the participants to make them familiarize with the problem and PRA methodology. The participants were provided with necessary material to build their own causal map with direct and indirect causes and the effect.

Once the causal map was completed, the participants were asked about the situations (states) that can take place for each of the causes. For instance, the states for rubber prices are; good, moderate or bad (an illustration is presented in Fig. 2). The probability tables for nodes; P (Rubber prices), R (Heavy rainfall) and S (Insufficient subsidies) are quite simple to complete with the farmers with the introduction of the concept of probability in a simple manner. However, the nodes; I (Reduced income) and E (Abandoning rubber cultivation) had Conditional Probability Tables (CPTs) (Fig. 2), which needs extra care in filling up. Therefore, the CPTs completed by the farmers were examined thoroughly by the authors before using them in analysis. Finally, these constructed causal maps were analysed using Bayesian networks and the model developed and was employed in studying the effect of changes in causes for the decision on giving up rubber cultivation by smallholder farmers.



CPT for the node I

$P(I P, R)$		I	
P	R	True	False
Good	True	0.35	0.65
Good	False	0.10	0.90
Moderate	True	0.40	0.60
Moderate	False	0.35	0.65
Bad	True	0.90	0.10
Bad	False	0.80	0.20

CPT for the node E

$P(E S, I)$		E	
S	I	True	False
True	True	0.20	0.80
True	False	0.15	0.85
False	True	0.13	0.87
False	False	0.05	0.95

Fig. 2. Tables of conditional probability associated with the Bayesian network

The software available for analysis of BNs is user friendly and simple and is 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. Several commercial software tools are available such as Hugin [www.hugin.com] and

Netica [www.norsys.com], which can automate the process of inference. Both these products allow the user to enter the Bayesian network structure graphically, enter the numerical details, and then make inferences. The resulting inferences can be then shown graphically using bar charts. This study employed the software, Netica for the analysis.

ANALYSIS AND INTERPRETATION

Present situation

The situation in September, 2002 is given in Fig. 3 which represents a simple conceptual model depicting the main factors affecting; why farmers evade from rubber cultivation. The factors that directly influence the decision of 'giving up rubber' are 'reduced income', 'shortage of labour', 'inefficient advisory service', 'insufficient subsidies' and 'long immature period'. Further, 'shortage of labour' is in turn affected by 'other occupations' and 'indifference to tapping' while 'reduced income' is due to 'rubber prices' and 'heavy rainfall' (Fig. 3). Under the conditions prevailed during the study period, there was a 20% risk of abandoning rubber cultivation.

