Project no. 022704 (SSP)

FOOTPRINT

Functional Tools for Pesticide Risk Assessment and Management

Specific Targeted Research Project

Thematic Priority: Policy-orientated research

Deliverable DL26

Beta version of FOOT-FS

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PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	**X**
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Foreword

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The present report was prepared within the context of the work package WP5 (Development of functional tools) of the FOOTPRINT project (http://www.eu-footprint.org).

The attention of the reader is drawn to the fact that the FOOT-FS tool is under continuing development and that the features and screenshots presented in the present document are likely to change by the time the final software is released at the end of 2008.

The preferred reference to the present document is as follows:

Lewis K.A. & Tzilivakis J. (2007). The Beta version of FOOT-FS. Report DL26 of the FP6 EU-funded FOOTPRINT project [*www.eu-footprint.org*]. 17p.

Executive summary

The FOOTPRINT FOOT-FS tool is mainly intended for use at the farm scale by extension advisers, farmers, agronomists and other individuals interested in evaluating the risks of pesticides polluting surface water and groundwater. It aims to assist in the development of environmentally-sound pesticide strategies for the farm by identifying the activities and pathways that most contribute to the contamination of water resources. It also provides site-specific recommendations for best practice and mitigation options to limit transfers of pesticides in the local agricultural landscape.

The present document describes the first working version (beta version) of FOOT-FS. It describes the functionality and style of the software. The under-pinning science, modelling and calculus used in the software have been described in previous FOOTPRINT deliverables and are thus not be repeated in the present document.

The FOOT-FS tool itself is a collection of modules and tools that can be used independently of each other but, more usually, are collectively managed from within a simple software shell (FOOT-FS shell) which is driven by a series of navigation menus. The facilities available include:

- A collection of modules used to collect and manage user data. These modules include facilities to describe the pesticides applied, the equipment used, cropping, local landscape and environmental characteristics, climate and soil type.
- Modelling and calculation routines.
- Reporting and interpretation routines which include advice on mitigation options and the ability to explore 'what if' scenarios.
- A collection of tools designed to support the end user and enhance the functionality of the software. These include: multi-lingual facilities, support and guidance tools, a point source pollution auditing system, access to the FOOTPRINT Pesticide Properties Database and system set-up options.

1   INTRODUCTION

1.1   Purpose of this document

FOOT-FS is a farm-level software tool to assess the risks of pesticides polluting surface water and groundwater and to provide information on the opportunities for mitigation. It is being developed by an international consortium of European researchers as part of the FOOTPRINT (Functional tools for pesticide risk assessment and management) project (Project #022707) funded by the European Commission via the Sixth Framework Programme.

The present document describes the beta-version of the tool, how the individual parts of the software operate, and interface. It also provides a description of the purpose and functionality of the developed software and the facilities that are currently available to end users. A 'beta' version of a software system is a fully developed and functional version but one which has not been tested or evaluated. Consequently, the functionality and style described within this document may require modification depending on the outcomes of the piloting and evaluation programme.

## 1.2   Overview of FOOT-FS

FOOT-FS is the FOOTPRINT farm-scale tool and is mainly intended for use by extension advisers, farmers, agronomists and others interested in evaluating risks at the field level. It aims to assist in the development of environmentally sound pesticide strategies for the farm by identifying the activities and pathways that most contribute to the contamination of water resources. The system also provides site-specific recommendations for best practice and mitigation options to limit transfers of pesticides in the local agricultural landscape.

FOOT-FS will be available in two formats. First, a stand-alone software system will be developed in Microsoft Visual Basic. The first full version of this software, i.e. the 'beta' version, is described in this document. In addition, a web portal to the FOOT-FS system will also be developed. The latter format, the web portal, is as yet undeveloped, but will take the form of a dedicated website. Users will be able to use simplified means of providing the data required to run FOOT-FS, for example spreadsheets or word documents. The data will then be used remotely to perform the modelling calculations and interpret the data. The results and their interpretation will then be returned back to the user via email or similar route. Alternatively, it will be possible to download tools for data collection and upload data files back to the website, again for remote use of FOOT-FS.

The stand-alone software tool itself is a collection of modules and tools that can be used independently of each other but, more usually, are collectively managed from within a simple software shell (FOOT-FS shell) which is driven by a series of navigation menus. This approach breaks the modelling and risk assessment process down into a number of discrete steps thus making it easier to use. A schematic of the system is given in Figure 1. The facilities available include:
-    A collection of modules used to collect and manage user data. This is known as the 'My Data' section. These modules include:
      ▪   The Pesticide Manager that collates information on pesticide programmes. This includes the Brand Manager that allows data to be managed via their brand name as opposed to the active substance chemical name.
      ▪   The Equipment Manager. This gathers and stores information on the types of spray equipment and nozzles used.

