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IMPACT AND AMELIORATION OF SEDIMENT AND AGRO-CHEMICAL POLLUTION IN CARIBBEAN COASTAL WATERS

**Database Review and User Requirements Analysis
prepared for the Caribbean Group of Pesticide
Control Boards**

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1 EXECUTIVE SUMMARY AND RECOMMENDATIONS

- The two database candidates for use in the management of pesticides and their use were reviewed with a view to future use and the possibility for extension and use throughout the region. These two databases are the FAO funded OECS database and the GTZ funded GEREFI database.
- Both systems suffered from being developed well over five years ago and not having been upgraded since. The OECS database was developed in Microsoft Access 2.0 and the GEREFI database in Microsoft FoxPro v2.6. Both of these databases showed a number of difficulties working within new operating systems and with current database software available.
- The OECS database was fully defined featuring many of the features required of a final product but was let down by a poor database design and high degree of replication within the database.
- The GEREFI database although less fully featured showed a better database design.
- Both user interfaces look dated and do not utilise any more recent developments and ideas in database design.
- Documentation for both users and technical staff in both cases was very limited. Little or no internal documentation of code or external technical documentation exists.
- A user requirements analysis was conducted as a first step to determining if either of these products would fulfil the requirements of the users who would need to use the database.
- The user requirements analysis showed that these databases although being available for the past five years have not been taken up by the user community. Most users still use spreadsheets for maintaining their records of pesticides and related information. This points to a lack of involvement and training in the development and deployment of the two database products.
- It is recommended that a more detailed inclusive user requirements study be conducted with a view to the development of a new database using up to date software.

2 ACRONYMS

ERD	Entity Relationship Diagram
FAO	Food and Agriculture Organisation (of the United Nations)
GEREFI	Gestión de Registro y Fiscalización
GTZ	Gesellschaft für Technische Zusammenarbeit
LWI	Land Water Interface
NRSP	Natural Resources Systems Programme
OECS	Organisation of Eastern Caribbean States
SQL	Structured Query Language
DFID	Department for International Development (UK)
CGPC	Coordinating Group of Pesticide Control Boards of the Caribbean Region
PIC	Prior Informed Consent
PDF	Portable Document Format
VBA	Visual Basic for Applications

3 INTRODUCTION

3.1 Background

This report contributes to a three-year research project *Impact and amelioration of sedimentation and agro-chemicals in Caribbean coastal waters* that is funded by DFID's NRSP LWI programme (R7668). It follows on from an earlier LWI project *Review of the impacts of pollution by sediments and agro-chemicals of tropical coastal waters with reference to the Caribbean region* (R7111). The present project is managed and conducted by two organisations: the University of York, responsible for the sedimentation aspects of the project (activities commenced in June 2000 and are concentrated in the SMMA in St Lucia); and MRAG Ltd, responsible for agro-chemical components of the project (activities are undertaken in St Lucia and Jamaica).

A key objective of the project team has been to link up with relevant stakeholders and institutions related to land-based sources of pollution in the Caribbean in order to increase knowledge and promote uptake of project research results and recommendations. In doing so, the project has made links with the Coordinating Group of Pesticide Control Boards (CGPC) of the Caribbean. The MRAG team was invited by the Secretary of the CGPC to present details of the project at the 6th CGPC meeting, held in Dominica in June 2001. Additionally a review of the regional databases (FAO-OECS and Geref) had been requested by members of the CGPCs. At the time of the meeting last year, only the FAO-OECS database had been comprehensively reviewed and details were presented.

At the 6th CGPC meeting, MRAG was invited to make presentations at the 7th and 8th CGPC annual meetings (i.e. within the life of the project). Subsequent to the meeting, MRAG received the Proceedings (issues, decisions and recommendations) and was formally requested to conclude the work commenced on the review of regional databases, as cited below:

- Ø That a user requirement analysis for a pesticide database, as well as a fuller assessment of the GERIFI database of Jamaica, be performed, taking into consideration issues of sustainability, local ownership and workability. Out of the study, if necessary, a project should be developed and submitted to FAO for updating of the respective databases and equipment in the countries.

This document forms the basis of the work that was recommended by the 6th CGPC and that will be presented at the 7th CGPC in Antigua (18-20th June 2002).

3.2 Document structure

This document consists of two reviews of the databases currently in use in the Caribbean region for the registration and management of pesticides, their use and operations along with a summary of the responses to a brief user requirements analysis questionnaire distributed in the region to re-examine the requirements of each member state.

The database reviews for the FAO and GTZ funded databases examine the following points for each of the databases:

- Technical structure of the databases,
- Ease of use for data entry, editing and reporting,
- Data exchange between sites and the ease of importing and exporting data from other sources,
- Backup and restore procedures,
- Database security,
- Database and application software used, and
- The level and ease of use of the documentation.

The summary results of the user requirements questionnaires are then combined with these database reviews to produce a synthesis of what sort of database will be required in the future to develop the management of pesticides in the Caribbean region.

4 DATABASE REVIEW FAO OECS PESTICIDES DATABASE

4.1 Database Structure

4.1.1 Introduction

The OECS pesticides database was funded by FAO and designed by an Australian company, for the OECS Member States (MS): Antigua & Barbuda; Dominica; Grenada; Montserrat; St Kitts & Nevis; St Lucia; St Vincent & Grenadines; BVI; and Barbados. It appears that the database has been largely unused by OECS MS and MRAG was given a copy of the database by the Director of Agricultural Services of MAFF, St Lucia, MR Julius Polius. The database consists of two Microsoft Access 2.0 databases, one containing 52 database tables (50 containing data and 2 internal administration tables), the other containing all the forms, reports and queries to provide the user interface to the database.

4.1.2 Table definitions

The OECS Pesticides database benefits from good clear naming of all the tables and fields, which make it easier for future developers to find their way around the database. No real naming conventions are used in the database, as they are not really applicable as most of the table and column names are fully detailed e.g. the phone number fields are all called **PhoneNumber**. The use of these column names is consistent throughout the database.

The choice of field sizes and types however in a number of the tables could be revised. For example the default for a text field within Microsoft Access is 255 characters long, which is quite a large field of text, especially when it is used for the street number for the contact details held in the database. The physical street number should never get above 5 characters, even doubling this to 10 characters in length would still save a lot of space and increase searching efficiency with the database.

Text fields are also used in the database as single fields for both the values and units. For example in the Constituents table a number of fields exist for the concentration of each constituent in the pesticide formulation. It is recommended that separate fields be used for the concentration (numeric) and units (text) fields, where at the moment this is held in one text field. This will allow easier indexing, sorting, calculation and conversion of values from one unit to another.

A large amount of space in the database is wasted by using the wrong field size or field type. A number of these fields could also be easily replaced with more efficient use of lookup tables that have been keyed on integer (or long integer) values and analysis of data types (See Section 4.1.5).

4.1.3 Database Normalisation

Database normalisation is defined as a series of steps followed to obtain a database design that allows for efficient access and storage of data in a relational database. These steps reduce data redundancy and the chances of data becoming inconsistent.

A table in a relational database is said to be in normal form if it satisfies certain constraints. Codd (1970, 1971, 1972) defined the basic three such normal forms but there are now five generally accepted steps of normalisation. The output of the first step is called First Normal Form (1NF), the output of the second step is Second Normal Form (2NF), etc. Most large modern databases fulfil these five criteria, although in some cases the formal correctness of the database design is overlooked in favour of a simpler more consistent design that can be understood by the majority of users. A simple breakdown of the five steps is described below;

First Normal Form eliminates repeating groups by putting each into a separate table and connecting them with a one-to-many relationship.

Second Normal Form eliminates functional dependencies on a partial key by putting the fields in a separate table from those that are dependent on the whole key.

Third Normal Form eliminates functional dependencies on non -key fields by putting them in a separate table. At this stage, all non -key fields are dependent on the key, the whole key and nothing but the key.

Fourth Normal Form separates independent multi-valued facts stored in one table into separate tables.

Fifth Normal Form breaks out data redundancy that is not covered by any of the previous normal forms

On analysing the OECS Pesticides Database it is clear that the underlying data model is not normalised, even to the First Normal Form. Taking the **Constituents** table as an example, there are fields for the name of each chemical (**ActiveConst*Chem**), the proportion (**ActiveConst*Propotion**) (sic) and the concentration (**ActiveConst*Concentration**). These three fields are repeated three times for the three allowed active constituents. This information should have been extracted into a separate daughter table and linked with a one -to-many relationship. The same of course applies to the ten non -active constituents that are recorded in the same way. The current table structure is inflexible allowing a maximum of three active constituents only, and will waste valuable database space if three active and ten non -active constituents are not used. An example solution is proposed in Figure 1 below;

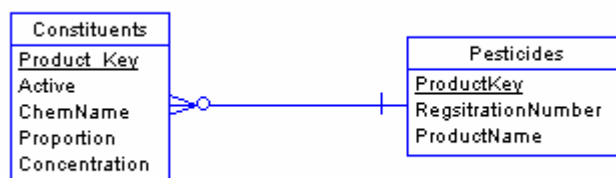


Figure 1 Example of normalised Constituents table linked to Pesticides.

A similar normalised approach to the database design would rationalise all the contact details held in the database into one table. There are eleven tables in the database that all contain virtually identical data for contact details (**Agent**, **Applicant**, **ManufacturerActive**, **ManufacturerActive2**, **ManufacturerFormulation**, **PestControlCompany**, **PestControlOperator**, **PestControlProprietor**, **PestOperatorApplicant**, **PestOperatorEmployer** and **ResearchInstitute**). These tables could be efficiently merged into one table with the addition of one extra table for storing details of contact type linked to an identifier for each person / company. This will eliminate the extreme level of duplication of these contact details in the database, and saving a lot of time entering duplicate data all the time. This would also give the added bonus that if a company or person moved premises or changed any other contact details then only one address would need editing thereby reducing inconsistency in the database.

4.1.4 Indexing and Primary Key / Foreign Key Relationships

As can be seen in the Entity -Relationship Diagram in Appendix 3 on page 42. Nearly all the relationships in the database are tied to the Pesticides table. This is not a very clear design, in most cases down to the lack of the implementation of a normalisation process. As such the primary key that is defined for the majority of the tables is the field **ProductKey**, which is the primary key for the **Pesticides** table. This means that only one record for most tables can exist, e.g. a pesticide can only have one Agent in the **Agents** table as the primary key field cannot allow duplicate values. It is easy to imagine a situation where more than one agent exists for a single product and that if the agent changed over time the details held previously in the database would be lost forever. A situation that should not occur. This situation would need to be repaired before the database could be effectively used. The correct implementation of this would be to have each table with its own unique

automatically generating primary key with the field product key as a foreign key related to the **Pesticides** table through a one-to-many relationship as shown in Figure 1.



Figure 2 Example of a one to many relationship

Very few other indexes besides that for **ProductKey** (the primary key for most tables) are to be found in the database. For the eleven tables holding contact information, the contact person, the organisation name and both postcodes (physical and postal) are indexed, along with application and registration numbers where they appear in tables. These indexes will be used for sorting and grouping of data in queries and reports and with the database structure as it is with the **Pesticides** table being at the heart of all queries and hence reporting on the database it is not surprising that more columns are indexed. If the database were fully normalised a great deal more indexing would be possible that would give much more efficient querying of the database.

4.1.5 *Lookup tables.*

Lookup tables for domains of values are not used very much in the database implementation. Lookup tables are generally used to avoid duplication of long text fields in the database, having integer or long integer values as key fields that are a lot smaller, easier and quicker to index than long text strings of forty or fifty characters. Only two tables in the OECS database really fit into the definition of a lookup table; **Chemical**, a lookup table for active and non-active components of a pesticide detailed in the table **Constituents**, and the table **PesticideType**, a lookup for the type of pesticide. Only the latter is keyed correctly though with **PesticideTypeID** being a long integer key, **Chemical** is keyed on the **ChemName** field which is Text(50) in **Constituents** or Text(250) in **Chemical** which again will waste valuable space and take longer to base queries on.

A few examples of where lookup tables could be used in the database are as follows;

- a lookup of container types for **ContainerDetails**;
- a lookup of concentration units for **Constituents**;
- a lookup of crops for **Uses**;
- a lookup of pests for **Uses**;
- a lookup of applications for **Uses**;

These lookup tables also provide a source of distinct values for producing reports sorted or selected upon certain criteria without having to perform a number of "SELECT DISTINCT...." SQL functions to define the scope of the selection first.

4.1.6 *E-R (Entity - Relationship) Diagram*

An entity - relationship diagram (ERD) is a visual representation of how the tables in a database are linked. A typical ERD will allow quick identification of the key tables in the database that are linked to a number of other tables. The full ERD for the OECS pesticides can be found in Appendix 1.

4.2 User Interface

4.2.1 General Impression

The general impression given by the user interface for the OECS database is one of a quite dated interface. The menu operates on a button selection basis, with no normal menu bar. This is not a very flexible interface. All the forms and report options are modal, i.e. once opened a form must be closed or another form opened. This does not allow multiple forms and therefore more than one record or types of data to be viewed at any one time. The choice of fonts and colours in the database also do not give the clearest view of the data presented at all times (See Figure 3 below).

The user interface is also only presented in one language. It is recommended that this be modified in future databases to allow multiple language versions (e.g. Spanish or French) to be easily created.

4.2.2 Menu Structures

The OECS database has a very defined linear menu structure controlled by button selection at each level. These menus are typically very clear, although the choice of fonts and colours in some cases means that the menu text is not totally visible in the space allocated for the button (See Figure 3 the main menu for the database as an example).

