Computer-Assisted Learning (CAL) to improve the quality of pest management in grain storage systems

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Abstract

Improving the understanding of underlying issues by all levels within a management hierarchy is a key to enhancing the effectiveness of pest management. Improvements to the decision-making procedures available to managers and pest control staff will lead to greater application of effective storage procedures and so to reductions in overall storage losses and improved efficiency of pesticide usage. A collaborative project between Indonesia and Australia has developed a Computer-Assisted Learning (CAL) system to augment conventional training methods The package includes a tutorial system, a game to train users in the logical processes used by experts in diagnosing problems, a simulated grain storage complex that allows the user to explore various pest management strategies, and an interactive pest identification component. Extension of this project, to include development and conduct of international training courses and the identification of mechanisms by which CAL can be integrated into the training infrastructures of the participating organisations, is discussed Benefits arising from this project can spill over to other countries in the region and adoption and integration of CAL by organisations should lead to substantial reductions in costs of training pest management staff, particularly where they have geographically-distributed workforces.

Introduction

Techniques for managing pests in grain stores are not always used in the most effective manner. Evans and van S. Graver (1989) suggest that this is often due to a lack of understanding of the technical and economic consequences of available pest management options Expert systems have been developed as decision-makers(e g. Jones et al , 1993; Wilkin et al., 1990; Flinn and Hagstrum, 1990; Longstaff and Cornish, 1994). However, their use sometimes required an act of faith rather than understanding which has probably contributed to their relatively low adoption rate

Other types of decision tools can help by improving problem specification to identify the key issues, allowing explicit and rigorous analysis of the problems and facilitating interactions between various management levels through improved training (Norton and Mumford, 1993; Longstaff, 1997).

Computer-Assisted Learning (CAL) has the potential to make a significant contribution to training pest management staff. CAL systems, which can utilise the latest multimedia technologies, are inherently interactive and allow self-paced learning. They can be structured to allow students to explore alternative pest-management options and learn the consequences of their actions, either on their own or in small groups

An ACIAR-funded project, involving Australia (CSIRO Entomology, Queensland Department of Primary Industries, and the Co-operative Research Centre for Tropical Pest Management in Brisbane) and Indonesia (BULOG), has developed a suite of CAL tools to facilitate training of staff in rational and sustainable use of grain pest management procedures. The focus of the project has been primarily on the Indonesian central grain storage system, which stores primarily milled rice and which is heavily reliant on combined use of fumigants and stack surface and structural spraying with contact insecticides. However, this generic approach is more widely applicable in Australia and elsewhere.

'Pest Management Workbench'

The project has focussed on the areas of pest identification, information access, developing expertise, and pest management strategies A number of discrete modules have been developed and integrated within a framework called 'Pest Management Workbench' (Halid et al., 1997; Sardjono et al., in press). The system has a bilingual graphical user-interface (GUI) and currently includes four modules, which use many common resources such as images, biological and chemical parameters, and language features. They are:

Teach

'Teach' is an interactive multimedia tutorial system covering a range of essential pest management concepts and

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techniques (Figure 1). The module includes a player and a builder which enables trainers to develop their own tutorials by importing text and making hyperlinks to other resources, including pictures, sound and video files, help files, and other tutorial sections (Figure 2). No particular computing expertise is required to create a tutorial with this product. The initial tutorial deals with the carbon dioxide fumigation of bag-stacks, based on the ASEAN manual (Annis and van S. Graver, 1990) and includes extensive video material on the procedures involved.