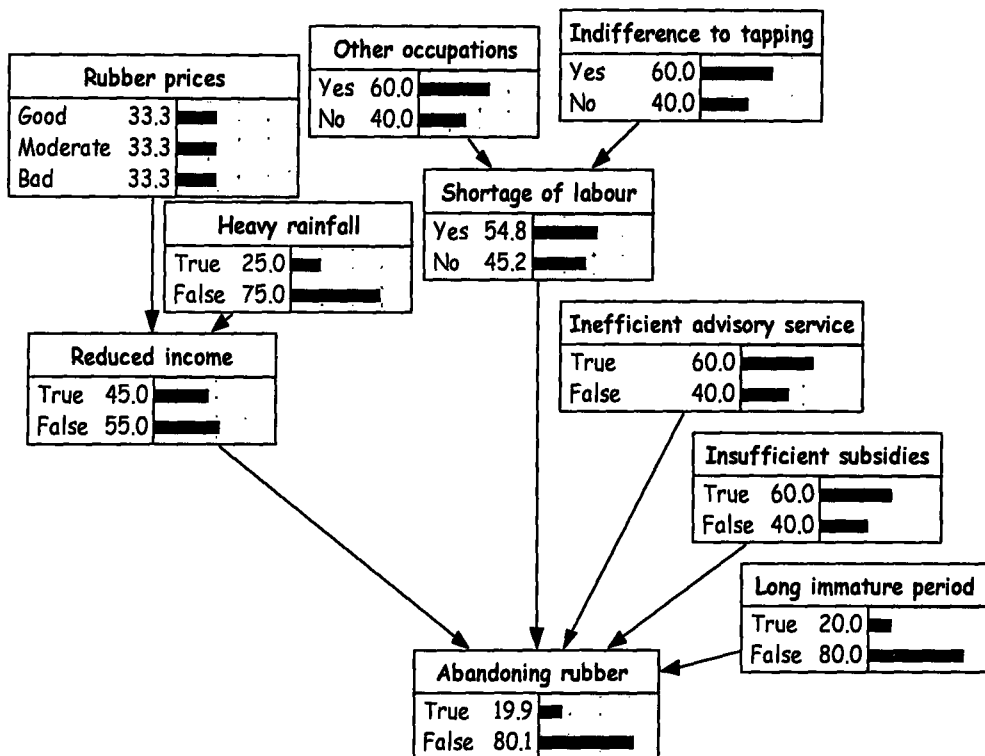


Fig. 3. Factors affecting the decision of giving up rubber cultivation

Making inferences under different situations

Once the CPTs are completed, the BN can be used to predict the probability of abandoning rubber cultivation under different situations. This can be easily done by changing the probabilities of nodes, which are of interest.

The scenario 'Rubber prices turned to be good' is depicted in Fig. 4. Increased rubber prices can have an impact on reduced income (the risk of reduced income can change from 83.7% to 55%), and consequently it reduces the risk of 'abandoning rubber' from 19.9% to 17.6%. This network can also be used to find the impacts of changing attitudes of people such as 'indifference to tapping', external institutional arrangements like improvements in subsidies and advisory services and the impact of recommendations focusing on reducing the immature period.

As indicated in Table 1, the highest reduction in risk (2.3%) of abandoning rubber cultivation was observed for the changes; increased rubber prices and subsidies. Rubber prices is a are factor usually determined by the international market and the government has no control over it, but may be able to reduce the degree of fluctuations through proper policy measures. Increasing subsidies is a possible remedial measure presently being taken up for discussions at national level favourably. Awareness buildup is in the hands of extension personnel and should be properly streamlined for better success. This will ensure better performance of rubber holdings in terms of both reduced immature period and high productivity during the mature period. Further, institutions involved in rubber cultivation should come up with ideas to change attitudes of people on rubber cultivation, especially rubber tapping in order to reduce the risk of shortage of labour. Thus, with all possible changes the risk of abandoning rubber cultivation can be reduced to 13% as depicted in Fig. 5.