- The Field Scenario Builder. This module collects information on the local landscape and environmental characteristics (climate, soil etc).
- Data in the 'My Data' section is fed in to the main modelling and calculation routines. These are known as the FOOT-FS 'Assessment routines'. These include:
  - The interrogation routines which select and interpolate the appropriate data from the meta-model database.
  - Calculation routines that determine Predicted Environmental Concentrations (PECs) in local water bodies, Time Weighted Average Concentrations (TWACs) and Toxicity Exposure Ratios (TERs) for a range of aquatic fauna and flora (fish, aquatic invertebrates, algae and higher aquatic plants for both acute and chronic effects).
  - Drift, run-off, erosion and leaching risk assessments.
  - Metabolites routines.
  - Reporting and interpretation routines which communicate the model results to the user.
- The FOOT-FS 'Toolbox' includes a range of tools designed to support the end user. These include:
  - Support and guidance tools,
  - A point source pollution auditing system,
  - Access to the FOOTPRINT Pesticide Properties Database (see Deliverable DL24),
  - System set-up options and multi-lingual facilities,
  - Updating and upgrading facilities.
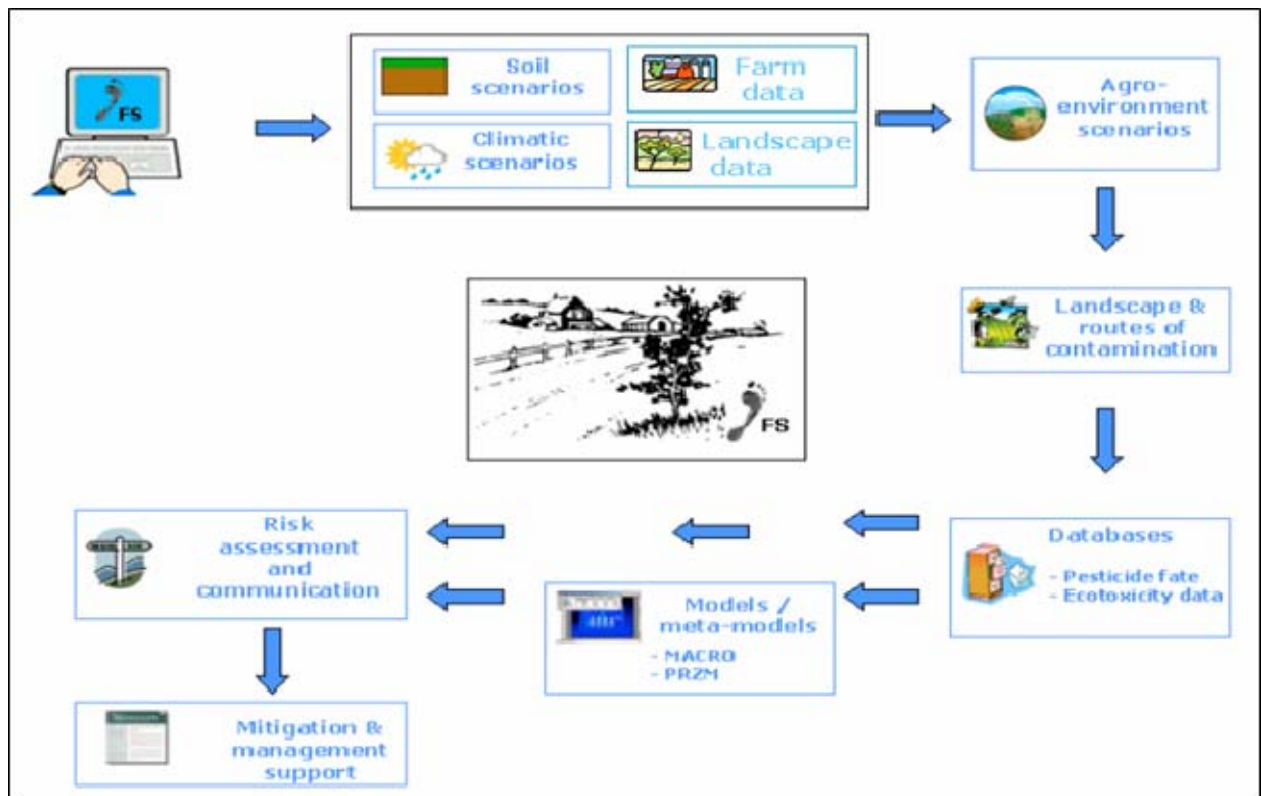
**Figure 1: The FOOT-FS Shell Schematic**