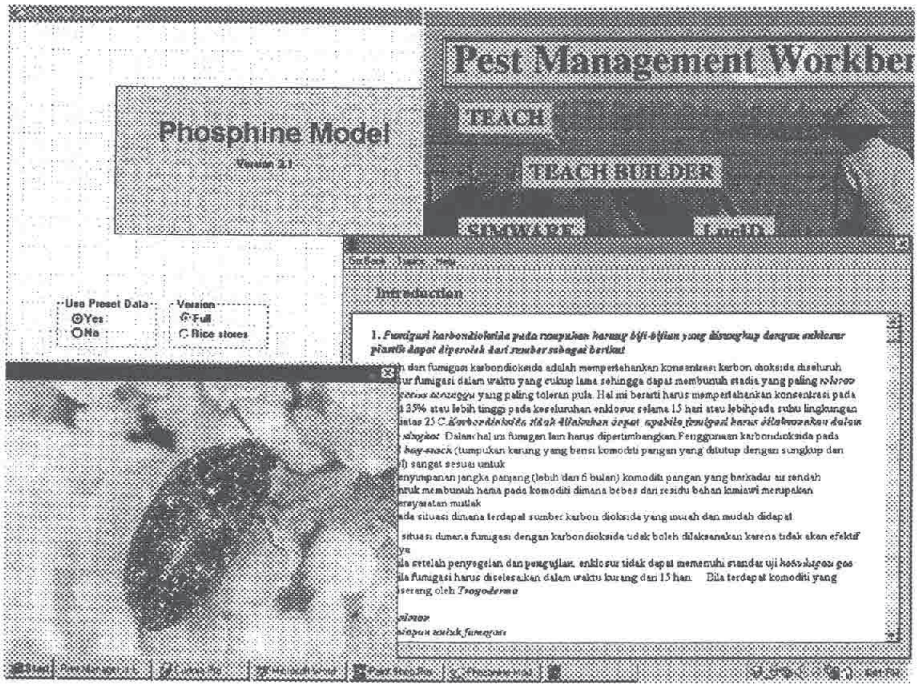

Fig. 1. An example from a Teach tutorial. Words or phrases in bold or italics represent links to other resources such as a picture or a model.

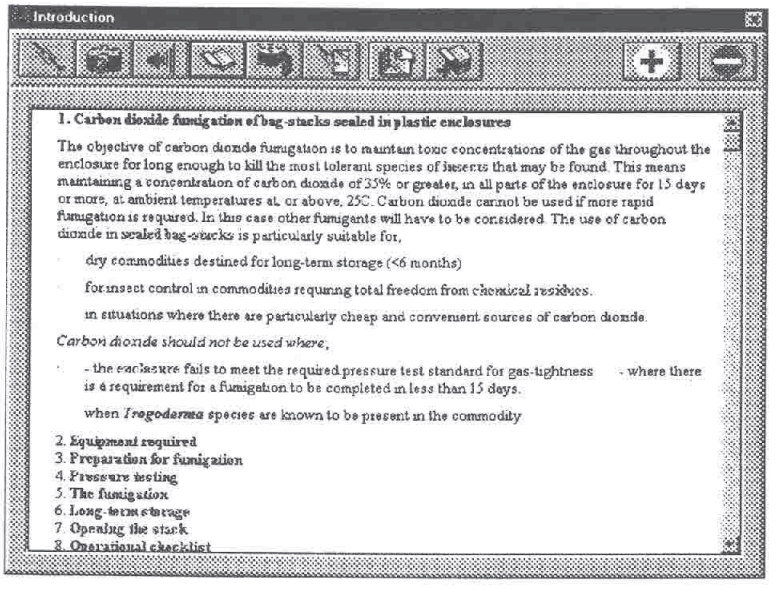

Fig. 2. The Teach Builder screen. The buttons along the top of the screen allow the user to make links between words or phrases and other resources.

Simulator

'Simulator' allows the user to explore various pest management strategies via a simulated grain storage complex, based upon real sites and grain movement statistics data. The system includes a number of simulation models, covering insect population growth (Longstaff, 1988), breakdown of residual chemicals (Bengston, 1986), the Fumigation Decision-Support Sytem developed by NRI (Hodges et al., 1997) and phosphine fumigation (Annis and Banks, 1993). The latter predicts the likely phosphine gas levels under defined storage conditions. It allows the user to explore the effects of changing particular variables such as fumigation time, dose rate or sealing level upon gas levels and also predicts the level of mortality achievable under these conditions.

The site layout comprises a suite of standard bag stores, each containing up to 8 small and 4 large stacks. The system creates a database to monitor the changing status of each stack, insect population growth and pest management actions. The amount of grain lost and the cost of management are indicated to the user (Figure 3). The user is able to manipulate a large number of variables within the system, including monthly grain arrivals and level of infestation at intake, fumigation strategy and success, and various costs. The user is able to see the consequences of varying one or more of these variables.

