A Proposed Expert System for the Management of Lucerne — LATIS

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Background

Over 640,000 ha of lucerne are grown in New South Wales. The total gross value of the crop in this State is conservatively estimated to be about $120 million per annum, thus making it one of the most widely grown and economically important agricultural industries. In 1977 two exotic aphid species *(Therioaphis trifolii* (Monell) f. *maculata* — spotted alfalfa aphid; and *Acyrthosiphon kondoi* Shinji — bluegreen aphid) were accidentally introduced into Australia. The lucerne industry was dominated by a variety (Hunter River) that lacked resistance to the aphids and widespread damage and economic loss ensued. Intensive research into the aphid problem subsequently resulted in the accumulation of considerable information on lucerne varieties and aphid control. To this could be added new and available data on economic analyses, herbicide recommendations, agronomic management and other pest and disease control.

Most farmer enquiries received at district advisory offices relate to lucerne establishment, management and persistence. However, the large amount of technical information available is fragmented into numerous published and unpublished sources making it difficult to access and soon out of date. There has been no attempt made to co-ordinate and interpret data in an advisory form.

A computerised, interactive information storage and retrieval system would overcome problems associated with the accession, co-ordination and updating of the technical material. This system could provide the essential link between research and advisory personnel, and producers.

The LATIS Program

The proposed program will be known as the Lucerne Agronomy and Technology Information System (LATIS). It will be designed as an interactive, menu-driven program for use on desktop micro-computers by advisory officers to assist producers in decision making and to provide answers to their most often asked questions. The concept will be developed by a multidisciplinary working group which will also co-opt experts in relevant areas when required.

The conceptual framework of the system comprises a series of basic modules representing major topics of lucerne production (Figure 1). Each of the topics can be accessed at different levels depending on the type of information required. As each module is used it forms a testable hypothesis, the rejection of which, from field experience, would identify areas for future research. Inherent in the program would be the feedback of multidisciplinary information to the system, an option not available in current extension publications.

It is proposed that LATIS be developed on four levels, but not necessarily as an hierarchical system as each level can be accessed separately. This will allow the user flexibility of operation since information can be obtained without having to go through the entire interpretative process to obtain answers to direct questions. The functions of the four levels will be as follows:

LEVEL 1   Answers to the questions most often asked by producers

LEVEL 2   An interactive decision-making process, menu driven for specific problems

LEVEL 3a   A data base containing a summary of experimental results and models used in the decision sequences at level 2

LEVEL 3b   An extensive data base of experimental data relating to lucerne research, located on a main frame computer

LEVEL 4   A bibliography of lucerne references and technical information relevant to Australia.

LATIS will consist of two types of information bases: knowledge bases and data bases (Figure 2). The knowledge bases will

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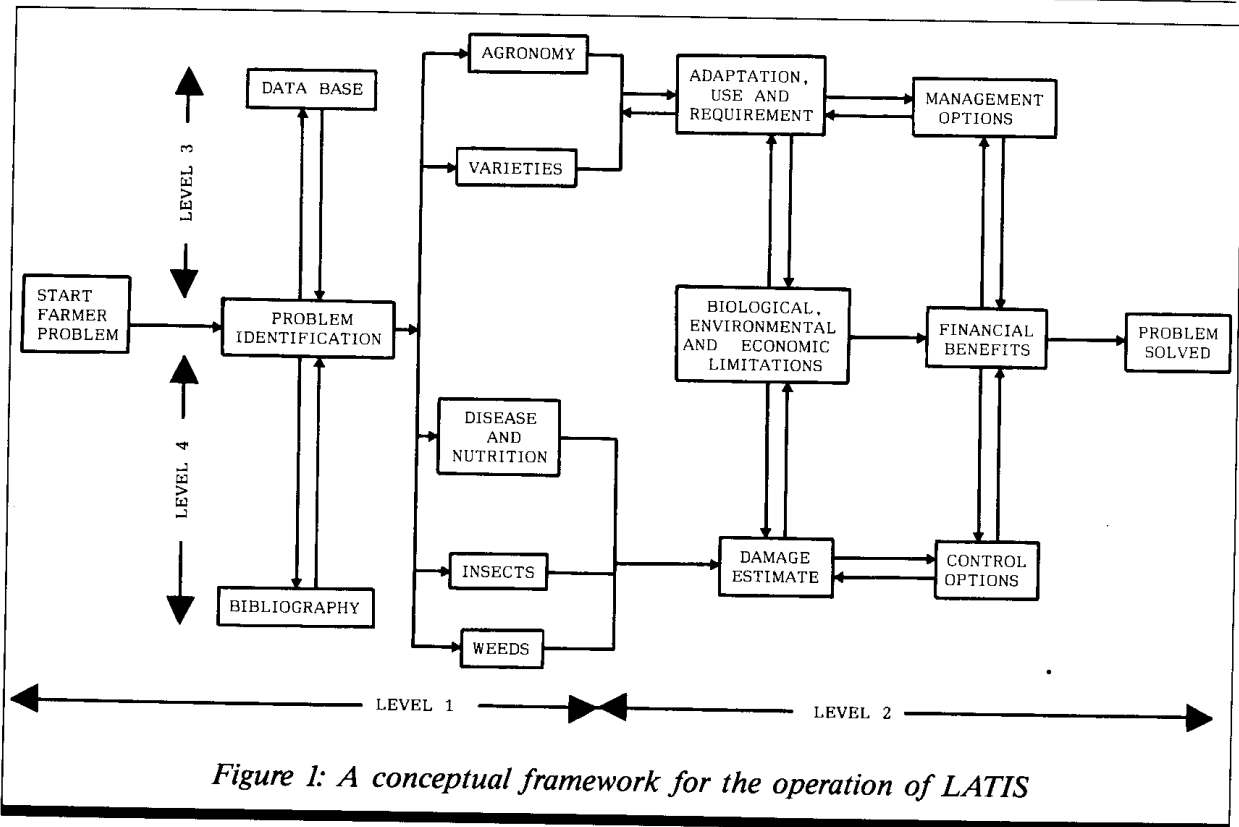* N.S.W. Department of Agriculture, Tamworth.