2   FOOT-FS DEVELOPMENT

FOOT-FS has been developed using the Visual Basic version VI programming language. Databases have been constructed in MS Access 2000. The interface between Visual Basic and MS Access is seamless. The FOOT-FS system has been developed in a modular format. Each module has a distinct purpose (e.g. collation of specific data from the user such as soil types and pesticide inputs) and operates both as a stand-alone system and as an integral part of the shell. This approach provides several advantages:

- FOOT-FS is a sophisticated and quite complex risk assessment system and, as such, requires a considerable amount of input data. This modular approach breaks the task down into small steps and helps simplify this input. Not all data need be input into the system at once and data can be stored and used again in different risk assessment scenarios or exploring 'what-if' questions. For example 'What happens if I use Pesticide Programme 2 on field X rather than Pesticide Programme 5?'.
- This approach has allowed project partners and other stakeholders to view and test the different modules as they have been developed rather than wait for the full system to be functional.
- It has allowed individual modules developed specifically for FOOT-FS to also be used by FOOT-CRS and FOOT-NES.
- The modular approach will also allow for simpler and more efficient maintenance and upgrading in the future. If a specific module needs attention, only that particular module will need replacing.

3   THE BETA VERSION OF FOOT-FS

3.1   The FOOT-FS Shell
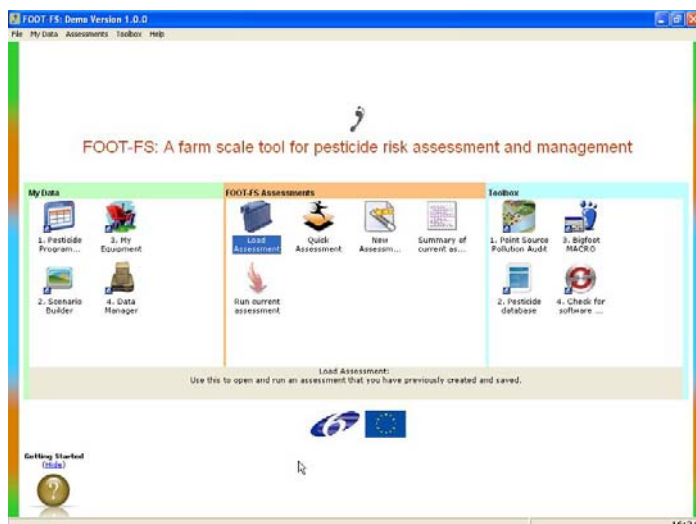
Figure 2: THE FOOT-FS Shell

The FOOT-FS Shell provides access to all the FOOT-FS modules and facilities and delivers the user input data to the modelling, risk assessment and reporting routines.

Broadly speaking the shell has three main sections:
1. Facilities to collate, check, format and store data provided by the user, which is then used to drive the risk assessments. This section is known as 'My Data'.

2. Routines to run the assessment and then deliver the results to the user in an appropriate format. This section is known as the FOOT-FS 'Assessment Routines'
A collection of tools (the 'Toolbox') which are designed to help the user get the most out of the software and which extends and enhances its functionality.

3.2   Data collation using 'My Data' modules
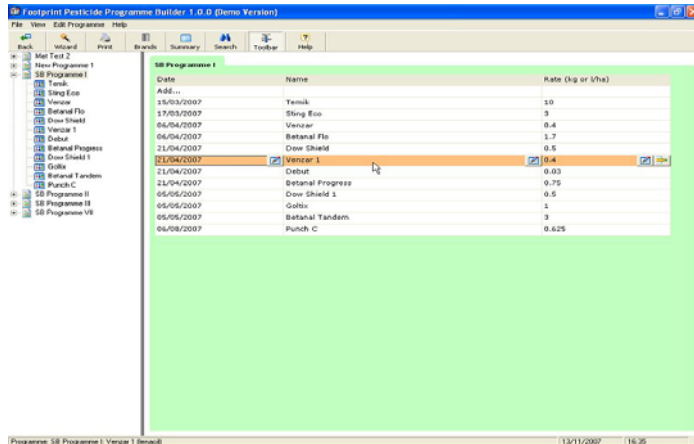
3.2.1. Pesticide Programme Builder

Figure 3: The Pesticide Programme Builder

The Pesticide Programme Builder allows the user to create a list of pesticides that are to be applied to a field. The programme consists of:

- The product applied
- The date of application
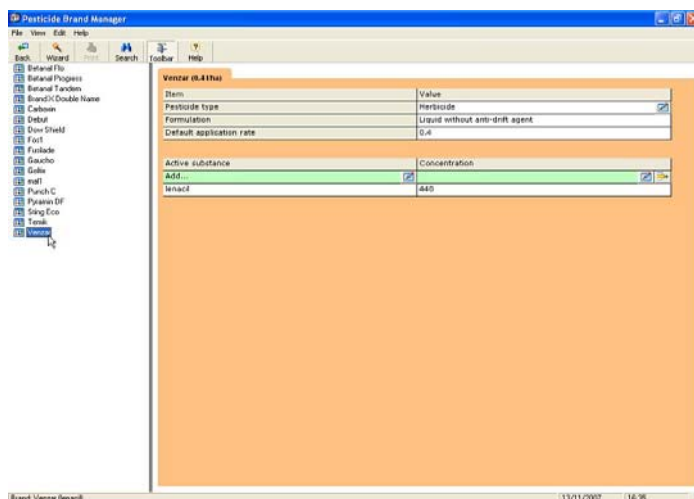- The rate of application (kg or l/ha)

Figure 4: The Brand Manager

To support the process the user can set up a number of pesticide product 'brands'. Each brand consists of:
- A distinctive name e.g. the brand name
- The active substances the brand contains
- The proportion of those active substances in the product (g/l or % w/w)
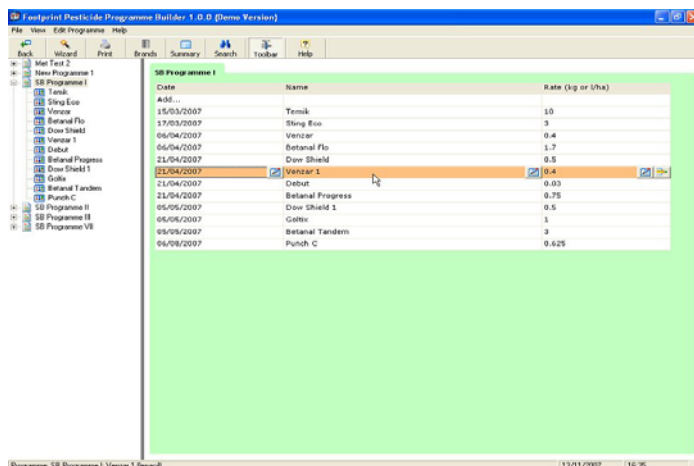- The typical application rate.

Figure 5: The Pesticide Programme Manager

Thus when a user is creating a pesticide programme, as they select the product/brand all the details about the active substances and amounts are transferred in the programme without the user having to re-enter them - they only need to adjust the application rate if required.

Once a user has created a pesticide programme it can be copied, deleted or amended - allowing the user to rapidly build-up variations of programmes.
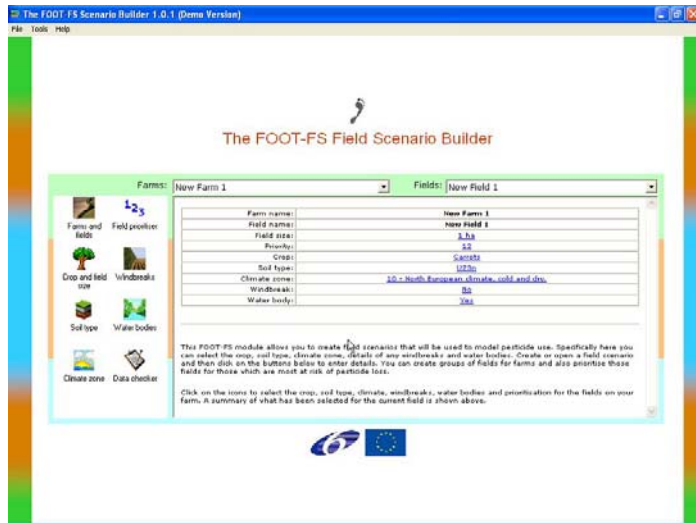
3.2.2. The Field Scenario Builder

Figure 6: The Field Scenario Builder

The Field Scenario Builder provides the user with a facility to build up a collection of farms and fields and record information about each field including:

- The crop being grown and the field size
- The soil type
- The climate zone
- Windbreaks (field bordering vegetation)
- Water bodies

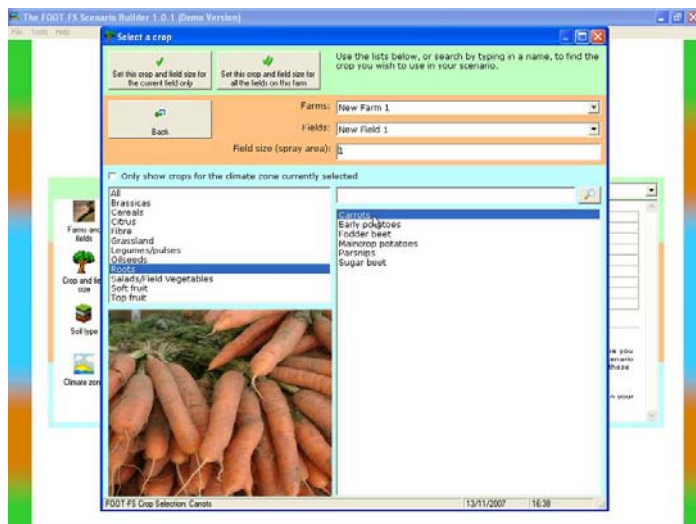This information is then used by the FOOT-FS risk assessment routines and mitigation reviews.