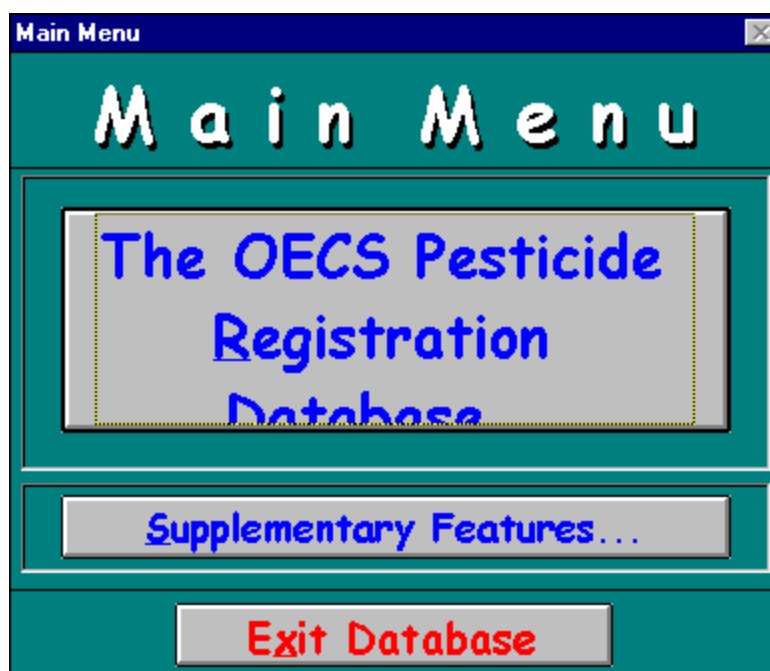


Figure 3 OECS Pesticide Registration Database Main Menu

The linear structure of the menu system employed has two main faults;

- **Lack of transparency of menu tree**

With a menu tree controlled solely by buttons a user not familiar with the whole menu structure of the user interface must search through each menu option by opening and closing the forms by clicking the different buttons. More modern styles of application development utilise standardised menu bar formats (as shown in Figure 4), at the top of the application window allowing the user to check the menu options for each branch of the tree very quickly. Using a more standardised format of menu tree will also make

users immediately feel more familiar with the system even though they may be using it for the first time.

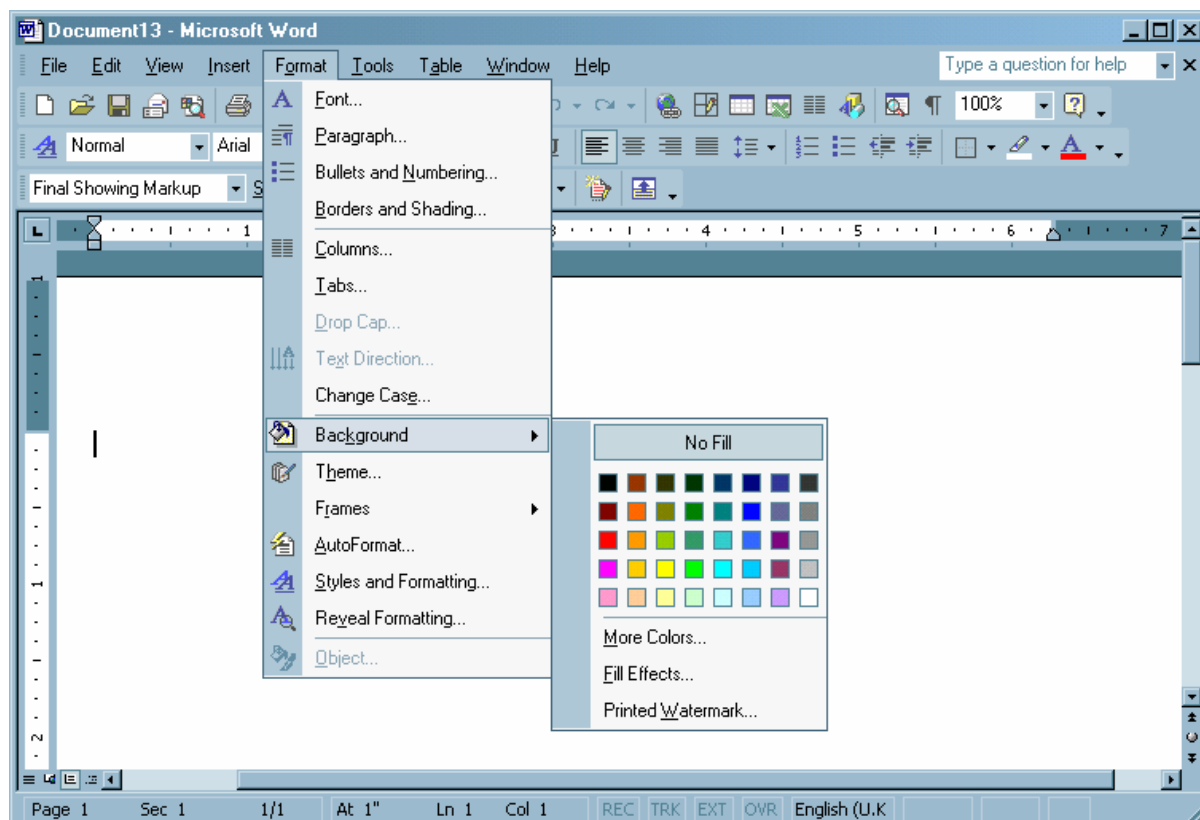


Figure 4 Example of Transparent Menu Tree

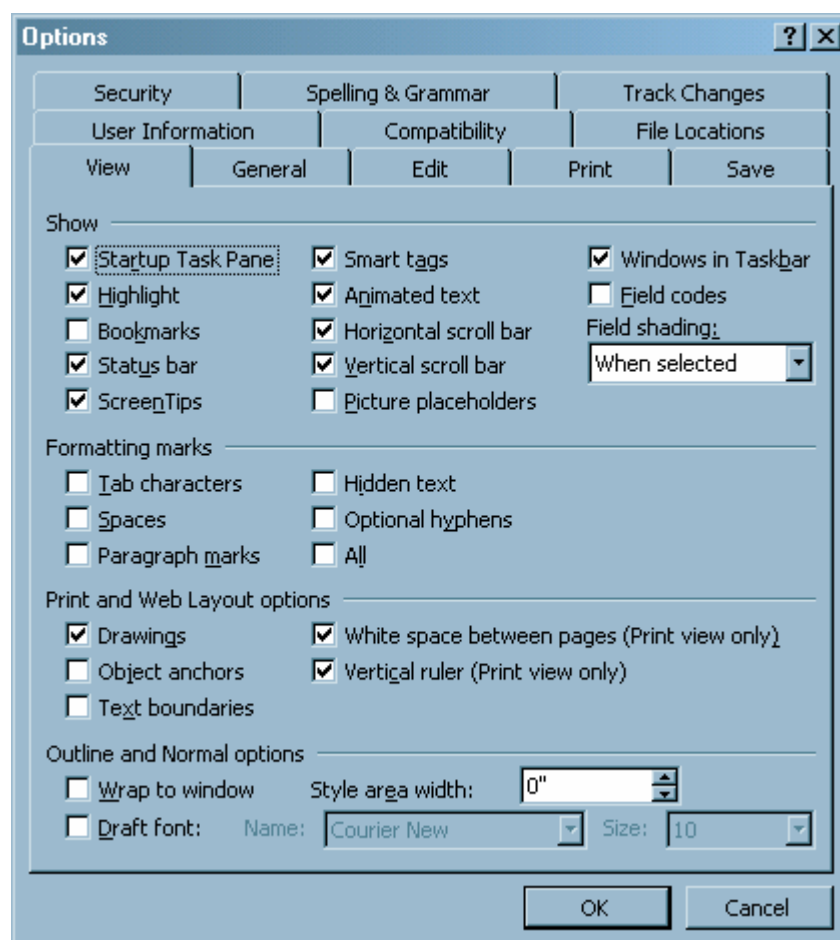
- **High Modality**

All the database forms used as menus in the database are opened in a modal mode that is they retain the focus on themselves until they are closed or another form opened by pressing a button on the form, which closes the original form. This makes the database application very linear, only allowing one form to be seen at the same time. The database would be made much more useful if this modality was removed which would allow for instance a pest operators details to be viewed on screen alongside the emergency antidote and treatment details for contact with a certain pesticide. With the current system the user would have to find the contact details, copy the details down or print out the details, then move back along the menu tree and then go through the tree again to find the antidote details.

4.2.3 Form Design

The general design of forms used either as menus or as data entry and editing forms is quite clear, though there are a few exceptions where data is not very clearly displayed but more information could be displayed on single forms. The amount of data collected and stored does not allow all the information to be displayed on the screen at once. The method used in the OECS database to allow the information to be displayed is to split the information over a number of forms with buttons controlling passage backwards and forwards along the set of forms. With more recent database interfaces that can be developed it is possible to add sets of tabbed controls as demonstrated in

Figure 5 which all the information to be displayed easily on one form. The changes proposed in the structure of the database will naturally change the structure of the data entry and editing forms and make it more natural for the information to be displayed in this way.



Figure

5

Example of a tabbed dialog box

The form titles on a number of forms are repeated in text on the body of the form and as the title caption for the form. The main menu is a typical example of this (See Figure 3).

There is a very good consistency in the design of the different forms between different types of pesticide application.

Error and range checking for a number of fields could be improved. This requires some modification to the underlying tables e.g. splitting up values and units as described and then applying range checks to the fields for the values.

Some information displayed is not appropriate for the choices made. For instance the same pull down menus are used for all applications. When checking for an operator's registration for instance you do

not need product name to be displayed. Problems of this type are small and easily fixed but can equally easily confuse inexperienced users.

The option to print does not work correctly on the version supplied for testing. After checking the user interface it seems that the print option on the form prints the form details out to a text file. This could be much better replaced by using the internal reporting functionality of Microsoft Access or an alternative package or by using a third party tool such as Crystal Reports.

4.2.4 Report Design

Only eleven reports defined in Microsoft Access exist in the OECS database. All the reports are very basic being based on the standard Microsoft Access templates. These seem to be used more as internal checks on the database and hence are not formatted as much as the forms.

More reports are needed in the database, firstly to replace the text file approach to reporting as described above. It is possible for instance to have the actual registration documents produced from within the database and printed directly.

4.3 Additional Features

4.3.1 Queries

The database contains a feature allowing the user to query the database on a number of selection criteria as detailed below.

Query of Registration Details	by Type of Registration by Type of Pesticide by Use by Applicant by Agent by Active Ingredients
Query of Pesticide Details	by Trade Name by Chemical Name by Crop by Pest Toxicity by Trade Name Critical Comments by Trade Name Rate of Application by Trade Name
Statistical Queries	Database Statistics List of Current Registrations List of Current Applications Expiry Dates of Registrations Revenue from Applications Revenue from Registrations Import Statistics

When a certain criteria set has been defined, the results are displayed on the screen. As an example the Product Name, Registration Number, Application Number and Type of Registration are displayed for all "Registration Detail" queries. From this point it is not possible to access the information for a particular registration or application quickly or indeed print out these reports in a standardised format for the queries sorted by registration or pesticide details. A simple print report option for each query option would be quite simple to implement. Similarly it would be advantageous to be able to move to the appropriate application or registration information if the appropriate field was double-clicked. The report formats that are available for the Statistical Queries are quite basic in design giving the basic information in a simple flat format.

4.3.2 Label Information

The label information option on the "Supplementary Features menu allows users to include any additional files, such as graphic or sound files inside the database, and view them at a later date. In this instance it is intended that a good quality label is scanned into a file which is then imported into the database. This method of storing graphics as objects within a database is particularly heavy on database table sizes especially as the files are usually maintained external to the database as well. This process is now not really necessary and the files could quite easily be left in a particular disk and /

or directory which can be accessed by the database and linked via a hyperlink instead. This will save greatly on database size and hence backup and restore times, access times.

4.3.3 Interactive Training

The interactive training section was missing from the version supplied for review. The idea of having an interactive training section within the data base is however very good. It may be safer however, to have any interactive training supplied as one or more external programmes. This will safeguard the integrity of the data in the database, with no possibility for confusion that a user is working on the “real” database or in a separate “training” database.

4.3.4 Glossary

The menu item “Glossary” would lead the user to expect a glossary of common terms related to databases and to pesticides and their use, but this was not present. This would be a very useful addition as it is unlikely that the database operators that would use the database would be fully conversant with both databases and pesticides. Instead of the expected glossary four menu options were presented, three of which were available.

4.3.5 FAO Guidelines

The FAO document entitled “International Code of Conduct on the Distribution and Use of Pesticides” is included within the database. This is a very useful reference document for the users of the database, but increases the size of the database and with improvements could be linked into the database but not included within it. For example the document could be made available in a PDF (portable document format) format with a hyperlink within the database.

4.3.6 Compatibility Chart

This option presents a graphical representation of the compatibility between any two pesticides, showing when these are compatible and when such a combination may be hazardous.

4.3.7 Pesticide Label

The pesticide label option displays an example of a pesticide label, in this case LORSBAN 500EC. As for the FAO guidelines this option will take up a lot of space within the database but does not provide commonly used and accessed information, and as such would be better removed and the database provided with a link to the information, which is held in a separate file.

4.3.8 Prior Informed Consent Register (PIC)

A menu button exists to allow the user access to the PIC register. Unfortunately as for “Interactive Training” section described in Section 4.3.3, a dialog box appears to inform the user that the version does not support this facility. The option to access this register should therefore be disabled or removed completely.

