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INCORPORATION OF SCIENTIFIC AND LOCAL KNOWLEDGE IN RUBBER FARMING SYSTEMS: A USEFUL TOOL

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INTRODUCTION

Locally derived understanding about agriculture and environment, based on experience and real world observation is commonly referred to as "local knowledge" (Sinclair & Joshi, 2000). This indigenous knowledge is commonly used in traditional agricultural systems by different communities in all over the world (Richards, 1985; Lawrence, 2000; Warren et al., 1994; Thapa et al., 1997) but such local knowledge in general confines to limited localities due to the lack of proper documentation and distribution. As a result, the understanding and the utility of such knowledge become minimal.

With smallholder plantation tree crops such as rubber, introduced to Sri Lanka only a little over a century ago in the colonial era, there has been a strong influence of government schemes and extension advice on cultivation of rubber. It can be expected that locally derived knowledge and practice about rubber growing will be intermingled with the conventional agricultural techniques and recommendations that have been associated with the promotion of rubber in the country. No detailed studies on local knowledge of rubber farming systems have been recorded in Sri Lanka. However, in other rubber growing countries, for example, Indonesia, where there is a tradition of farmers growing rubber on their own accord (Salafsky, 1994), there have been studies of local knowledge. A systematic documentation of such knowledge in Sri Lanka too can be helpful in future farmer participatory research and extension work.

The computer software, Agriculture Knowledge Toolkit (AKT) developed by the School of Agricultural and Forest Sciences of the University of Wales (Sinclair & Walker, 1998) is very useful in documenting and analysing local knowledge and incorporate them in scientific research on rubber with farmer participation.

Methodology of developing a knowledge base

Creating a knowledge base (KB) involves four main stages; knowledge elicitation from the appropriate sources, converting the acquired knowledge into simple unambiguous statements, inserting those statements into the computer software (AKT) using formal representation and defining the formal terms used (Dixon *et al.*, 1999; Fig. 1).

Knowledge elicitation is the initial process whereby selected informants are encouraged to articulate their knowledge by asking non-leading questions. This is normally done through repeated interviews with farmers and domain experts. Use of tape recorders facilitates continuous and uninterrupted conversation with farmers in order to acquire their knowledge as far as possible.

Creation of unitary statements is the process of extracting knowledge from interviewed material and breaking it down into simple statements each containing one unit of knowledge. The unitary statement is the smallest useful unit of knowledge, that cannot be broken down into further unitary statements (Sinclair & Walker, 1998).

Formal representation is the process of coding knowledge for input into a computer using a restricted syntax as defined by a formal grammar developed in the software, AKT.

Formal term specification is the process of identifying and organising key components of knowledge. Formal terms in AKT are either: **Objects** (*e.g.* rubber, crops, field), **Processes** (*e.g.* growth, erosion, dripping), **Actions** (*e.g.* planting, pruning, harvesting), **Attributes** (*e.g.* rate of erosion, tree height), **Values** (500 t/ha, 3m, high, low) or **Link** types (*e.g.* 'pollinate' as in 'bees pollinate rubber'). The following example shows formal language representation and different formal terms of the statement, '*decrease in fertility of soil causes decrease in rate of rubber growth*'

Attribute *Value* *Object* *Process* *Attribute* *Value*

att_value (soil,fertility,decrease) causes2way att_value (process (rubber,growth),rate,decrease)