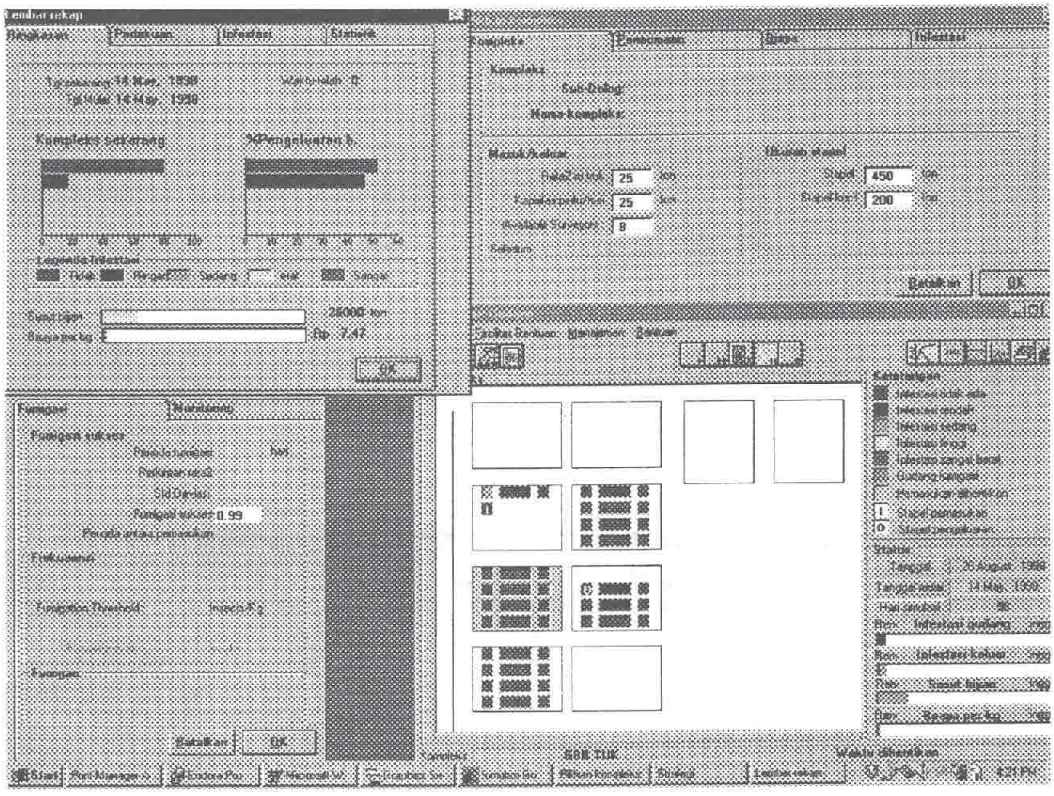

Fig. 3. A set of windows from Simulator, showing the layout of a warehouse complex in Indonesia on the lower right and 3 of the other windows that may be called up allowing the user to change various aspects of the simulation. Each stack within each warehouse is monitored and management processes, such as inloading and outloading of grain, sampling, chemical treatment and fumigation are recorded. A population growth model runs within each stack and insect densities are indicated by different colours. Grain losses and treatment costs are shown in the lower right of the screen.

Diagnosis

'Diagnosis' is a game to teach users the logical processes used by grain storage experts in problem diagnosis. Users are presented with pest management scenarios and resources, including comments from pest control staff, access to a laboratory and to field sites. They must then use the resources and apply reasoning to diagnose the problem. Diagnosis then offers the correct solution and describes the most efficient way of reaching this conclusion. At any point in the process the user is able to seek clarification of most issues through the extensive common Help system.

LucID

'LucID' is an interactive key for identifying insect pest species. At the highest level, users are presented with a set of pest taxa and a set of characters of all of the major pest species found in storages (Figure 4). These are used to identify the order, family and then species in question by viewing the various character states and selecting appropriately.

The sequential selection of character states reduces the number of taxa remaining until a point is reached where a lower level key must be accessed and the process continued. Once the species has been identified, the user is able to access the pests help file, which provides detailed background information about the species (Figure 5).

System requirements

Incorporation of videos into the package is demanding in terms of storage space but delivery in a CD-ROM format means that the system requirements are relatively modest, in terms of memory and hard disk storage. Pest Management Workbench will operate on a Windows® -based 386 computer with 8 Mb of RAM but, for best results, a Pentium® with 32 Mb is probably the minimum necessary to achieve adequate video playback. This is still quite modest in terms of current industry standards. It is important to remember when designing such a system that not all potential users have access to the very latest equipment and that design compromises may have to be made to ensure that system requirements are not unrealistically high.