4.4 Data Exchange / Import / Export Protocols

4.4.1 What is provided?

Information exchange facilities are provided within the database as a supplementary feature. Two options exist for exchange between member states and the OECS Secretariat and exchange over the Internet.

4.4.2 What is needed?

The facilities provided for exchange between Member States and the OECS Secretariat are limited in that only one permit or registration is available to be sent at a time. Options are available for sending the information in printed formats or in an email format. The email format is currently setup for

Microsoft Mail (mailboxes) only, and it is recommended that options should be available for more commonly available email packages such as Microsoft Outlook, Eudora and Lotus cc:Mail.

A much simpler alternative is to have the information exchange simply exported to file (s), which can then be manually emailed by the user. When the original database application was developed five years the use of email was not as widespread as today and therefore it was much more useful to automate the process as much as possible. Nowadays, with email being a much wider used medium for communication many more people are familiar with its use and can attach a file to an email and send this with very little problem. This system would also have the advantage of tracking all data transfers as they are stored as files initially. These files can be stored and if necessary resent at a later date.

4.5 Backup and Restore Procedures

4.5.1 Ease of Use.

The backup database option is very simple to use. It is accessed from the "Supplementary Features" menu, and then selecting "Options" and then finally "Backup the Data". As backup and restore procedures are very important features of the database it would be preferable if these were highlighted on the Main Menu screen as a separate option. The simple act of seeing the button saying "Backup and Restore the Database" each time that the database opens will prompt the user to backup the database on a regular basis (See Section 4.5.3 for timetable for database backups and restore testing).

The directory tree where the backups are to be made need to exist otherwise the backup will fail. Unfortunately the backup routines do not check these as a matter of course and prompt to create the directory if needed. The user must create a new directory for the database backups or select an existing one into which to place the backups. Once the directories have been created it is a simple matter of choosing an appropriate filename and clicking on one of the buttons to create a backup in a particular directory. The database uses the PKZIP compression utility to compress the two Microsoft Access files. Once complete the PKZIP window stays open and must be closed manually. This process would be a lot "cleaner" if the client application window closed automatically on completion.

PKZIP is a good choice as a compression utility as all subsequent versions are backwards compatible. It is also possible to restore the database without entering the database application.

The backup to floppy diskette option also assumes that the floppy diskette is drive A: which is not always the case, and is one option that is not available through the "Defaults and Directory Paths" menu under "Options".

It should be noted that even if the backup fails to be completed then the field identifying the date and time of the last backup is updated. This is incorrect and can cause users to continue having thought that the database is safely backed up when it is not.

4.5.2 Accuracy

Only the "data" database of the two databases is backed up. The "application" database should also be backed up manually, just in case of a hard disk failure or corruption of the application file. There were no problems with the accuracy of the backups taken.

4.5.3 Timetable

A timetable for backups should be developed, with a rotating set of directories and filenames, as this does not exist at the moment and is not discussed in the User Manual. A daily backup to the hard disk, with copies taken on a weekly basis "off-site" on floppy disk, zip disk or CD-R and stored permanently.

It is also recommended that a regular restore test is done, (after first backing up the database of course). This will familiarise the users with the database restore procedures. The last thing anybody

would wish is to have to do a restore of a database and not having tested an unfamiliar procedure before.

4.5.4 Disaster Recovery Plan

It is recommended that a disaster recovery plan be developed for the OECS database in each location that it is installed. This plan should consist of the following items to be kept in a prominent location close to the workstation where the database is in use.

One simple double sided A4 sheet (preferably laminated) containing:

- **Emergency contact details for information technology staff. The IT staff responsible should be contacted before starting any restore procedure.**
- **Location of backups: On-site and Off-site**
- **Copy of the backup schedule to identify the location of the latest backup.**
- **Restore instructions**
- **Database checking instructions for restored database.**

A more detailed plan should be developed for the IT staff responsible for the database and they should be very familiar with the backup and restore procedures in the database.

4.6 Security

4.6.1 Ease of Use

Microsoft Access 2.0 security is used to restrict access to the database. Two levels of users exist, **Users** and **Administrators**. User access is initially gained through the **operator** account (a member of users). Password access can be modified through the application with users capable of modifying their passwords by entering the current password and then typing the new password twice. It is possible to modify both user and administrator passwords but at no place in the documentation supplied with the database, is a username supplied for **Administrator** Access. So therefore, although you can modify the password, access as an administrator is still not possible.

4.6.2 General access to the database

The access to the database is very well controlled. Most data is available to all registered users, although to amend registrations the supervisor password must be entered. However it is possible to access all the data in the data tables and export these to other data sources.

Database tables and queries are not protected in the database. This is a critical issue in that when database and query definitions are altered the user interface will not function correctly as the forms rely on the information to be provided in a certain format.

All forms and reports in the database are protected against modification by non-administrators.

4.6.3 Addition of new users

New users are not required, as all database users will log on either as "operator" or with the "supervisor" login only.

4.6.4 Modification of user rights / privileges

No modifications of user rights and privileges are possible.

4.7 Choice of Software

The OECS Pesticides database is a combination of two Microsoft Access (v2.0) databases. One Access database holds the data stored in table format only, the other Access database provides the user interface to the data, with all the data entry forms, reports and queries. The data tables in the first database are attached as linked tables.

4.7.1 Advantages

One of the biggest advantages of using Microsoft Access as the database and user interface was that at the time that the database was originally developed, Microsoft Access v2.0 was probably the most widely available and advanced desktop database packages available.

The links between Microsoft Access and the other Microsoft Office products allow a great deal of flexibility and easy transfer of data to spreadsheets or other documents.

Training (both formal and self-taught courses) and user support are readily available.

4.7.2 Disadvantages

Since the development of the database, Microsoft Access has moved on through three versions to the latest version Access 2002. Microsoft Access databases of earlier versions are quite easily converted by an experienced database programmer upwards between versions from 2.0 to 95, 97 or 2000, though particular attention must be paid to a number of points such as the changes in security and moves to integrate VBA (Visual Basic for Applications) with the mainstream Visual Basic.

As mentioned in Section 4.6, the security system and password access to the database has changed dramatically in the move between versions, which physically restricts Access 97 and later versions even starting up the OECS Pesticides Database correctly.

Cost implications are a consideration. Microsoft Access is supplied as part of the Microsoft Professional Office Suite, which costs in the region of \$US600 per licence, or individually for \$US400 (upgrade \$US150). Upgrades to the software occur on average at two year intervals, and a choice must be made to upgrade the database software every two years or keep with a previous version, which may cause problems if more than one version of Access is installed.

A discussion of potential replacement database management software is to be found in Section 6.6.

4.8 Documentation

4.8.1 User help files

Windows help files of the standard type supplied with most Windows applications have not been developed and integrated with the database. At the time the database was developed the standard help files using the Windows help file engine were available, and could be easily integrated into applications, but they were not simple to generate.

Recently however, third party help development tools have appeared on the market for easy generation of help files (e.g. SOS Help Author).

These help files can be linked through a series of bookmarks to particular forms or controls in a database and when the <F1> key is pressed the appropriate page of the help file is displayed.

Windows help files would have been expected for a product developed in a more recent version and would be of great benefit to the database application.

4.8.2 User Documentation

The user manual released with the OECS Pesticides database is complete and fully defined. The only criticism about the manual provided is that in many cases it follows the data entry procedures for the database in repeating information a number of times on virtually identical forms. The database and manual would both benefit from some degree of standardisation and removal of the duplicate information.

It would also be advantageous, considering that no windows help files exist for the application, to have the user manual released in an electronic format, such as Microsoft Word or preferably in Adobe PDF (Portable Document Format), to allow electronic searching for terms within the manual. This will also ensure that versions of the manual and database are concurrent as they can be released on the same media.

4.8.3 Technical (code) Assistance - Comments in code, Functional level

4.8.3.1 Data Tables

Each of the data tables in the "data" database is fully commented with the description fields completed. This is not as important in this database as in many others due to the good clear naming used when naming tables and columns.

4.8.3.2 Visual Basic Code (Form / Report / Module)

Due to the security passwords not allowing access by any user accounts to the underlying structure of the database forms, reports, macros and modules, it is impossible to comment at this time on the technical assistance given in the visual basic code underlying the forms, reports and modules.

4.8.3.3 Technical Documentation

No technical documentation was available for review. In view of the licensing agreement for the distribution of the software it is assumed that the technical documentation is retained by the developer (TORUS Technologies, Australia) and is not released to the client.

This would greatly restrict any future development of the database unless the development was to be conducted by the original developers.

5 DATABASE REVIEW GEREFI DATABASE

5.1 Database Structure

5.1.1 Introduction

The GEREFI database was originally designed in Spanish for Central American countries through a GTZ-funded project. The Jamaican Pesticide Control Authority (PCA) subsequently requested that a version be prepared for them and they have been actively using the database to record registration, importation and manufacture (registration) of pesticides in Jamaica since 1994 (Hyacinth Chin Sue, *Pers. Comm.*). Data about pesticide registrations and importation are extracted from the database each year for presentation of the PCA Annual Report. MRAG received a copy of the GEREFI database from the Registrar of the PCA, Ms Hyacinth Chin Sue.

The GEREFI database consists of a large number of independent DBase files accessed through an application using Microsoft FoxPro for Dos v2.6a. It was very difficult to access these files and obtain information needed to conduct the review.

5.1.2 Table definitions

Each individual table within the database is represented by a separate dbase file. The definitions for the tables are relatively simple, being restricted to the more basic field types available (numbers (N), strings of characters or text (C) and dates (D).

The table definitions are clear with sensible field widths for the various elements. As an example, Figure 6 shows the table that stores personal information in the GEREFI database. Here the fields for the name of each individual, forename(s) (APPELLIDOS) and surname (NOMBRES) are correct at 30 and 25 characters in length, with the address (DIRECCION) and telephone number at 50 and 15 characters respectively.

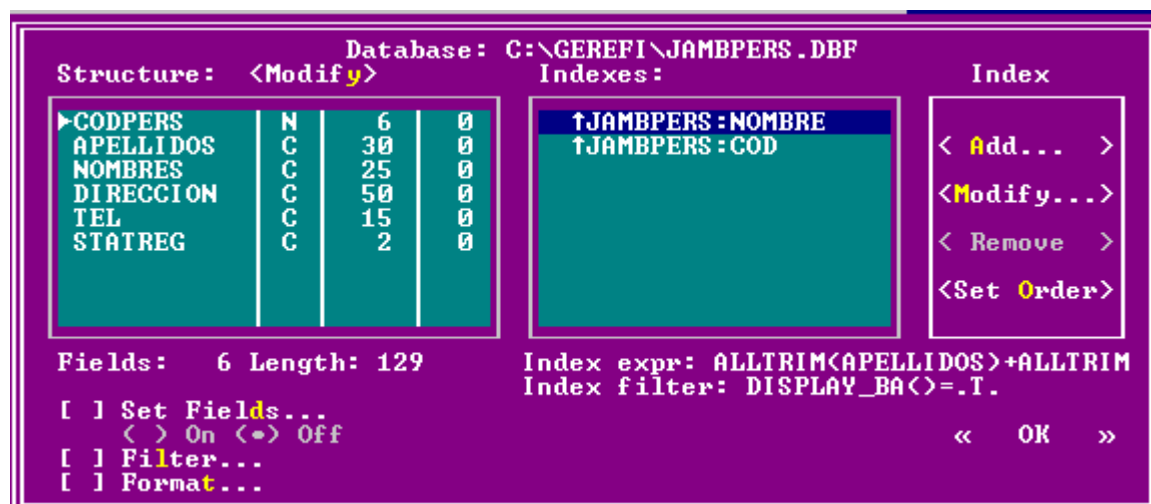


Figure 6 GEREFI database personal information table

The database definitions are in Spanish but no technical documentation either internally within the database tables or externally as a technical user manual was provided with the database. This makes it difficult to investigate the table definitions clearly. (See Section 5.8.3)

Naming conventions have been used to a degree throughout the database, though with the associated language problems this cannot be fully confirmed. Another problem is that dbase tables of the version used for this database only allow field names of ten characters in length. This is limiting in terms of database design, especially when a large number of columns hold very similar data and confusion may occur when extracting data and generating queries.

There are a number of lookup tables in the database. These tables provide information for standard domain lists for other fields in the database. The column names however do not match those in the main database tables as would normally be expected. This makes it impossible to fully complete the entity – relationship diagram for the database. The entity – relationship diagram can be found in Appendix 2.

5.1.3 Database Normalisation

From the entity – relationship model that has been generated from the database tables provided the database design appears to be normalised correctly, as far as can be determined with the problems experienced with the lack of documentation.

5.1.4 Indexing and Primary Key / Foreign Key Relationships

A sensible system of indexing has been applied to the individual database tables. Primary keys have not been setup for each of the major database tables, although each table has an index based on those columns that would have contributed to the primary key.

No secondary or foreign keys have been implemented though between the individual database tables. The absence of any foreign keys means that referential integrity in the database cannot be maintained and no cascade updating or deleting of tables is possible.

Example keys can be seen in Figure 6 which shows indexes for the surname of individuals and the code attributed to each individual.

5.1.5 E-R (Entity - Relationship) Diagram

The full ERD for the GEREFI database can be found in Appendix 2.

5.2 User Interface

5.2.1 General Impression

The DOS interface supplied for the GEREFI database via FoxPro for DOS looks extremely dated, which is unsurprising, as the database has not been updated since October 1996, and the version supplied with the database not since 1994. The database uses a very simple user interface. Although the DOS screen is limited in size to 80 characters wide to 25 high the user interface allows access to other “daughter” forms from the base form through keyboard shortcuts (highlighted on the forms) or by mouse clicks.