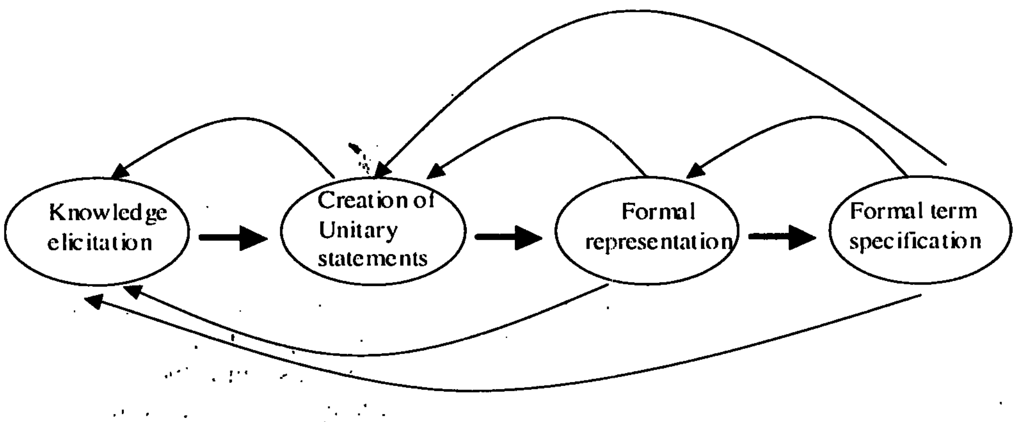

Fig. 1. The process of creation of a knowledge base and interconnections between different steps

In principle, the process is linear but in practice, it is interactive in nature (Fig. 1). Therefore, it is important to emphasise that the knowledge base should be evaluated at each stage of development. Evaluation of the knowledge base involves assessing the relevance, utility and ambiguity of individual unitary statements, and also checks for repetition and contradiction amongst statements.

The formal grammar comprises four fundamental types of statements namely attribute-value, causal, comparison and link statements, as shown in the Table 1. Causal and link statements can be represented as diagrams using the diagram interface present in the software.

Table 1. *Different types of unitary statements in a knowledge base. "Causes2way" denotes the reversibility of the causal mechanism, that is that as well as a decrease in soil fertility reducing rubber growth an increase in fertility would increase rubber growth – for some relationships this does not apply (time for example is unidirectional so things can get older but not younger), in which case the relationship is represented as "causes1way"*

Type of statement	Natural language	Formal language
Attribute-Value	the fertility of black-soil is high	att_value (black_soil,fertility,high)
Causal	decrease in fertility of soil causes decrease in rate of rubber growth	att_value (soil,fertility,decrease) causes2way att_value (process (rubber,growth),rate,decrease)
Comparison	the root-depth of rubber is greater than banana	Comparison (root_depth, rubber,greater_than, banana)
Link	Bees pollinate rubber	Link (pollinate, bees, rubber)

Most of the unitary statements built up from farmer interviews are only valid in certain conditions, and therefore, the general format of a unitary statement is combined with *IF* condition. See the following example.
'The germination percentage of rubber seeds is high IF the seeds are new and the soil moisture content is between 80 and 90%'.

The formal representation of this is as follows.
att_value (process(part(rubber, seeds), germination), percentage, high)
IF att_value (part(rubber, seeds), condition, new) and att_value (soil_moisture, content, range('80%','90%'))

Important factors to be considered in knowledge elicitation

Of the process of developing a knowledge base, the most important step is knowledge elicitation. Researcher should understand well the farmer is the first person and researcher is going to learn from the farmer. Therefore, asking non-leading questions (*i.e.* questions not to get '*yes*', '*no*' answers) in knowledge acquisition is highly important. Generally, it is not possible to elicit knowledge from all appropriate sources from a local community. Therefore, a sampling strategy must be designed in order to efficient development of a knowledge base that is representative of the knowledge of a defined community. The framework for knowledge elicitation comprises four stages namely Scoping, Definition of the domain, Compilation and Generalisation. A broad range of activities such as rapid rural appraisal techniques can be used to familiarise the community at the **Scoping** stage. **Definition** stage is used to develop an overall understanding of the domain. Sources are purposely and non-randomly selected from the source community. These key informants are selected on the basis of interest, articulateness, depth of knowledge and willingness to participate. The **Compilation** stage is used to record detailed knowledge and variability of knowledge over the community. The focus at this stage is on talking to few knowledgeable people in depth, rather than attempting to obtain statistically representative samples. As repeated interview of the same person is important in obtaining deeper explanatory knowledge and resolving inconsistencies, willingness to participate must be an important criterion for selecting of key informants. In general, it is more productive to speak to fewer people on more occasions than to cover a large number. Having obtained a knowledge base from a few informants, the **Generalisation** stage involves testing the representativeness of this knowledge across the community. This requires a random sample that is statistically representative of the community as a whole, typically upwards of 100 people who have not been previously interviewed.