Adoption

Pest Management Workbench is an example of a powerful generic technology that has widespread relevance in the agricultural and horticultural sectors, both as a decision-making support tool, and as an educational tool to illustrate integrated pest-management principles. By improving the ability to correctly identify insect pests, LucID will facilitate use of the most appropriate control measure whilst Teach will provide managers and pest control staff with a much greater level of understanding of both the problems and their solution. The Simulator will allow the user to explore, in a non-threatening manner, a range of different management strategies, their effects upon the quality of grain in store and their cost-effectiveness. Diagnosis will give the user some insight into the ways that experts interpret problem symptoms.

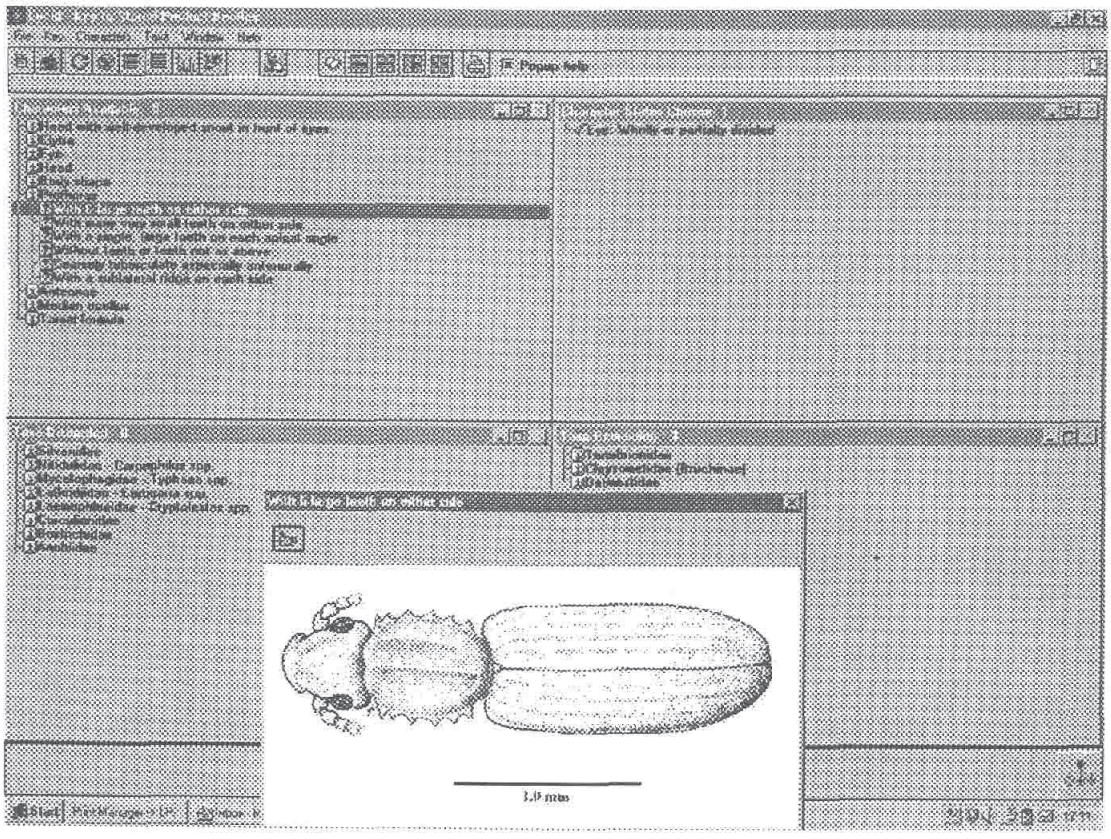

Fig. 4. An example of a screen from LucID, showing character states and taxa.