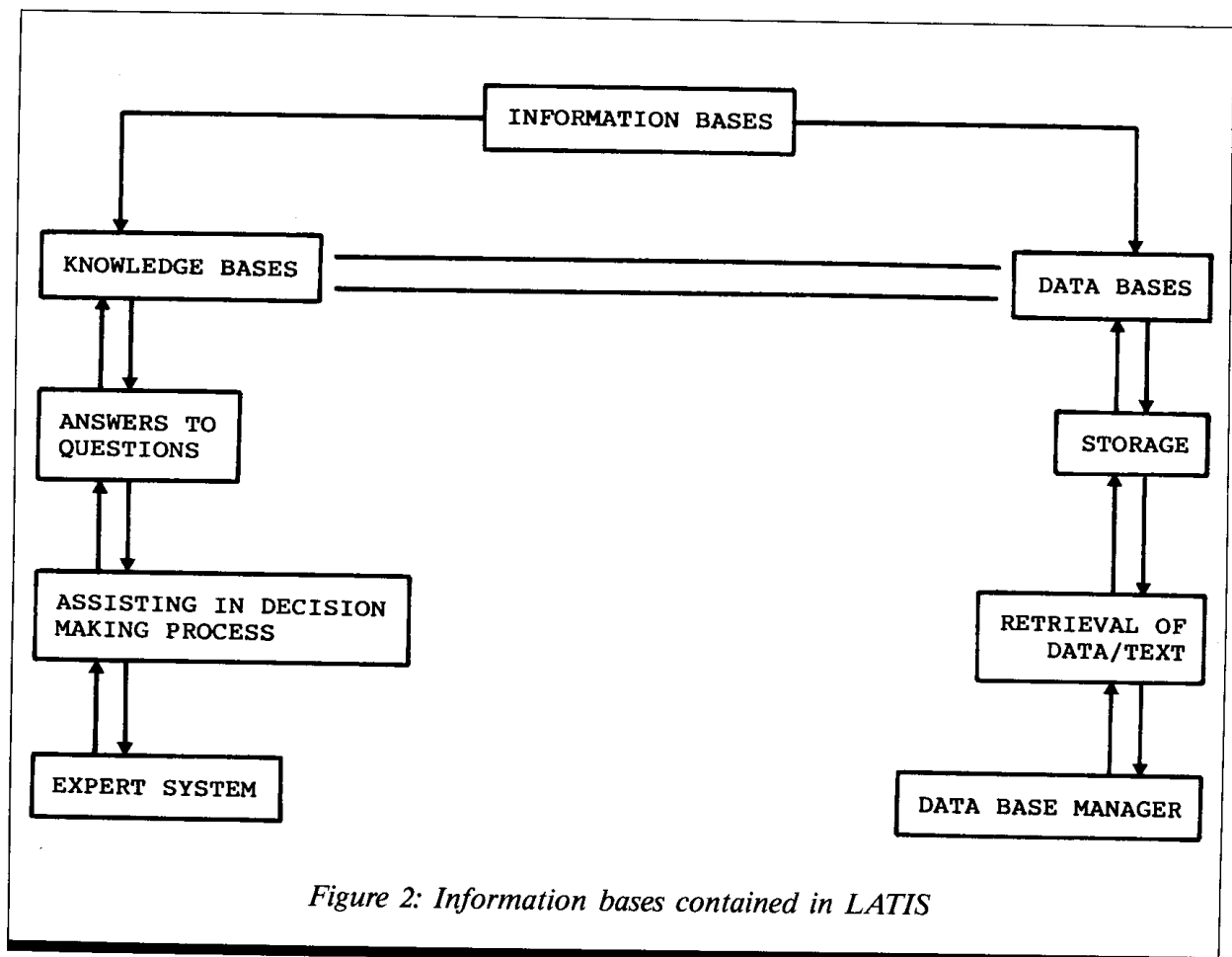*Figure 1: A conceptual framework for the operation of LATIS*