Figure 7: The Cropping Manager

The Cropping Manager is a facility which allows the user to select a crop from the list of about 80 crops.

In this tool each crop also has an associated picture of the crop to aid with crop selection across Europe (where common names could differ and thus cause confusion).

The user also enters the size of the field when they select the crop.

If the user has already selected a climate zone (see below) then the software checks to see if the crop they have selected is actually grown in this climate zone and alerts the user if the crop does not exist. Alternatively the user can select an option to only display crops that can be grown in the climate zone they have selected.

Figure 8: The FOOT-FS Soil Selector

The Soil Type Selector provides an electronic form of a complex questionnaire / flowchart which guides the user through to selecting one of over potentially 900 soil types. This process has been streamlined and is completed via a maximum of 7 questions. The soil selection process also identifies the Flow Pathway Category (FPC). (See Deliverable DL8)

There is also the option to provide definitions, a glossary and further information about some of the scientific terms used within the questionnaire.
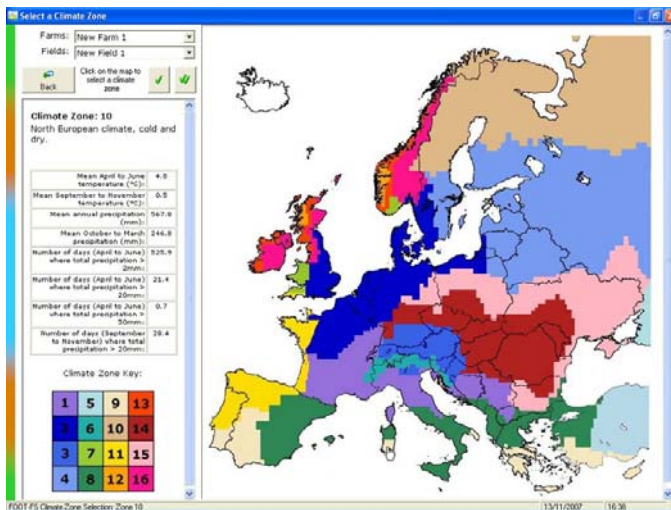

Figure 9: The FOOT-FS Climate Zones

Selection of the Climate Zone is achieved via a 'clickable' map of Europe showing the 16 FOOTPRINT climate zones (FCZs). (See Deliverable DL9). The user simply clicks on the map with their mouse and details regarding the climate zone are displayed on the left. The FCZ can then be selected as required.

If the user has already selected a crop (see above) then the software will check to see if crop can be grown in the climate zone selected - if it can't be grown then the user is alerted.
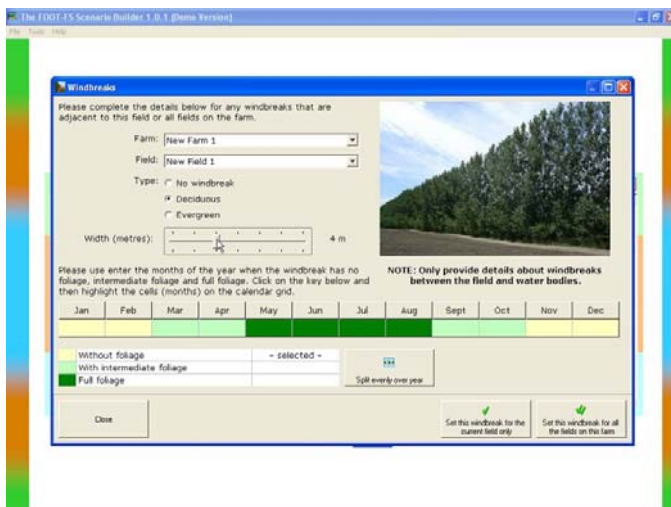

Figure 10: Entering Data on field-bordering vegetation

Data on field-bordering vegetation is required in order to assess the risks from spray drift and for evaluating potential mitigation options. A facility to enter details about any vegetation that exist between the field and any water bodies adjacent to the field (see below) is provided within FOOT-FS. The details of the vegetation include whether it is deciduous or evergreen and its width (2-8m).