A case study on local knowledge of rubber based farming systems

Some farmers have detailed understanding of their entire cropping system and their knowledge was incorporated into their management practices. For example, one of the innovative farmers who has intercropped his rubber land in Kegalle had detailed explanatory knowledge of his farming system. He was interviewed three times in 6 months intervals following the methodology given in this paper. Concise diagrammatic representation of his understanding created by the AKT software is given in the figure 2.

His rubber was intercropped with banana, maize, seasonal vegetables, yams, papaya and some locally important medicinal plants. Two banana varieties named locally as "ambune" and "kolikuttu" were planted separately according to differences in soil texture. "Kolikuttu" was planted in the topmost part of the land, which has a gravelly texture, and "ambune" was planted in the lower part, which is much less gravelly. He had a problem of low growth rate of crops close to the fence due to the extensive shade cast by the plants in the fence ("boundary plants"). The removal of selected branches of the boundary plants increased light penetration and hence increased growth of edge plants (rubber and banana). His land had few rocky outcrops and was sloping. He had constructed terraces and drains along contours, and grown leguminous cover crops in between to prevent soil erosion. The cover crops grew over the rocks to prevent them heating up in the sun, which he thought prevented plants heating up. According to him, soil moisture and fertility near the rocks was high and therefore, the growth of plants near them was good; also banana plants grown near rocks reduced the heating of rocks and enhanced soil moisture under the banana leaves. The growth of rubber was facilitated by the application of compost fertiliser in planting holes, in addition to the increased soil moisture provided by planting banana. He had grown two rows of banana between two rows of rubber; and did not want to grow three rows of banana because he expected reduced growth of both crops when banana density was high. He loosened soil around banana plants to enhance root growth and hence to increase plant growth. Recently he bought a land with mature rubber adjacent to his intercropped land. He observed bark wounds due to the unskilled tapping by the previous tapper. Therefore, he decided to apply a mixture of clay, cow dung and Sulphur ("clay mixture") on affected tapping panels in order to heal the wounds and to enhance bark growth.

The causal diagram (Fig. 2), which shows the interconnections among different knowledge items, created by the software, summarises the whole story of the farming system into a concise form. This diagram interface is very useful and convenient to study and understand the causal and link relationships of knowledge items rather than having a list of items on a paper.

DISCUSSION

Documentation of local knowledge is of prime importance; as such knowledge can disappear from the community with modernisation of local communities with time. Computer based Agricultural Knowledge Toolkit (AKT) is a useful programme in documenting and analysing of such important knowledge for the use of future research and for understanding of existing knowledge of local communities.

Use of farmers' knowledge and understanding of their farming systems are very useful especially in the fields of adaptive research and advisory services. In these areas of research and services, farmers acquire new knowledge and technologies or refine existing knowledge that can be applied in their cultivation systems. As a researcher who is going to interact with farmers, it is necessary to bear with existing knowledge and practices of farmers and farming communities before the introduction of new knowledge and technologies to them. Researcher is able to reach his/her objectives successfully when understand farmers' know how first and after building up of close links with them. Therefore, this method of knowledge elicitation is very useful in obtaining local knowledge of a research area or in technology adoption in a manner of non-leading interviews.