Figure 2: Information bases contained in LATIS

apply to Levels 1 and 2 (the question and answer sessions and the interactive decision-making processes). Data bases will apply to Levels 3 and 4 and include such information as experimental results, key references, economic analyses and irrigation water scheduling.

The Knowledge Bases

The knowledge bases will form part of an expert system defining the facts and rules and allowing a control structure to be developed which applies the knowledge to the solution of a particular problem.

Traditionally, the use of information bases has been restricted to either a key word retrieval system or decision tree modelling. Both these approaches are application specific, are relatively inflexible to change and fail to adequately simulate the exchange between the producer and the agricultural adviser. Conversely, an expert system has these retrieval and modelling characteristics and a knowledge base that has been provided by research and advisory specialists. It contains a set of rules and conditions that, when applied to information provided by a user, allows a uniform and precise set of recommendations to be given. These systems are designed to assist decision makers, not to represent the critical pathway of the decision-making processes. They are intended to be interrogatory (i.e. the user can query the reason for decisions at any time and have an explanation given). Ultimately, their success is dependent upon the quantity and quality of knowlege provided by the experts.

One expert system (ESP Advisor) has been evaluated and identified as suitable for our purposes. The advantages in using this expert system for LATIS are that it is capable of storage and use on desktop micro-computers; is compatible with existing hardware; is user friendly, menu driven, interactive and has suitable run times; can be written and updated easily without complex programming requirements (e.g. ESP Advisor has a command language syntax that approximates written English); allows text entry through word processors; has an inference rule structure that restricts the number of questions in relation to the complexity of the problem thereby reducing consultation and run times; has both screen and file output options; and can be easily modified for alternative uses such

as for other pastures and crops.

However, the expert system approach is not without some limitations. There are moderate constraints in terms of memory storage and run time access to external data bases. For this reason it is anticipated that a dual system will initially be developed — i.e. the expert system will be used for the question and answer and decision applications. A free text data base and retrieval system will be used for other purposes. These systems may possibly be linked at a later stage with improved technology and expertise.

The Data Bases

At present the data base requirements are fulfilled by the data base manager, Quic and Easi, that will run on existing Departmental hardware with little or no modification. Quic and Easi is a program developed entirely for writing software applications on micro-computers. It contains three basic sections: an application generator, a report generator and an applications development language. The applications generator is used to set up and access data files and can be used to input, edit and compile data. The report generator sorts the data files, performs calculations, manipulates data fields and prints the reports. Quic and Easi is a self-documenting, self-writing program in a fourth generation language, which reduces program development time and provides user friendly application.

Use of LATIS

The value of any program ultimately depends on its eventual adoption and use. It is envisaged that LATIS will extend beyond a purely advisory function and will serve a range of needs. Those groups seen as having a use for such a program include:
1. Advisers: These are potentially the largest group of users. LATIS will be developed as a data base and information storage/retrieval system with integrated management decision processes primarily for use by this group.
2. Researchers: The development of this system will greatly enhance research efforts by agronomists, livestock officers, entomologists and pathologists. It will provide a multi-disciplinary approach to problem definition and solving, assist with the identification of problem areas for future research, and provide a bibliography of

reference material.

3. Educational Institutions: This system may serve as a model for technical information transfer and program development in colleges and universities. As resource material, it will prove invaluable to agronomists-in-training and newly appointed Advisory Officers.

4. Programmer/Analyst: The successful development of a computerised system for information storage and retrieval for lucerne may well be a blueprint for other pastures and crops.