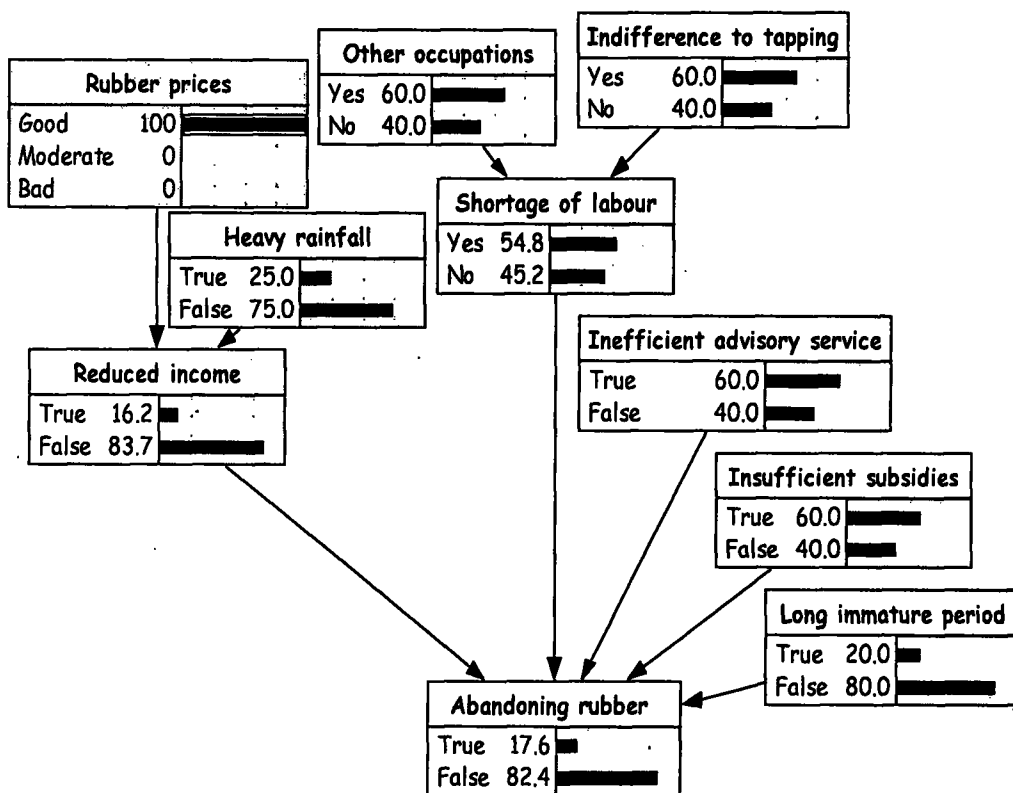


Fig. 4. Effect of increased rubber prices on the decision of giving up rubber cultivation (values given are percentages).

Table 1. Effect of possible changes in factors related with the decision on giving up rubber cultivation

Change	Risk of abandoning rubber (%)	Change with respect to present situation* (%)
1. Rubber prices being 'Good'	17.6	2.3
<i>Change in attitudes:</i>		
2. Indifference to tapping being 'No'	19.5	0.4
<i>Improvements in external institutional arrangements:</i>		
3. Insufficient subsidies being 'false'	17.6	2.3
4. Inefficient advisory service being 'false'	18.6	1.3
<i>Awareness build up:</i>		
5. Long immature period being 'No'	19.4	0.5
6. All 5 above	13.1	6.8

* The risk of abandoning rubber is 19.9%

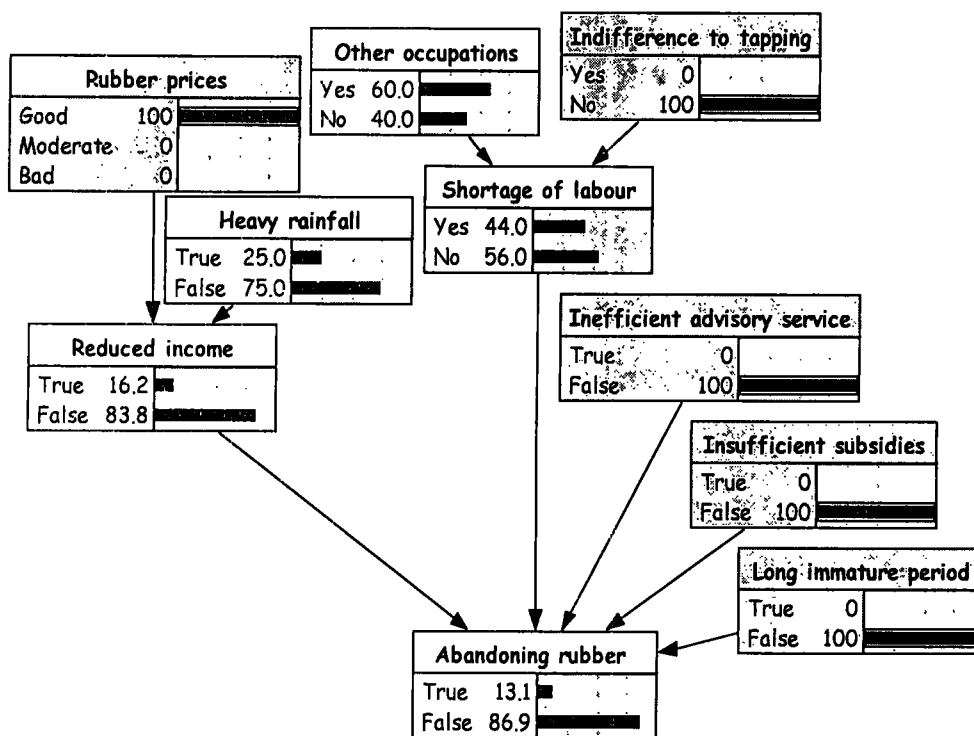


Fig. 5. Effect all possible changes on the decision of giving up rubber cultivation (values given are percentages)

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