5.2.2 Menu Structures

The GEREFI database has a well structured transparent menu bar that controls access to the database. Access to the menu options is controlled through the arrow keys and spacebar or mouse in a very intuitive fashion.

5.2.3 Form Design

The data entry and editing forms in the GEREFI are very simple, but elegant DOS based forms. The forms make good use of pop-up menus for database lookups for a wide variety of fields.

5.2.4 Report Design

None of the reporting facilities supplied with the GEREFI database worked correctly under the operating system used. This is probably due to the operating system and Microsoft FoxPro not working correctly together (See) and a non-standard installation of the software and database.

5.3 Additional Features

No additional features beyond the registration of pesticides, their use, control and people and legal entities involved in the pesticides industry are supplied with the database.

5.4 Data Exchange / Import / Export Protocols

5.4.1 What is provided?

No data exchange functionality or for standard import and export of data is supplied with the GEREFI application other than the standard Microsoft FoxPro routines or copying of the database source files.

5.4.2 What is needed?

A specific data exchange menu option should be provided that automatically runs the appropriate import and export protocols for regular data exchange and for exports of partial or full datasets for archiving purposes.

5.5 Backup and Restore Procedures

5.5.1 Ease of Use.

The only backup and restore procedures available for the GEREFI database are through the standard operating system interface where the whole files can be copied to another location and restored in full. No options exist within the application. Partial dataset backup must be completed by manually exporting the required data using the standard Microsoft FoxPro interface to a file and then backing up that file.

5.5.2 Accuracy

Standard file backups are assumed to be 100% accurate, though data loss may occur due to the interval between backups being larger and that no database access may occur during the backup and restore processes.

5.5.3 Timetable

No backup timetable or testing schedule for backup and restore procedures was provided. Due to the lack of built in procedures it can be assumed that this is not done in a formalised manner.

5.5.4 Disaster Recovery Plan

As with the backup timetable no disaster recovery plan was provided. It can be assumed that none exists and that a plan be drawn up as described in Section 4.5.4.

5.6 Security

5.6.1 Ease of Use

Database access is relatively simple to use with a password based entry system to the application implemented on a user-by-user basis on running the database application.

5.6.2 General access to the database

Access to the database however is not secure. The individual database tables are stored as DBase files and can therefore be accessed and imported to another database with no password protection and all the data accessed immediately.

5.6.3 Addition of new users

New users can be added relatively straightforwardly using the inbuilt Microsoft FoxPro routines.

5.6.4 Modification of user rights / privileges

User rights can be modified relatively straightforwardly using the inbuilt Microsoft FoxPro routines as for addition of users above.

5.6.5 Restriction of Database Access

Not applicable as database access is insecure.

5.7 Choice of Software

The GEREFI database was developed in Microsoft FoxPro for DOS v2.6. FoxPro databases use the standard DBase file format to store the data in with a number of forms and procedures to provide the user interface as a number of small individual files.

5.7.1 Advantages

One very important advantage at the time of development of using FoxPro for DOS as the driving software for the GEREFI database was that the database could then be easily installed and used on the majority of machines available in the region. The installation takes up very little space, especially when compared to some of the Windows based applications available at the moment, and can run on quite low specification hardware. This however is not as much of a concern any longer as most of the countries in the region have upgraded their hardware at least once during the intervening period and are now capable of running Windows based applications with no problems.

Also of great importance is the use of FoxPro as a user interface with DBase files as the storage format, which allows very quick and easy access to the actual database tables from any other application. As noted in Section 5.6 though this negates the need for any security, as the DBase tables are not password protected only the application so anybody with access to the files can view all the data without any problem.

5.7.2 Disadvantages

FoxPro is no longer the mainstream Microsoft database product now. It has been replaced almost entirely by Access, which is supplied as standard with the Office suite (professional versions) and by Microsoft SQL Server for larger scale database deployments in multi-user environments. This means support and training are less likely to be available and may cost more.

The version of FoxPro used to develop and run the system will not operate correctly on many 32-bit operating systems such as Windows NT, 2000 or ME. This makes it difficult to find machines that can be used for more than just running this database as any new machine will more than likely have one of these new operating systems as standard and this would have to be removed to allow the database to run.

The look and feel however of the database seems rather dated now. With the market domination of the Microsoft Windows family of product and the general look and feel of this style of interface being very common with other operating systems the DOS based front -end provided with the GEREFI database seems very dated. The common look and feel of a Windows interface, with pull -down menus, the same method of closing forms and reports in windows and many of the settings for all Windows applications taking on the default styles for each user allow any windows application an immediate sense of familiarity for all users, even on the first time of use.

A discussion of potential options for replacement database management software is to be found in Section 6.6.

5.8 Documentation

5.8.1 User help files

No user help files were to be found with the database as supplied.

5.8.2 User Documentation

No user documentation was to be found

5.8.3 Technical (code) Assistance - Comments in code, Functional level

5.8.3.1 Data Tables

No labelling or comment codes on the individual database tables were to be found.

5.8.3.2 Technical Documentation

No technical documentation was supplied with the database.

6 USER REQUIREMENTS ANALYSIS

6.1 Background

MRAG was requested to conduct a User Requirements (UR) analysis during discussions after a presentation at the 6th CGPC and, more formally, through a Recommendation of the Proceedings of the Meeting. The UR questionnaire was subsequently designed by MRAG and a consultative draft finalised by August 2001¹. The questionnaire was distributed to representatives of the CGPC member countries (see Table 1 and Appendix 3) and responses collated between September and November 2001. This section is based on the analysis of the UR questionnaire.

6.2 Introduction

The process of requirements gathering for software development is quite a difficult process and one that can quite often lead very quickly to extensive lists of individual requirements that drive the software development process. Unfortunately this process often leads to the development being driven by a small number of individuals.

Traditional requirements analysis in this way can take a lot longer than first anticipated, it can document the wrong thing or take the wrong emphasis on priorities and can often be out of date by the time it is finally completed.

However the regular updating of a user requirements analysis for any software is a necessary part of the evolution of any software. Both the FAO and GEREFI databases are over five years old, a long time in terms of database development, (e.g. Microsoft Access has moved from v2.0 used in the FAO database to Access 97, Access 2000 and the latest release Access 2002 in the intervening period). The database reviews conducted as part of this project provided an ideal opportunity to quickly gain an overview of the requirements of the user community and to determine if the databases in use still match their requirements or alternatively if new versions need to be developed or indeed if a new database needs to be developed.

This user requirements analysis should only therefore be taken as a starting point to determine the scope for a more detailed user requirements analysis that would start the development process. It is critical in this process to take into account not only the views of the managers of the system but also of all the people who use the system. This process would critically need to include any data entry staff, who use the system on a daily basis to those people at executive and managerial levels who may only use a database once a month to provide summary information.

The user requirements questionnaire that is attached as Appendix 3, asks a number of questions about the functional and non-functional requirements of the database, which provide a basis for drawing up functional and technical design specifications.

A functional design specification is a collection of functional requirements that have been identified, and are needed by, users for the system. The functional requirements of a system describe in detail the individual functions and features that a system must perform. Typical functional requirements could be along the lines of “*The system shall show all available stock in a warehouse*” or “*The system shall produce a daily list of a items sold in each store*”.

A functional design should ideally be independent of any user interface or system constraints, although this is not always possible. A bad example of a requirement would be “I want to choose an item from a pull-down list and then press a button to process the order”, this would be better phrased as “The system shall allow users to select items and then proceed to process the order”.

¹ In collaboration with the Secretary and Chair of the CGPC and a representative of FAO (Mr Everton Ambrose, Miss Claudia Bellot and Dr Gene Pollard respectively)

Non-functional requirements (see Section 6.4.1) for the database have also been developed independently for future reference.

The technical design specification is a combination of the functional design specification detailed by the users in a framework defined by the non-functional requirements.

The countries and people requested to complete the questionnaire is shown in Table 1.

Table 1 List of People and Countries Requested to Complete the User Requirements Questionnaire.

	NAME	DESIGNATION	ORGANISATION/ COUNTRY	EMAIL ADDRESS
1.	Basudeo Dwarka	Registrar	Pesticides Board – Guyana	moasl2@guyana.net.gy
2.	Guy Mathurin	Secretary	Pesticides Board – St. Lucia	guymathurin@yahoo.com
3.	Hyacinth Chin Sue	Chairperson/Registrar	Pesticide Control Board - Jamaica	chinsue@caribpesticides.net
4.	Florita Kentish	Chairperson	Pesticide Control Board - Antigua	diragr@candw.ag kentishf@candw.ag
5.	Joan Steer	Plant Protection Officer	Department of Agriculture – Cayman Islands	ciagric@candw.ky
6.	David Malone	Deputy Director	MRCU – Cayman Islands	David.malone@gov.ky
7.	Guido Marcelle	Chairperson	Pesticide Control Board - Grenada	guimacel@caribsurf.com
8.	Claudia Bellot	Chairperson	Pesticide Control Board – Dominica	agrilibrary@marpin.dm
9.	Jerome Thomas	Registrar	Pesticide Control Board – St Kitts	doastk@caribsurf.com
10.	Gerard Grey	Registrar	Pesticide Control Board – Montserrat	minagric@candw.ag
11.	Chester Polo	Registrar	Pesticide Control Board – Trinidad	iicatt@iicacarc.org
12.	Philmore Isaacs	Registrar	Pesticide Control Board – St Vincent	agrimin@caribsurf.com
13.	Arona Fabie-Forbes	Deputy Chief Agricultural Officer/Chairperson	Department of Agriculture - BVI	284-495-1269 (fax)
14.	Everton Ambrose	Technical Secretary/ Plant Protection Officer	CGPC/IICA	iica@candw.lc
15.	Gene Pollard	Regional Plant Protection Officer	FAO	Gene.pollard@fao.org

6.3 Results of the Draft User Requirements Analysis

The following results are based on the returned questionnaires from seven of the twelve countries contacted for comments. One questionnaire was not included in the analysis as the organisation contacted has indicated that they are not directly involved with pesticide registrations and that the replies they would give to the questionnaire would not indicate their country's needs but could only give their own requirements which have a more research orientated focus.

6.3.1 Currently in use

Figure 7 below shows that databases are not used very much in the region to manage data for pesticide composition, registrations

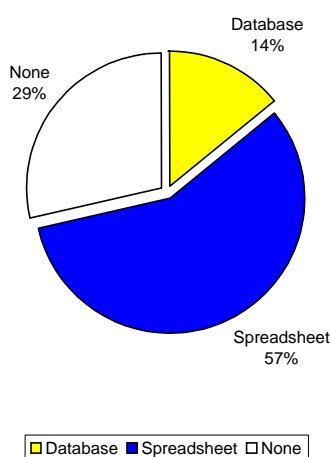


Figure 7 Database and Spreadsheet Use for Pesticide Data Management.

6.3.2 Software and Hardware

All the respondents to the questionnaire indicated that they use Microsoft Windows products as their standard operating system. A number indicated that they use the 32-bit versions of the software such as Windows NT or Windows 2000 which has implications on the choice of database software that can be used. Five out of the seven respondents indicated that they also use Microsoft Office in one of its forms as their standard desktop office suite, and it can therefore be assumed that Microsoft Excel is used to maintain the spreadsheets when a database is not used.

The computer hardware used in the region is all Intel x86 based, ranging from 486 based machines through to Pentium II machines. A consideration should be made of the approximate lifetime (both technical and useful) of these machines and the likelihood of replacement machines taken into account. Creating software that will run on such a wide range of operating systems machines and future proofing such software will be critical.

6.3.3 Number of staff and sites

Figures 3, 4 and 5 below show the frequency distribution of staff involved in pesticide management, data entry personnel and database administrators and developers. These figures show quite clearly that there is usually only one key user on the management side in each country, with in some cases one full or part time staff member for data entry and editing. Of key to any user requirements is that only one database administrator or developer has been identified from the seven countries. This means that any development will likely have to be done external to the current setup and that any

applications should be developed in such a way as to minimize the requirements for database administrators and the requirement for technical skills of this type.



Figure 8 Number of Pesticides Management Staff (Full and Part Time)

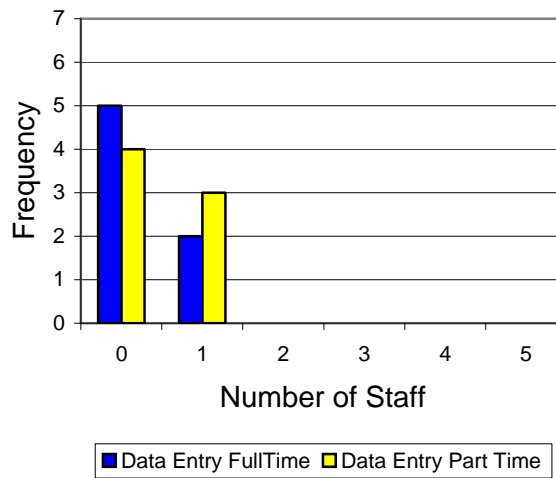


Figure 9 Number Data Entry Staff (Full and Part Time)

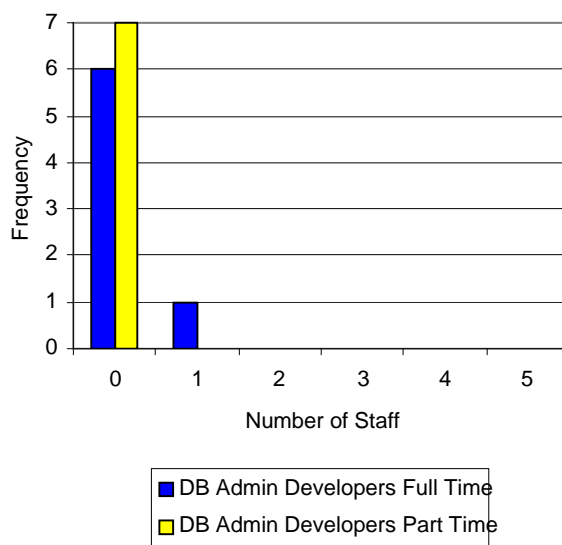


Figure 10 Number Database Admin / Developers (Full and Part Time)

6.3.4 Database requirements

Figure 11 shows the basic information requirements for pesticides to be stored in the database. All the respondents require information to be stored on the majority of the basic fields highlighted and a number of other factors were also suggested including post harvest intervals, compatibility with other pesticides, description of all names (scientific and trade) and images of the labels for each trade name, the mode of action of the pesticide (contact, systemic etc.) and the impacts of the pesticides on human health and the environment. One other important feature highlighted that should be readily available to all users quickly is the emergency first aid advice for each pesticide, detailing the treatment required and antidote information.