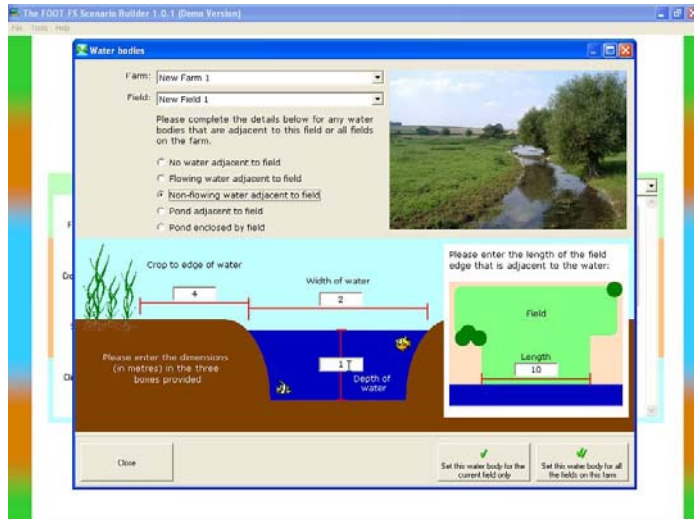The pictorial layout of the screen aids the user to identify the data required.

Figure 11: Entering Data on Water Bodies

Details of any surface water bodies are also required by the calculation routines. A graphical facility is provided allowing the user to enter details of surface water bodies close to the field being evaluated. Data required includes:

- Water body type – stream, ditch, pond etc.
- Physical dimensions – width, depth etc.

The pictorial layout of the screen aids the user to identify the data required.
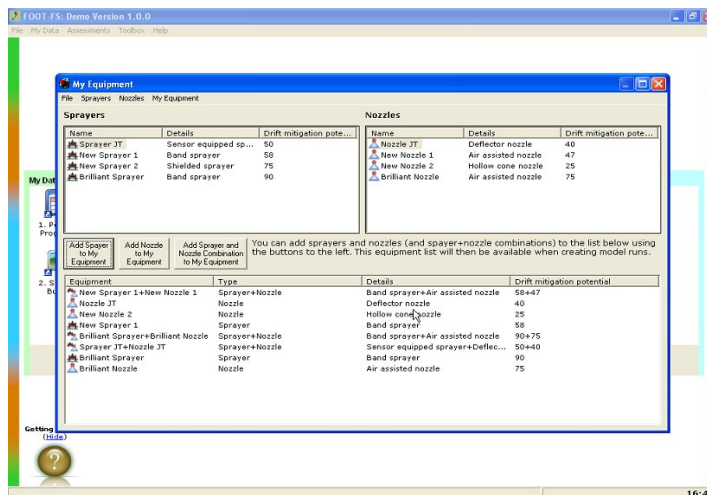
3.2.3. Equipment used

Figure 12: The Farm Equipment Manager

In order to determine mitigation options it is necessary for the user to supply details of equipment used to apply the pesticides and what other equipment they might have available. The Farm Equipment Manager allows the user to build up a list of sprayers and nozzles that they have available for applying pesticides. This list is then available when the user creates a risk assessment - they can simply select the sprayer and nozzle (or sprayer/nozzle combination) they wish to use for each product in the pesticide programme.
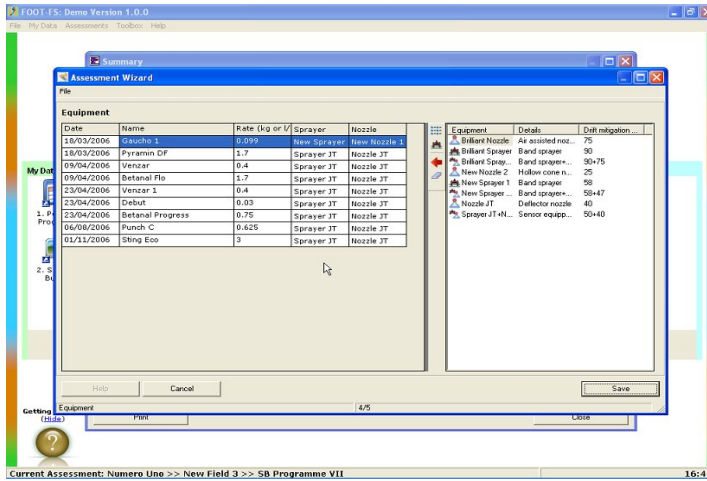
Each sprayer and nozzle has a drift mitigation potential attached to it. This relates the rating of the equipment to how much drift it causes when applying the pesticide.