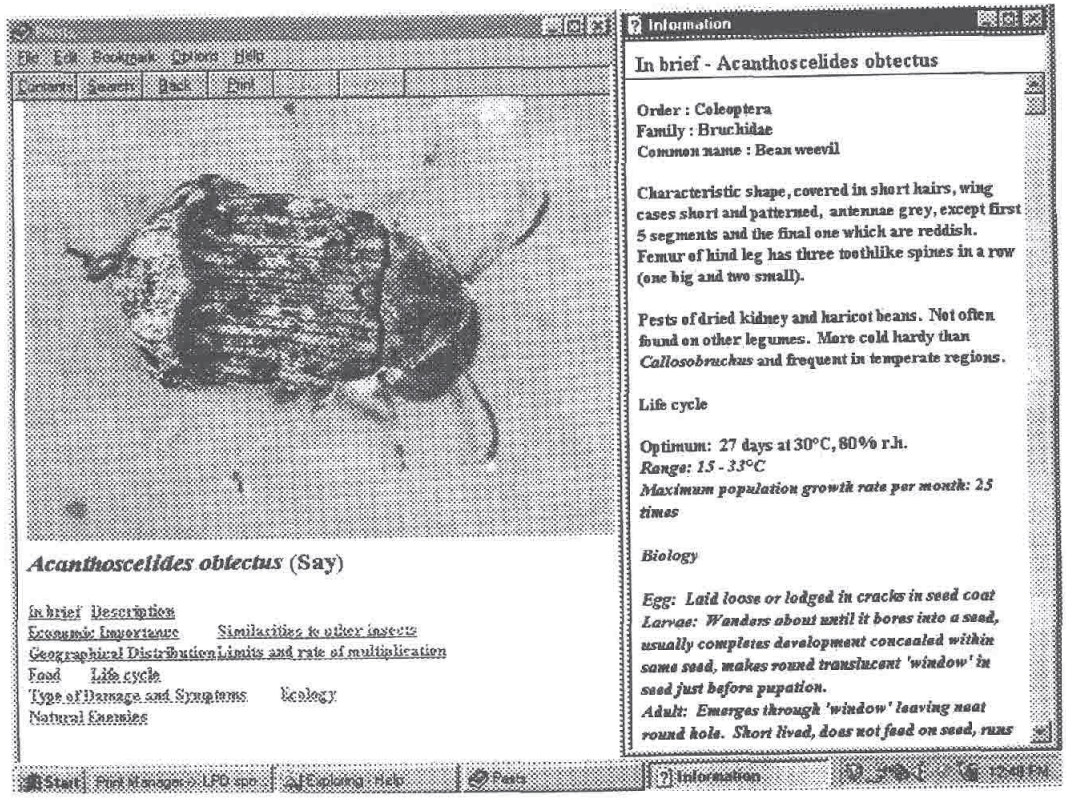

Fig. 5. An example of a page from the Pests help file, providing the user with a picture of the pest, a synopsis of the biology, and links to more detailed information.

To illustrate the inherent flexibility of this approach, an Australian version of Workbench incorporates two additional features not found in the Indonesian version. These are the PestMan expert system and GrainMan, a graphical tool that calculates dose parameters for fumigation of multi-celled storage complexes with phosphine using the SIROFLO® technique. The former provides advice on appropriate treatments for particular infestation problems, the latter is a very user-friendly graphical tool that significantly simplifies a fairly complex set of calculations, and provides a facility to create an organisation-wide database to collate pest management actions.

A number of countries are placing increased reliance on fumigation to control insect pests and the potential for the development of serious levels of phosphine resistance, resulting from poor practices, has been clearly identified (Bengston, 1986). CAL systems could play an important role in enhancing the effectiveness of pest management by improving understanding of underlying issues at all levels within a management hierarchy. Widespread adoption of CAL systems will lead to greater application of effective storage procedures and thus to reductions in the cost of storage and in overall storage losses. It will also contribute to the sustainability of these practices and facilitate the introduction of new ones. For example, by improving the capacity of organisations to carry out effective fumigations the development of phosphine resistance could be significantly delayed. The introduction and integration of alternatives to methyl bromide into existing post-harvest systems could be significantly enhanced through the appropriate use of CAL.

The next phase of this work is to validate the approach and deploy the technology in the field. To achieve this, courses will be run in Indonesia, the Philippines, Thailand and Vietnam. CAL will be essential parts of the course but will be integrated with more traditional methods. The course would be conducted in English, but Workbench will allow self-paced instruction in the students' own language. In addition to this, new tutorials will be incorporated into the system, encompassing grain drying and mycotoxins.

An important secondary objective of this new project will be identification of mechanisms by which this novel approach to training in the region can be integrated into the training infrastructures of the participating organisations. In the case of Pest Management Workbench, the collaborating organisations will be able to refine and extend the course content as they wish, and to develop new courses in their own languages. This will contribute to improvements in technology transfer and training in the agricultural sector and, ultimately, to improved overall food security, through

reduced wastage. Adoption and integration of CAL into corporate training systems will lead to more effective training programs, particularly where organisations have geographically-distributed workforces, as is the case with our collaborators in Indonesia. There will also be substantial cost savings: For example, in Australia, the Department of Education, Employment, Training and Youth Affairs (DEETYA) claim that the recent adoption of a CAL system to train staff has produced savings of greater than 50% (pers. comm. Michael Grosser, Catalyst Interactive Pty. Ltd.).

Acknowledgements

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