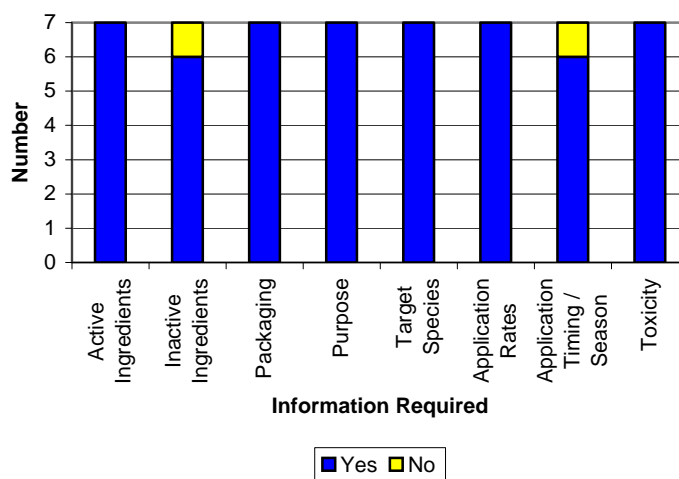


Figure 11 Information requirements for Pesticides

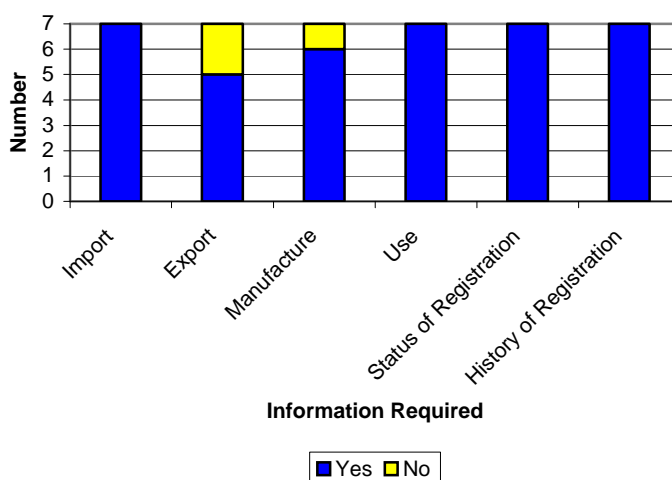


Figure 12 Information requirements for Applications for Pesticide Imports, Exports, Manufacture, Use etc.

Figure 12 details the information required for each pesticide in terms of applications received for imports / exports, manufacture, use and histories of the registration for each of these. The majority of users identify all of these as important factors, with a few countries saying that export and manufacture details were not required with may be attributed to the size of the country and that pesticides are not manufactured and therefore not exported from these countries. Other additional information highlighted for applications were to add in applications for experimental and research permits and any reasons given for refusals for applications.

Figure 13 shows the information requirements for the importation and exportation of pesticides. The respondents indicated that most of the criteria identified in the questionnaire would be required for any future database development, although a number indicated that value and volume may not be required. Additional suggestions include conditions of import / export licences, details of agents, reasons behind the importation / exportation and exporter details.

Figure 14 shows details of the information requirements for applications to manufacture pesticides. As for importation / exportation, most of the information suggested in the questionnaire is required, the only exception being where as before it is unlikely that manufacture will take place in country.

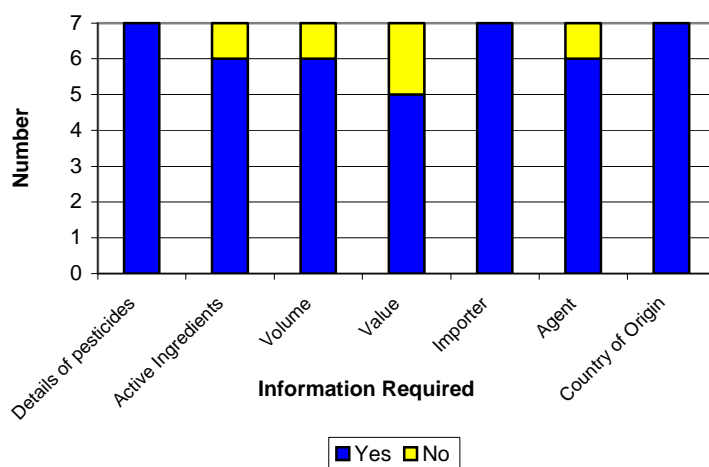


Figure 13 Information Requirements for Imports and Exports of Pesticides.

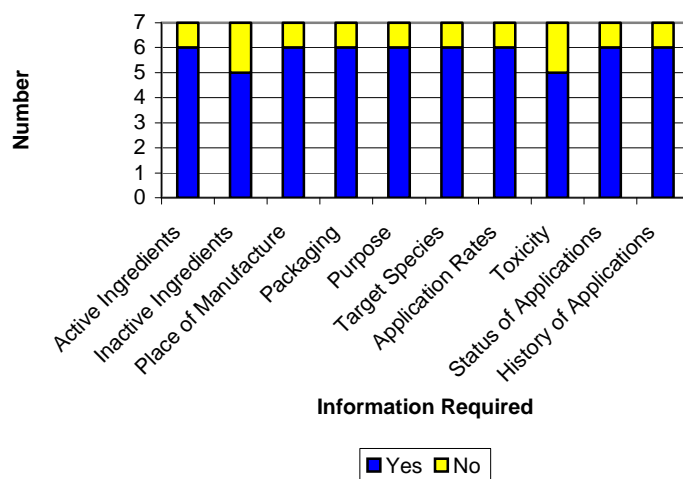


Figure 14 Information Requirements for Pesticide Manufacture.

Figure 15 shows the information required on inspections and quality control. This figure shows clearly that all the respondents recognise the need the database should contain a section on inspections and quality control and such information should be more clearly identified at a later stage.

Figure 16 shows the information required on experimental protocols. The majority of respondents require records of the experimental protocols used and research reports on pesticides to be recorded. A majority of the respondents also would like to see some method of storing information on internationally recognised protocols for pesticides as a starting point or cross-reference for their own experimental work.

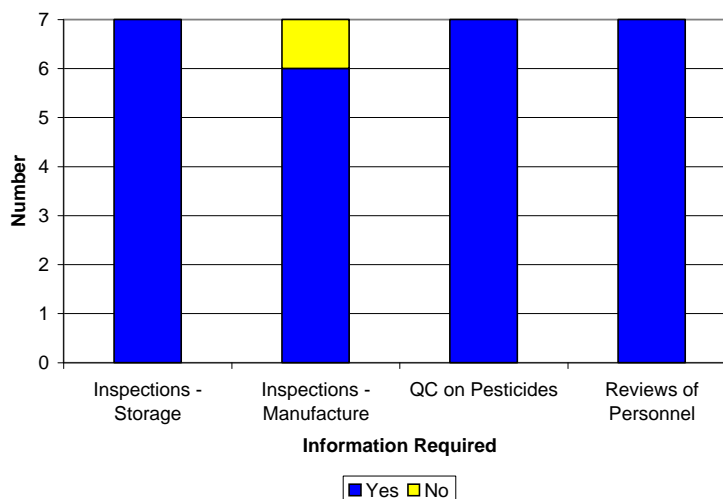


Figure 15 Information Required on Inspections and Quality Control

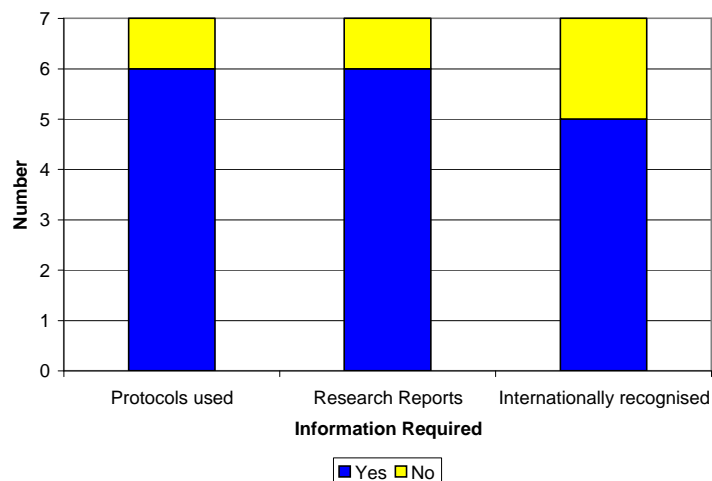


Figure 16 Information Required on Experimental Protocols

Figure 17 indicates the responses to the requests for a set of database tables to store details of people and / or companies that are involved in any way in the pesticide industry. The list suggested provided most of the possible options with the respondents also suggesting the addition of contact details for Emergency Services and dealers or traders in pesticides.

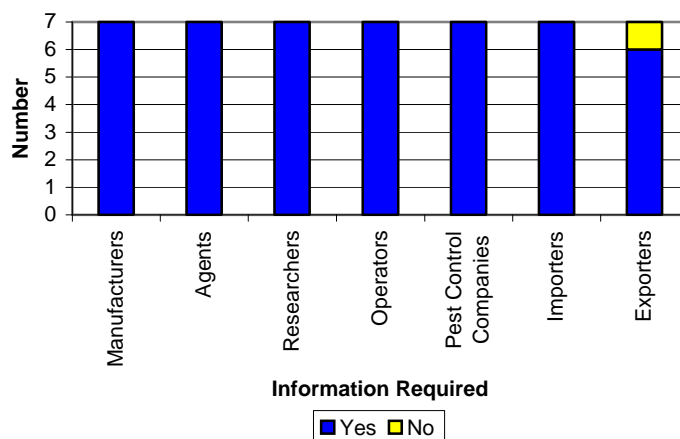


Figure 17 Information Required for Legal Personalities involved in Pesticide Registrations

Figure 18 indicates the responses to the requests for a set of database tables to store details of pesticide operators. All respondents indicated that details of certification, training and medical details on operators would be required as part of a database along with any indications of overexposure, emergency contact details for each operator, duration of licences held and a historical record of each operator's pesticide use.

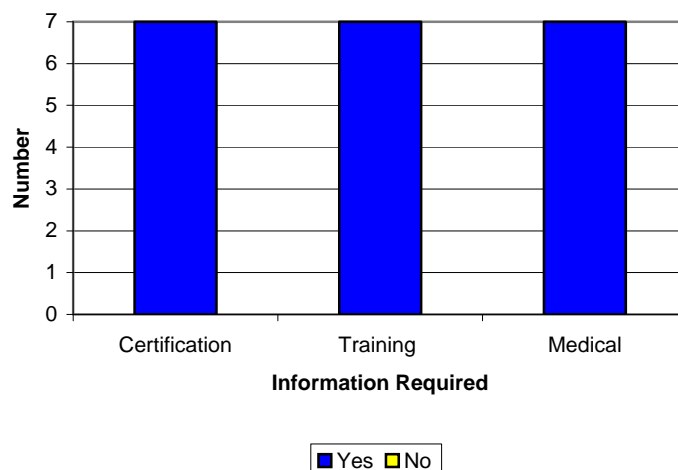


Figure 18 Information Required for Pesticide Operators

Figure 19 indicates the responses to the requests for a set of database tables to store details of premises that are involved in the use, storage or manufacture of pesticides. The list suggested provided most of the possible options with the respondents also suggesting the addition of contact details for Emergency Services and dealers or traders in pesticides.

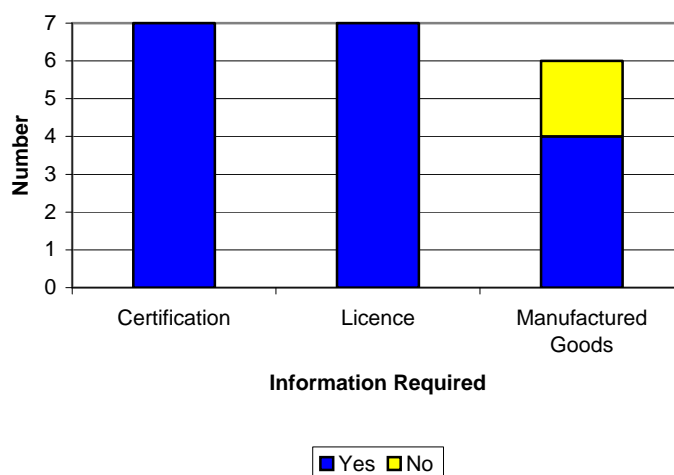


Figure 19 Information Required for Licensed Premises Involved in Pesticide Use, Storage or Manufacture.

6.3.5 Data Import / Export and Exchange

Figure 20 shows the preferred routes for data exchange as identified through the questionnaire. It is clear that data exchange is required within the Caricom and CGPC countries and that over 50% of the respondents have identified needs for data exchange beyond this set of countries with secure data transfers as an important feature.