Figure 13: Farm Equipment Manager – entering data

The Field Scenario Builder also has a simple system for prioritising fields according to the relative risk they present in terms of potential loss of pesticides. This is a simple system designed to focus attention on those fields that are in need of risk assessment modelling or those that should be assessed first. It uses a simple scoring and ranking technique that takes into account basic field information regarding its location with regard to the water body, field topography and drainage etc.

The Field Scenario Builder also has a Data Checker. This facility displays all the fields for the farm currently selected and shows where data have yet to be entered. This helps the user ensure that they have entered all the information required for risk assessment modelling. The Field Scenario Builder also has a facility for managing farms and fields. This allows users to create new farms and fields, delete them or rename them.

3.3 FOOT-FS assessments and reporting

3.3.1 Starting the assessment

Within this section the user can construct risk assessments by selecting a combination of a field description (from the Field Scenario Builder), a Pesticide Programme and an Equipment Programme.
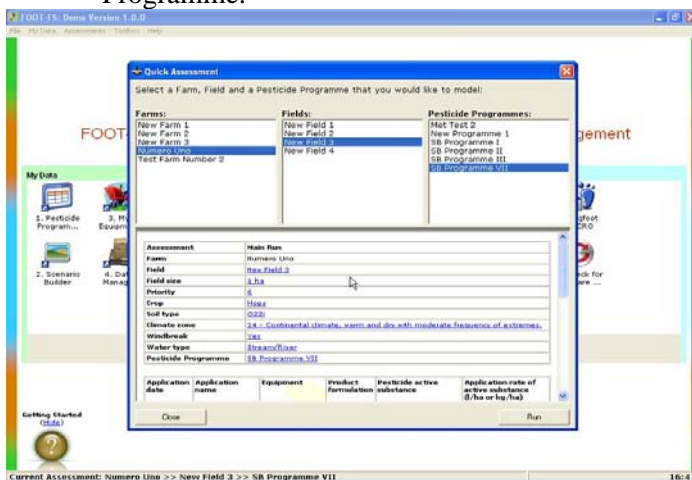
This selection process can be done by using one of two options:

1. Quick Assessment Tool. This option allows a risk assessment to be carried out very quickly but does not store input data against a 'named' assessment run. The data is, however, kept in the 'My Data' files.

New Assessment Wizard. This option will save a record of the input data used in the assessment. The user provides the name for the assessment and this can then be opened again in the future using the 'load assessment' facility.

Figure 14: The 'Quick Assessment' option

Once a user has created an assessment they can view a summary of all the information within the assessment by clicking on the 'Summary of the current assessment' facility. This displays a screen with all the relevant input data shown. The user can edit any of these data by clicking on the appropriate hyperlink and this will then open the appropriate data input tool (e.g. Field Scenario Builder or Pesticide Programme Builder) to edit the data.

Clicking on the 'Run current assessment' button will start the risk assessment modelling.

The calculas undertaken is described in Deliverable D23. It includes the following processes:
- Calculations of Predicted Environmental Concentrations (PECs) and Time Weighted Average Concentrations (TWACs) for surface waters from spray drift, runoff and erosion including losses from sediments.
- Predicted groundwater concentrations from leaching.
- The consideration of significant metabolites.
- Calculations of Toxicity : Exposure ratios (TERs) for fish, aquatic invertebrates, higher aquatic plants and algae. Both acute and chronic endpoints are considered where data exists in the FOOTPRINT Pesticide Properties Database (PPDB). Mesocosm studies are also included where these are reported in EU data dossiers for inclusion into Annex 1 of Council Direct 91/414/EEC.
- Conversion of TERs to FOOTPRINT 'Risk Scores' for simplifying interpretation.

3.3.2   Reporting

There are several options available for reporting and interpretation of the risk assessment results. The actual format utilised is governed by the options selected in the FOOT-FS set-up routines available in the FOOT-FS Toolbox (see Section 3.4). These included very simple graphical indications of the risk and mitigation options which might be the most appropriate format for farmers to the full modelling data (including PECs, TERs and risk) which might be required by researchers carrying out field level environmental impact assessments.
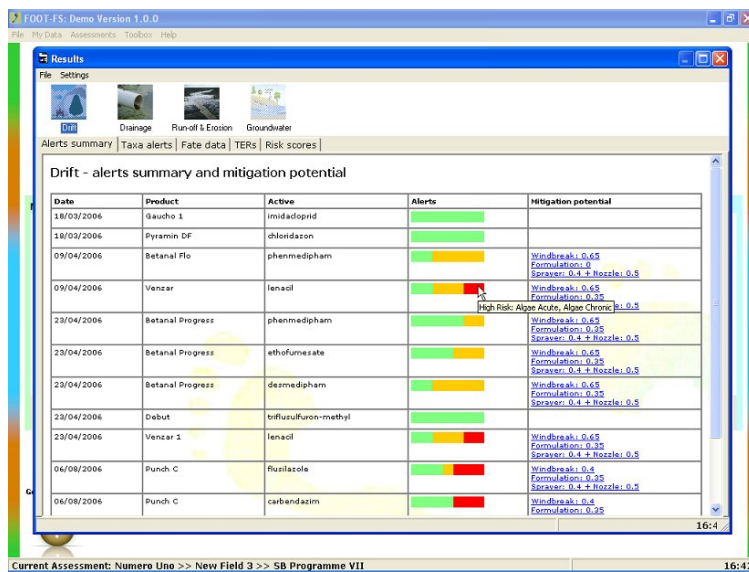