The farmer involved in the case study, had a very good understanding of his farming system especially, site and crop selection, soil management and efficient utilisation of natural resources like sunlight and soil nutrients, as reported in Senevirathna (2001). To overcome adverse environmental conditions, use of simple methods such as growing of creepers over rocks, growing plants on rocks where possible and planting of crops like banana which has larger leaves and higher water content, near rocks to prevent heating up rocks are examples of his use of knowledge gained through experience. Although he was not able to scientifically explain those practices, he possessed admirable knowledge on the things being happened in the environment of his farming system. If such knowledge had not been acquired by someone in doing on-farm research or in transferring technology, researcher would attempt to implement his own ideas without evaluating farmers' knowledge which can be helpful in achieving researchers' and extension workers' objectives successfully. Therefore, 'farmer first' approach (Chambers *et al.*, 1989) is important in successful on-farm research and extension services.

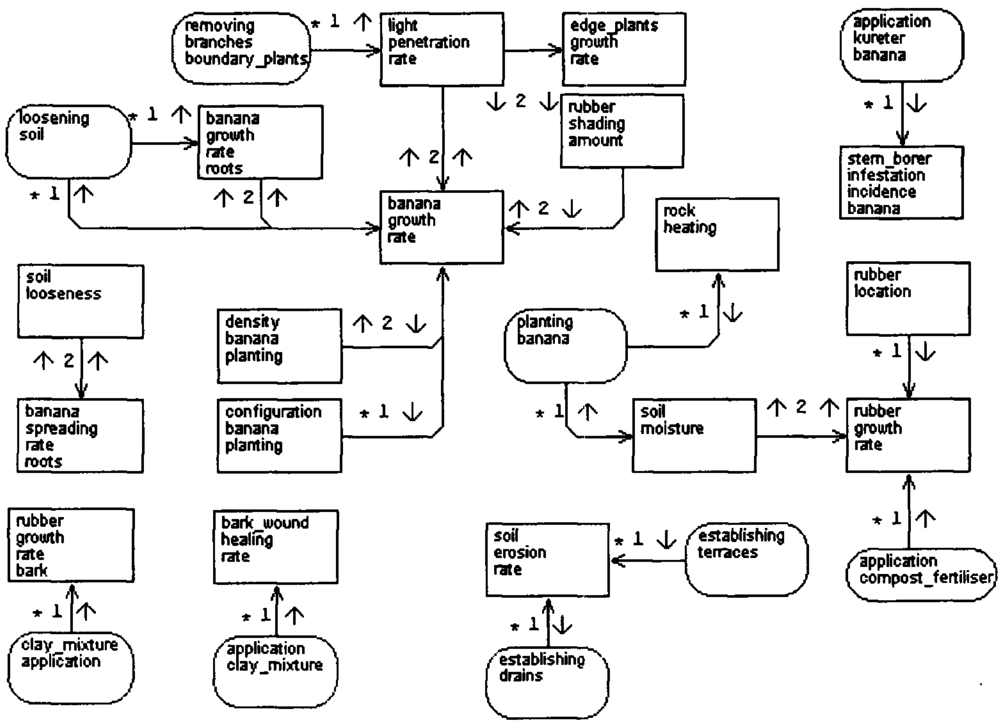

Fig. 2. A systematic representation of causal knowledge of a farmer who is intercropping with rubber. Nodes with sharp corners and with blunt corners represent attributes and actions involved, respectively. The direction of the arrow, which connects two nodes, indicates the direction of the causal influence. Upward and downward small arrows at the sides of the numeral indicate an increase or decrease in the causal or effect nodes, respectively; whilst an asterisk (*) indicates anything other than increase or decrease (*e.g.* no change or low) that is specified in the knowledge base. The numeral is used to describe whether the cause is one-way (1) or two-way (2) as explained in the legend to Table 1.

The methodology of interacting with farmers, gathering knowledge and documentation process mentioned in this report will be supportive in planning and conducting on-farm research, adaptive research and extension services in a successful manner.

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