Figure 21 shows the data identified by the respondents that they would like to exchange. All the data types highlighted for transfer in the questionnaire were selected as being necessary for exchange, with the exception of data relating to the volume and value of imports and exports. Nearly half the respondents indicated that they would not be prepared or capable of exchanging information of this type.

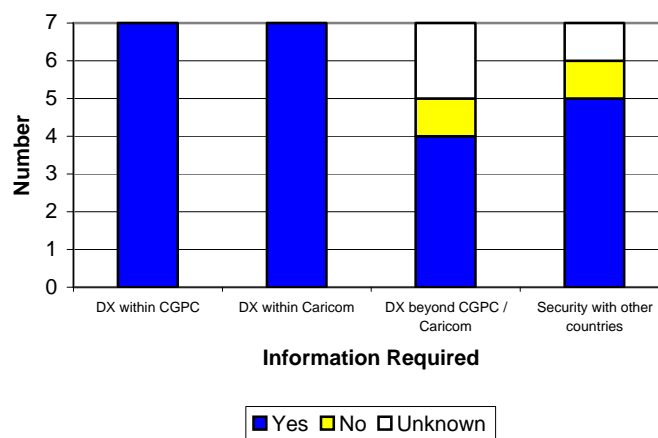


Figure 20 Data Exchange Requirements – “Where to Exchange Data?”

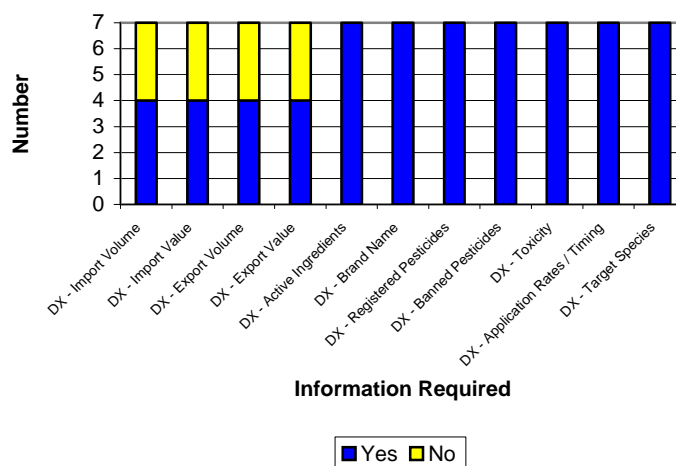


Figure 21 Data Exchange Requirements – “What Data to Exchange?”

6.3.6 Reporting

Figure 22 and Figure 23 show the reporting requirements required by the respondents from the database for Registrations (Figure 22) and for Pesticides (Figure 23). Registrations need to be reported for all criteria noted, though a number of respondents indicated that reports of licensed premises would not be required. Reporting requirements for pesticides are very similar with the respondents indicating that a wide variety of reports in a number of formats will be required. The only choices that were indicated as not being necessary by any respondent were reports based on trade names for pesticides, where they would be traced by their scientific names or active ingredients.

Figure 24 shows that historical information on registrations, rather than just current registrations is required by 72% of the respondents. Therefore the database should maintain all records as current and not archive data at regular intervals as could have been possible.

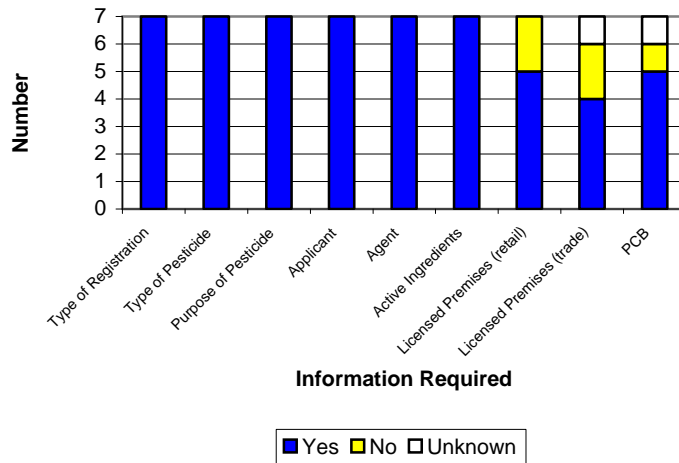


Figure 22 Reporting Requirements – Registration Details

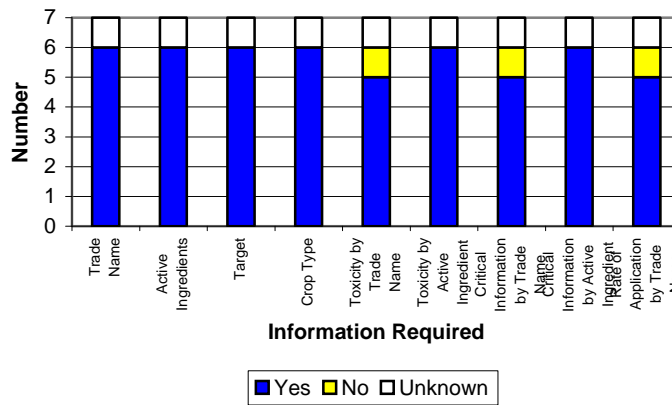


Figure 23 Reporting Requirements – Pesticide Details

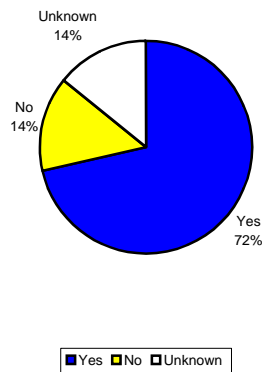


Figure 24 Pie Chart to Show the Requirement for Historical Data on Prior Registrations

Figure 25 shows the requirements for statistical queries from the database. These queries are similar to the reporting requirements but have been separated out in one of the two databases current designed for use in pesticides management in the region. These should be considered just as reports as for the data represented in the reporting section. Over 50% of the respondents considered each of the queries presented a requirement for the database.

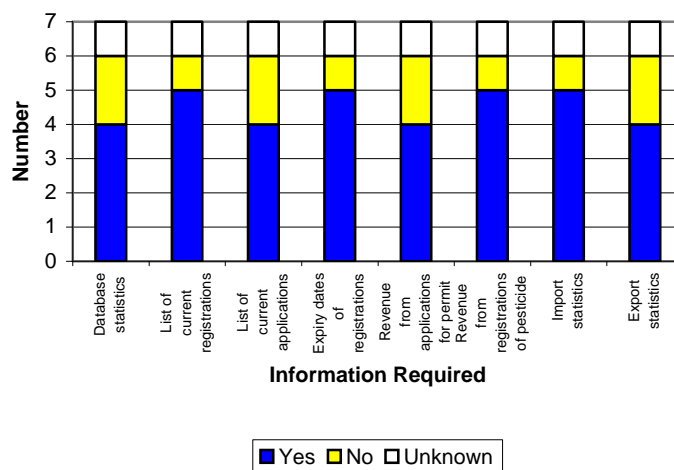


Figure 25 Statistical Queries required from a database.

6.3.7 Additional features

Figure 26 shows the requirements for additional requirements for the database. All the respondents indicated that backup and restore functionality should be built into the database. This would have been suggested as an integral part of the database regardless of the result of the questionnaire but it is encouraging to see the recognition of this in the questionnaire results. The respondents also indicated that access to glossaries of terms and common phrases for pesticides (100%) and IT (67%) would be an advantage. These would best be displayed as on-line help files or as Portable Document Format (PDF) files supplied with the database.

Over half the respondents indicated that certain information in the database would be of a sensitive nature and to be released to other countries automatically. A further review of security needs should be conducted to determine the exact requirements for each country.

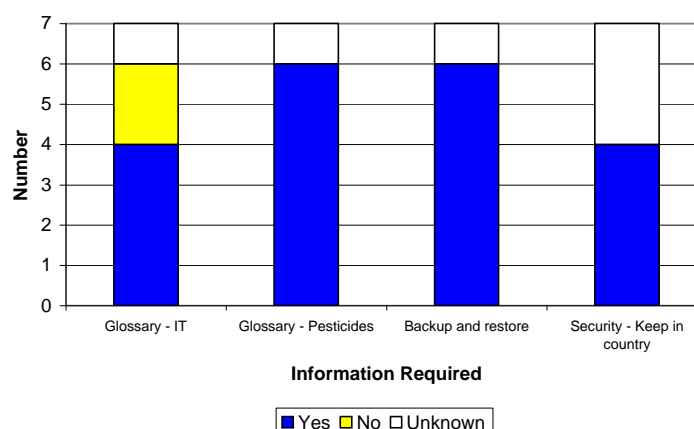


Figure 26 Additional Features to be Included

6.3.8 Choice of Application

The operating systems used by all the respondents were Microsoft Windows based, split between Windows 98, NT and Windows 2000. All the respondents selected a Windows based database interface in preference to the text based DOS interface.

6.3.9 Documentation

Those respondents who responded to the questions on documentation asked for a variety of documentation. From this it can be assumed that a database to manage the data associated with pesticide registration and management would need a combination of on-line help files, printed user and technical manuals and technical assistance to future developers in the form of in-code comments. Although these may duplicate information different users will still be able to access the information in the easiest and most familiar way for them.

6.3.10 Training

The absence of any full or part time database administrators and developers to develop these products in region continues in the absence of training facilities. Any database developed to fulfil the requirements detailed in this document will require training courses to be developed and run for database administration, for the data entry staff and in the management of the database, though it is possible that due to the small numbers of staff involved in each organisation (see **Figure 9** and **Figure 10**), that one combined course specific to this database could be organised.

6.3.11 Summary

In summary a database is required to manage the data entry, editing, storage, management and display of the following data types:

- Pesticides
- Applications for Import, Export, Manufacture, Use etc
- Licensing of Premises, Operators, Resellers, Manufacturers etc
- Imports and Exports
- Manufacturing
- Inspections and QC of Premises, Operators, Resellers, Manufacturers etc
- Experimental Protocols

The database must be secure in terms of maintaining confidentiality and also in terms of being safe against corruption and computer failure through a regular system of backups.

The database must also be able to import and export these data between OECS and CARICOM countries.

6.4 Non-Functional Requirements

6.4.1 What are Non-Functional Requirements?

When describing a system in terms of its functional requirements, the constraints that would be placed on the system in terms of the real world are removed. The aim of "non-functional" requirements are to describe the range of the system in the real world. They often address the hidden technical components of the system that are of great importance to the users even though they may not realise it. The common fifteen standard types of non-functional requirements are described in Table 2. A simple example of a non-functional requirement would be "The system must operate between 09:00 and 18:00 Monday to Friday".

Table 2 Definition of the standard types of non-functional requirements

Type	Description
Availability	Rate of hardware and software component failure (Mean Time Between Failure).
Cost of ownership	Overall operating costs to the organisation after the system is in operation.
Maintainability	Ability of the support staff to keep the system running after development.
Data integrity	Tolerance levels for the loss, corruption or duplication of data.
Development Cost	Overall cost of development and deployment.
Extensibility	Ability to accommodate increased functionality.
Flexibility	Ability to handle requirement changes.
Functionality	Number, variety and breadth of user-orientated features.
Installability	Ease of system installation on all necessary platforms.
Leverage / Reuse	Ability of system to be used on number of different platforms.
Operability	Ease of everyday operation and level of support required.
Performance	Ability to meet real-time constraints (batch and online).
Portability	Ability to be moved between platforms and operating systems.
Quality	Number of severe defects.
Robustness	Ability to handle errors and boundary conditions while running.
Scalability	Ability to handle a variety of system configurations and sizes

6.4.2 Description of Non-Functional Requirements for a regional pesticides database

Due to the lack of a large number of database developers and administrators working within any of the organisations contacted, the development of the non-functional requirements would not be an easy task for any of the organisations. Presented in Table 3 below is a draft list of non-functional requirements.

Table 3 Definition of the non-functional requirements for a regional pesticides database.

Type	Description
Availability	Software to be reviewed every three years with a view to upgrading. Hardware MTBF to be set at three years, with a rolling upgrade programme to be considered alongside software upgrades.
Cost of ownership	No additional software licensing costs to be incurred. No additional support costs beyond basic user and technical support.
Maintainability	Database to be 100% maintainable after a period of two days training.
Data integrity	Data loss to be 0% to the previous day's backup.
Development Cost	Minimal development cost to be determined through detailed User Requirements Analysis.
Extensibility	Increased levels of internal and technical documentation will allow easier extension to the database software. Database software to be reviewed on a three yearly basis to determine any changes in requirements or modifications needed due to upgrades to hardware and

Type	Description
	software.
Flexibility	Minimal flexibility. User Requirements Analysis will determine full scope of the database.
Functionality	User Requirements Analysis will determine full scope of the functionality of the database.
Installability	Database to be installed on Windows 98 / NT / 2000 platforms only. Minimum hardware and software configuration to be determined at User Requirements Phase.
Leverage / Reuse	Not applicable in this case as database only required to run on a standard PC based platform.
Operability	Users to be able to use the system after a training period of 2/3 days (depending on functionality defined in User Requirements Analysis).
Performance	All basic reports and queries on the database to be executed within 20 seconds of user request on minimum hardware configuration.. Complex querying to be completed within 2 minutes of request on minimum hardware configuration.
Portability	Not applicable in this case as database only required to run on a standard PC based platform.
Quality	Post revision phase – 0 major errors.
Robustness	Built in error and logic checking at a number of levels within the database.
Scalability	Not applicable in this case as database only required to run on a standard PC based platform.

6.5 Discussion

6.6 Choice of Database Software

6.6.1 Why Change

The biggest problem with the two databases that currently are available to be used for the management of pesticide registrations in the Caribbean is that the database management software used to run the databases is out of date. Both Microsoft FoxPro and Microsoft Access software programs have moved on through a number of versions from the versions used to develop the GEREFI (FoxPro for DOS 2.6) and FAO (Access for Windows v2.0) databases respectively.

One critical result of this is that support is now limited for either package, so that if a problem exists in the software there is very little that can be done to remedy the situation. In addition, little or no new literature and training is available for the older products, companies preferring to concentrate their resources on the newer products where demand is higher. In the case of both the versions of FoxPro and Access used, there are incompatibility problems with newer operating systems. Both products are not certified to work on the newer 32-bit Windows operating systems such as Windows 2000, and users are warning not to mix the two together as this may result in data loss and other such problems.

In fact Microsoft Access is actually incompatible with newer versions of itself. When loading the FAO database the inbuilt security that comes with the Access 2.0 database is incompatible with that for later versions of Microsoft Access. This means that if the database is installed on a machine with a later version already installed on it, the database cannot be accessed correctly.

Newer versions of the software are often quicker, having much improved database engines underlying them and have a much improved user interface, allowing easier database maintenance and further development of user interfaces for a variety of users or user groups.

It is apparent from the user requirements questionnaire in Section 6.3.1 that over half the respondents currently use spreadsheets to maintain their records of pesticide registrations etc., although it was apparent that all respondents recognised the need for a database to be used in this role.

There are a number of reasons why databases are more preferable in this role to using spreadsheets. The first and probably most important is that databases have a much more strongly defined structure for data to be entered into than spreadsheets, a concept called database integrity where only data of certain types can be entered into certain fields. This relational structure enforces, through a system of key fields, a system of referential integrity where rows of similar related data require entries in other tables to exist. For example to make a booking in a rental system both a valid customer must exist and a resource to be booked out must exist in the customers and resources table before an entry can be made in the booking table. In reverse you cannot delete a customer who has bookings live in the system. This same well-defined structure also allows queries to be developed on the data that has been entered into the database format.

Databases also allow much clearer and simpler user interfaces for users to conduct data entry and editing processes and to produce reports of the data to the screen and printer. These interfaces can be internal within the database management software as in Microsoft Access, or as a number of separate individual programs written in other languages and compiled to run with a database file (or files).

User interfaces when combined with in-built error checking within the database provide a very robust mechanism for trapping errors or highlighting potential mistakes in data entry. In addition to the general integrity rules (entity and relational) described above, the system should include a number of methods to check and restrict data entry for every applicable field in the database. These rules are based upon natural logic (i.e. the end of an event is after the start) or the business rules. These are as important to the efficient functioning of the system as the general integrity rules. This error checking should be achieved at a number of levels within the system through a number of methods detailed below;

- **Pull-down menus and restriction of data entry**

Where required, pull-down menus of lookup tables such as for fields can be set up allowing the user only to choose from a domain of pre-defined values. The flexibility of the user typing in the data is retained. It is also prudent to set formats for numerical and date / time field inputs before development and keep these consistent throughout. As an example, it is suggested that all dates are kept in the format "dd/mm/yyyy" and times as "hh:mm".

- **In-field value checking (i.e. on leaving a field)**

For numeric and text fields constraints will be placed on the fields. For example all information will be checked to ensure it is within reasonable boundary conditions (i.e. that proportions of constituents are less than 100%).

- **Out-of-field value checking (i.e. at end of row)**

Where two or more values are related, e.g. the start and end positions and times of a journey, checks will be made to ensure logical rules are followed, i.e. the start time is before the end, and the distance between the start and end positions is within reasonable bounds.

- **Data verification flags**

A system of data verification flags can also be appended to each row in each database table. This system of flags will allow easy referencing of any suspect data, with a standardised coding system developed to describe the type of error encountered.

Databases also have much better security protocols than spreadsheets, with different users or user groups being allowed access to different sections of the database and user interface. With spreadsheets on the other hand, access is either granted or not by password on the individual files.

6.6.2 Options

The following three options are presented as potential choices for the further development of a database.

6.6.2.1 Upgrade to latest version of Microsoft Access

Microsoft Access has been through a number of version upgrades since Microsoft Access v2.0 used to develop the OECS database. The latest version is Access 2002, which is supplied as part of Office XP and as a separate product.

Microsoft Access has a number of advantages that stem from the fact that most computers when bought come ready supplied with a copy of Microsoft Office. Therefore most users have a ready familiarity with the standard Microsoft interfaces used. This is particularly evident from the questionnaires where Access is often used in organisations but not for the registration of pesticides. Microsoft Access is well structured product with good connectivity to other office products and other databases through ODBC links.

As a market leader, there are good support and training courses available for Access worldwide and a large developer market is available.

The disadvantage of Access is that Microsoft will continually upgrade products and databases seem to be more susceptible to versioning problems than simple word processing or spreadsheet files. This means that both the product and the database should be upgraded at regular intervals which will have obvious cost implications.

6.6.2.2 Move to "Open Source" Software

The most important fact about "Open Source" software is that the software is freely distributed over the Internet. For the more widely available "Open Source" databases such as MySQL a large user community has developed, and work together via the Internet to provide a large user support base for administration and development. As it is freely available the database management software and all its associated documentation can be downloaded from a number of Internet sites around the world. Upgrades to the database management software are also free and notified over the Internet. The problem of versioning is much less than for Microsoft Access as a great deal of trouble is taken to enforce backwards and forwards compatibility between different versions.

This distributed network of users around the world though means that there is often a lack of formalised support and training although this situation is improving for the more widely used packages.

6.6.2.3 Move to web hosted database

One option that may need to be considered with the continuing expanding use of the Internet is to have a database that is distributed over the Internet. Database structures would need to be modified to accommodate the different mechanisms of access. However the database could then be accessed from any machine connected to the Internet via a secure website interface. All the administrative functions to the database would be handled by a third party, which would remove the need for database administration staff at each site and therefore will reduce these individual costs. This option however would increase communications costs due to the increased use of the Internet, which would vary dependent on the amount of usage of the database and for the development and provision of the central web server.

6.6.2.4 Summary of Options

Table 4 summarises the three options displaying in a simple format the advantages and disadvantages of each

Table 4 Summary of database application options

Option	Advantages	Disadvantages
Upgrade to latest version of MS Access	<p>Familiarity with Access</p> <p>Supplied as standard with many machines, therefore low cost.</p> <p>Good connectivity with other office products</p> <p>Good support and training available.</p>	<p>Will be upgraded, therefore recurrent upgrade costs.</p>
Upgrade to Open Source Code	<p>Software is free.</p> <p>Large user community for support and development help.</p> <p>Easier to upgrade, (no versioning problems).</p>	<p>Lack of formal support for some products.</p> <p>Smaller number of formal training courses.</p>
Upgrade to web based database	<p>Easy access from any machine.</p> <p>Database administration is conducted by a third party.</p> <p>Large number of users can be connected at any one time.</p> <p>Slower than direct access.</p> <p>Centralised database negates the need for data exchange as all data is available (subject to national restrictions).</p>	<p>No centralised control.</p> <p>Increased costs for hosting to be spread amongst users.</p> <p>If Internet connection is lost, the database cannot be used.</p>

6.6.3 Recommendations

Based on the findings of the User Requirement analysis, it is recommended that a further discussion on the direction of the database be conducted as part of a more detailed User Requirements Analysis. This discussion could be usefully generated following presentation of this review at the 7th CGPC in Antigua in June later this year.

In conclusion, if costs and funding allow, the web-hosted database option would be more preferable for future development of a common database for use across the Member States of the CGPC. At the current time however the simplest and lowest overall cost solution in terms of development and training is the Microsoft Access option which is also the easiest to further develop and maintain on an individual country by country basis.

7 REFERENCES

E.F. Codd, "A Relational Model of Data for Large Shared Data Banks" , Comm. ACM 13 (6), June 1970, pp. 377-387.

E.F. Codd, "Normalized Data Base Structure: A Brief Tutorial", ACM SIGFIDET Workshop on Data Description, Access, and Control, Nov. 11 -12, 1971, San Diego, California, E.F. Codd and A.L. Dean (eds.).

E.F. Codd, "Further Normalization of the Data Base Relational Model", R. Rustin (ed.), Data Base Systems (Courant Computer Science Symposia 6), Prentice -Hall, 1972. Also IBM Research Report RJ909.

Appendix 1 – Physical Data Model FAO OECS Database

The following twelve pages show the physical data model underlying the FAO OECS database. The pages are arranged as per Figure 27 running in order from TOP LEFT across to TOP RIGHT then down a row and continuing through to BOTTOM RIGHT.

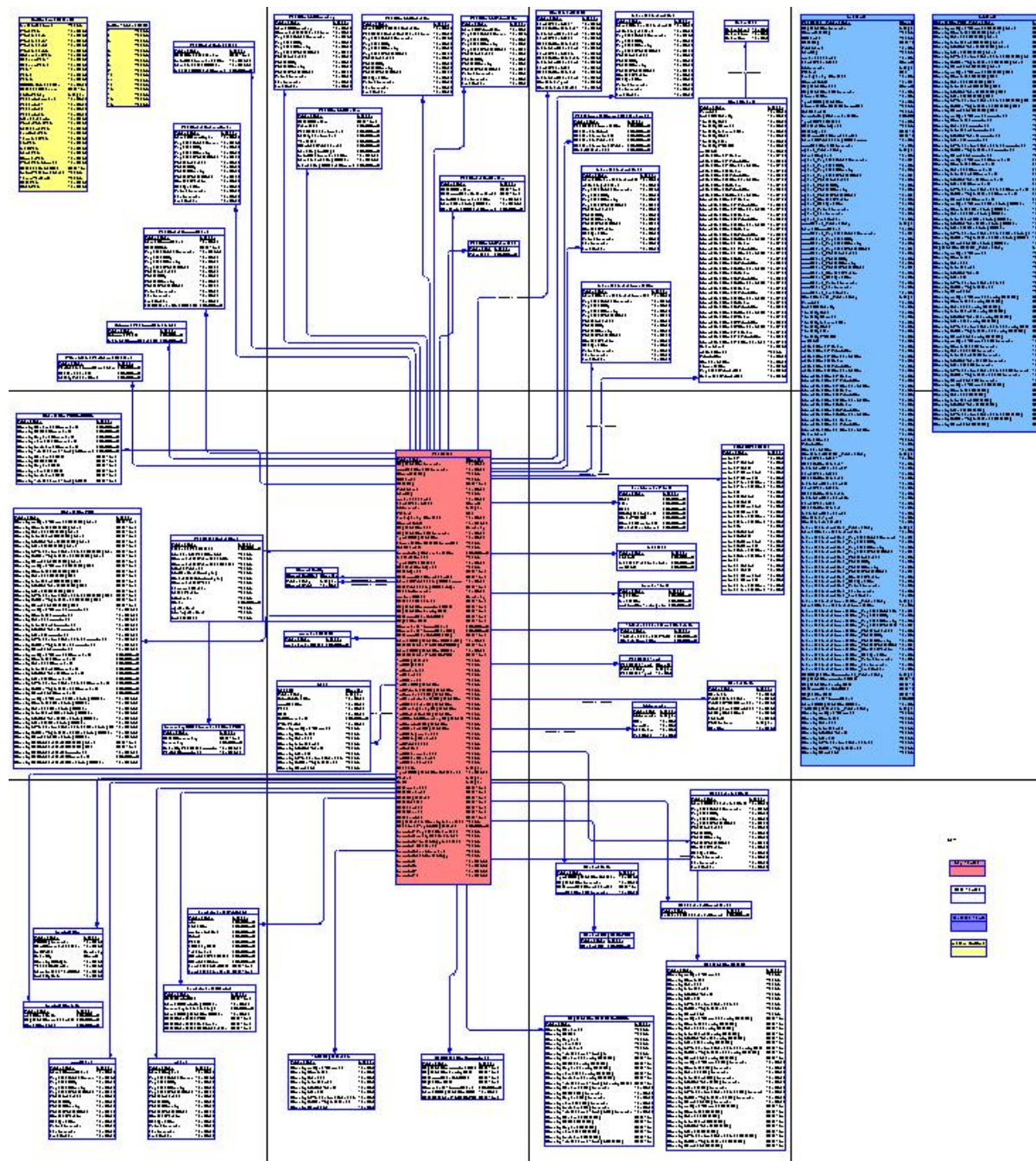


Figure 27 FAO OECA Physical Data Model

Appendix 2 – Physical Data Model GEREFI Database

The following four pages show the physical data model underlying the FAO OECS database. The pages are arranged as per Figure 28 running in order from TOP LEFT across to TOP RIGHT then down a row and continuing through BOTTOM LEFT to BOTTOM RIGHT.

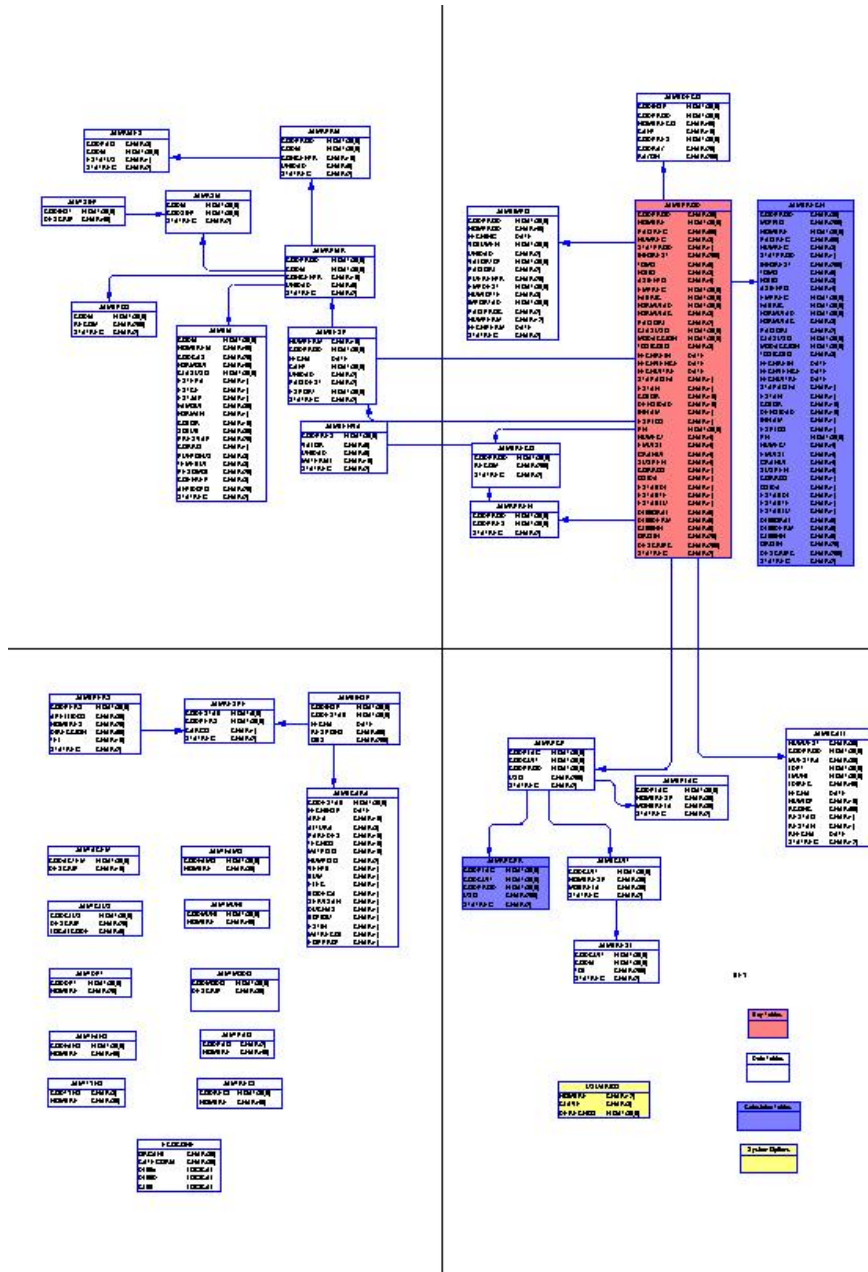


Figure 28 Physical Data Model of the GEREFI Database

Appendix 3 – User Requirements Questionnaire

QUESTIONNAIRE FOR CGPC PARTICIPANTS

Objectives:

The 4th recommendation arising from the 6th meeting of CGPC in Dominica was: *‘that a user requirement analysis for a pesticide database, as well as a fuller assessment of the GERIF database of Jamaica, be performed, taking into consideration issues of sustainability, local ownership and workability. Out of the study, if necessary, a project should be developed and submitted to FAO for updating of the respective databases and equipment in the countries’*. MRAG Ltd has been requested to follow up on this recommendation as part of a project² that is relevant to CGPC.

Methodology:

This User Requirements (UR) questionnaire has been developed with feedback from the following people: the incoming CGPC Chairman (Claudia Bellot), outgoing CGPC Chairman (Hyacinth Chin Sue), Secretary of the CGPC (Everton Ambrose) and FAO Regional Plant Protection Officer (Gene Pollard). Questionnaires will be distributed to representatives of all countries attending the CGPC. Completed forms will be used to develop the UR analysis and draft functional design specifications for the pesticide database. We will then follow up with individual queries relating to non-functional requirements.

The questionnaire is divided into 3 sections: background information, functional requirements (i.e., those required to do the job) and non-functional requirements. It is important that you enter an answer against the appropriate box for every question, even if it is negative (put a tick for ‘yes’, √, or a cross for ‘no’, X).

Please return all completed questionnaires to Nicole Esteban at MRAG Ltd (n.esteban@ic.ac.uk) by the end of September 2001. We will advise you of all reports concerning the UR analysis and hope to present the final report at the 7th meeting of CGPC.

Thank you for your time.

Nicole Esteban, Project Researcher (n.esteban@ic.ac.uk)
John Pearce, Senior IT Consultant (j.pearce@ic.ac.uk)
Chris Mees, Project Manager (c.mees@ic.ac.uk)

² The project researches the *Impact and amelioration of sedimentation and agro-chemicals on Caribbean coastal waters* and is funded by the UK Department for International Development (DFID) under the Natural Resources Systems Programme – Land-water Interface system (project R7668). Two project presentations were made at the 6th CGPC meeting and further details of the project are available on our web site www.mragltd.com.

Database Review and User Requirements Analysis

8. STAFF DIRECTLY INVOLVED IN REGISTRATION OF PESTICIDES
- Number of full time _____
- Number of part time _____
9. DATA ENTRY PERSONNEL
- Number of full time _____
- Number of part time _____
10. ARE THERE ANY AVAILABLE TRAINED DATABASE ADMINISTRATORS/DEVELOPERS
- Number of full time _____
- Number of part time _____
11. SITES AT WHICH PESTICIDE DATABASE WOULD BE USED?
- Number of sites _____
- Number of personnel at each site:
- Site #1 _____
- Site #2 _____
- Site #3 _____
- Site #4 _____

- 13b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS
- All permit applications for import
 - All permit applications for export
 - All permit applications for manufacture
 - Use of pesticide
 - Status of pesticide registration
 - History of pesticide registration
 - Other (specify) _____
 - _____
 - _____

- 14a. DO YOU REQUIRE A DATABASE OF IMPORTS/EXPORTS OF PESTICIDES?
- Yes
- No

- 14b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS
- FY
- Details of pesticides
 - Details of active ingredients
 - Volume
 - Value
 - Importer
 - Agent
 - Country of origin
 - Other (specify) _____
 - _____
 - _____

- 15a. DO YOU REQUIRE A DATABASE OF PESTICID MANUFACTURE?
- E Yes
- No
- Other (specify) e.g spreadsheet _____
- _____

- 15b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS
- FY Details of active ingredients
- Details of inactive ingredients
- Place of manufacture
- Packaging
- Purpose of pesticide
- Target species
- Application rates
- Application timing
- Toxicity
- Status of manufacture application
- History of manufacture application
- Other (specify) _____
- _____
- _____

- 16a. DO YOU REQUIRE A DATABASE OF INSPECTIONS/QUALITY CONTROL?
- Yes
- No

- 16b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS
- FY Inspections of premises used for storage
- Inspections of premises used for manufacture
- QC on pesticides inspected
- Reviews of personnel
- Other (specify) _____
- _____
- _____

- 17a. DO YOU REQUIRE A DATABASE OF EXPERIMENTAL PROTOCOLS?
- Yes
- No

Database Review and User Requirements Analysis

17b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS

	FY	<input type="checkbox"/>	Protocols used
		<input type="checkbox"/>	Research reports
		<input type="checkbox"/>	Recognised by international authority
		<input type="checkbox"/>	Other (specify) _____

18a. DO YOU REQUIRE A DATABASE OF ALL PEOPLE AND/OR COMPANIES INVOLVED WITH PESTICIDES?

	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>

18b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS

	<input type="checkbox"/>	Manufacturers
	<input type="checkbox"/>	Agents
	<input type="checkbox"/>	Researchers
	<input type="checkbox"/>	Operators
	<input type="checkbox"/>	Pest Control Companies
	<input type="checkbox"/>	Importers
	<input type="checkbox"/>	Exporters
	<input type="checkbox"/>	Other (specify) _____

19a. DO YOU REQUIRE DYNAMIC LOOK-UP TABLES?

	Yes	<input type="checkbox"/>
	No	<input type="checkbox"/>

19b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS

	FY	<input type="checkbox"/>	Target species
		<input type="checkbox"/>	Crops
		<input type="checkbox"/>	Application methods
		<input type="checkbox"/>	Purpose of pesticide
		<input type="checkbox"/>	Other (specify) _____

Database Review and User Requirements Analysis

- 20a. DO YOU REQUIRE A DATABASE OF PESTICID OPERATORS? E Yes No
- 20b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS FY Details of certification
 Details of training
 Details of medical check-ups
 Other (specify) _____

- 21a. DO YOU REQUIRE A DATABASE OF LICENSED PREMISES? Yes No
- 21b. IF YES, PLEASE SPECIFY WHICH REQUIREMENTS FY Details of certification
 Expiry of license
 Manufactured goods
 Other (specify) _____

DATA IMPORT / EXPORT / EXCHANGE

22. WOULD IT BE ADVANTAGEOUS TO EXCHANGE DATA WITHIN CGPC? Yes No
23. WOULD IT BE ADVANTAGEOUS TO EXCHANGE DATA WITHIN CARICOM? Yes No

24. WOULD IT BE ADVANTAGEOUS TO EXCHANGE DATA BEYOND CGPC/CARICOM? Yes No
 If Yes, where: _____

25a. DO YOU REQUIRE SECURITY OPTIONS TO PREVENT OTHER COUNTRIES FROM ACCESSING RESTRICTED DATA? Yes No

25b. IF YES, PLEASE SPECIFY WHICH DATA YOU NEED TO RESTRICT _____

26. WHICH DATA WOULD YOU LIKE TO EXCHANGE?
- Import volume
 - Import value
 - Export volume
 - Export value
 - Data by Active Ingredient
 - Data by Brand Name
 - Registered pesticides
 - Banned pesticides
 - Pesticide toxicity
 - Pesticide application rates/timing
 - Target species of pesticides
 - Other (specify) _____

REPORTING

27a. DO YOU NEED TO REPORT BY PESTICIDE REGISTRATION DETAILS? Yes No
 If No (specify) _____

- 27b. IF YES, WHAT DETAILED DATA DO YOU NEED TO PRODUCE PESTICIDE REGISTRATION REPORTS? D [] Type of registration
[] Type of pesticide
[] Purpose of pesticide
[] Applicant
[] Agent
[] Active Ingredients
[] Licensed premises (retail)
[] Licensed premises (trade)
[] By Pesticide Control Boards
[] Other (specify) _____
- 28a. DO YOU NEED TO REPORT BY PESTICIDE DETAILS? T Yes []
No []
If No [] (specify) _____
- 28b. IF YES, WHICH DATA DO YOU NEED TO PRODUCE PESTICIDE REPORTS? O [] Trade name
[] Active Ingredient
[] Target pest species
[] Crop type
[] Toxicity by Trade Name
[] Toxicity by Active Ingredient
[] Critical information by Trade Name
[] Critical information by Active Ingredient
[] Rate of application by Trade Name
[] Other (specify) _____
29. DO YOU NEED TO KNOW OF PRIOR REGISTRATIONS OF SIMILAR PESTICIDES? OF OF Yes []
No []
- 30a. DO YOU NEED TO MAKE STATISTICAL QUERIES? Yes []
No []

- 30b. IF YES, WHICH STATISTICAL QUERIES?
- Database statistics
 - List of current registrations
 - List of current applications
 - Expiry dates of registrations
 - Revenue from applications for permit
 - Revenue from registrations of pesticide
 - Import statistics
 - Export statistics
 - Other (specify) _____

31. DO YOU NEED TO MAKE ANY OTHER FORM OF REPORTING? PLEASE GIVE DETAILS

ADDITIONAL FEATURES

32. WOULD YOU USE A GLOSSARY OF 'IT TERMS' IN THE DATABASE?
- Yes
- No
33. WOULD YOU USE A GLOSSARY OF PESTICIDE TERMS IN THE DATABASE?
- Yes
- No

SECTION 3: NON-FUNCTIONAL REQUIREMENTS

BACK-UP AND RESTORE

34. DO YOU REQUIRE BACK -UP AND RESTORE OPTIONS ON THE MENU IN THE DATABASE? Yes No

SECURITY

35. DO YOU REQUIRE OPTIONS FOR MULTI-USER DATABASE USE? Yes Indicate number of users _____
No

36. WHAT INFORMATION WOULD YOU WISH RESTRICTED/KEPT WITHIN COUNTRY?
Please detail. _____

APPLICATION

37. WHAT IS YOUR PREFERRED INTERFACE FOR THE DATABASE? Windows
 DOS
 Other (specify) _____

DOCUMENTATION

38. WHICH OF THE FOLLOWING WOULD BE PREFERRED FOR THE DATABASE?
 Published User Manual
 On-line help
 Electronic Manual
 Technical Manual
 Combination of above (specify) _____

 Other (specify) _____

TRAINING

39. DO YOU HAVE STAFF FAMILIAR WITH DATABASE ADMINISTRATION? Yes No

40. DO YOU ENVISAGE A SPECIALISED TRAINING PROGRAMME FOR THE FOLLOWING:
- Database administration
 - Database entry
 - Database management
 - Other (specify) _____

OTHER INFORMATION

41. DO YOU HAVE ANY OTHER COMMENTS THAT YOU WISH TO NOTE HERE?
- _____
- _____
- _____
- _____
- _____
- _____

Thank you for completing this questionnaire and we look forward to sharing the results of the UR analysis with you.
Please return to Nicole Kenward at n.Kenward@ic.ac.uk (postal address: MRAG Ltd, 47 Princes Gate, London, SW7 2QA, UK, fax: +44 207 823 7916)