This screen illustrates an output option where the user has selected to view the full risk assessment results for drift. A screen is shown displaying a range of detail including the risk scores, toxicity-exposure ratios (TERs), fate data, taxa toxicity icon alerts and a summary of risk alerts.

Mitigation options are also displayed - showing the drift reduction potential which is available from changing the product formulation, the type of windbreak; or the equipment.

Figure 15: Reporting the Modelling Results in detail.

Clicking on the relevant mitigation hyperlink will open the appropriate data management tool. The user can then change the data and when complete the risk assessment model will run again and display the result based on the changes made.
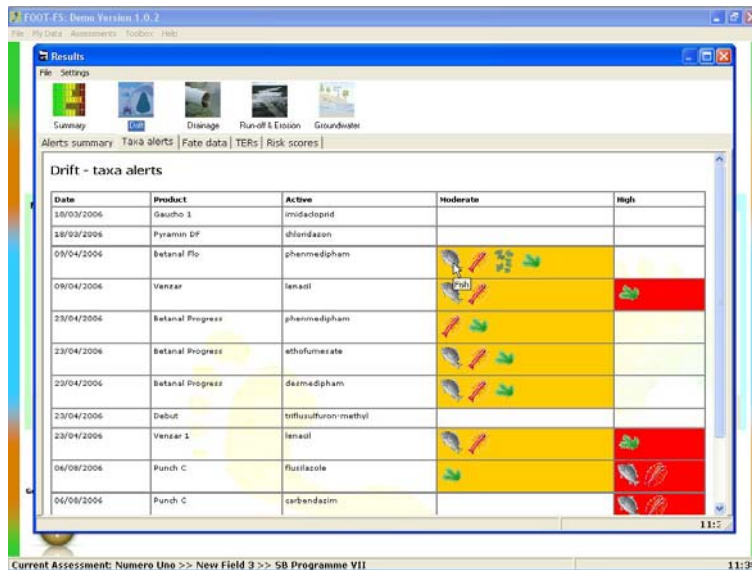
For those users wishing a more simplified report this format utilises an icon approach to highlighting the risks to different taxa. The individual icons show where a high (red) risk or a moderate (orange) risk has been identified to fish, aquatic invertebrates, algae or higher aquatic plants.

Figure 16: Simplified reporting.
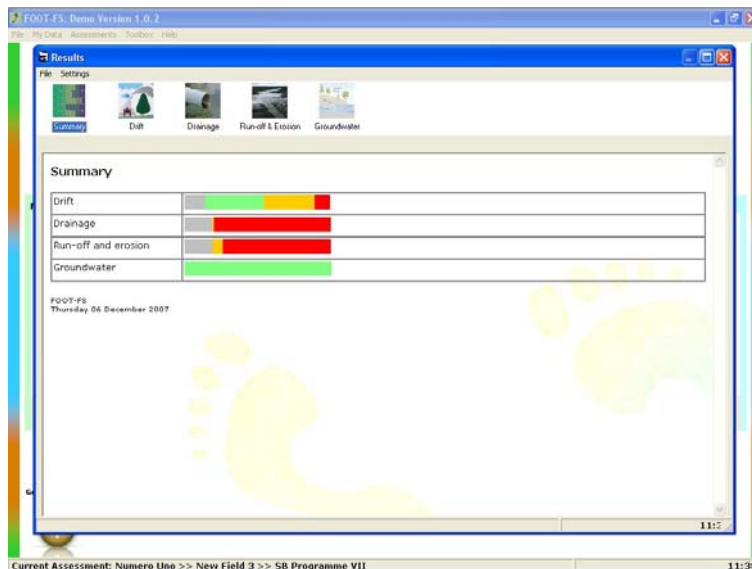
Data can be further summarised on the basis of pollution pathway. Here the risks for the different actives applied and the different aquatic taxa are aggregated and classified by colour coding.

Red – high risk identified
Orange – moderate risk
Green – acceptable risk
Grey – inadequate data to determine risk

Figure 17: Reporting the modelling results as a summary.

3.4   The FOOT-FS Toolbox
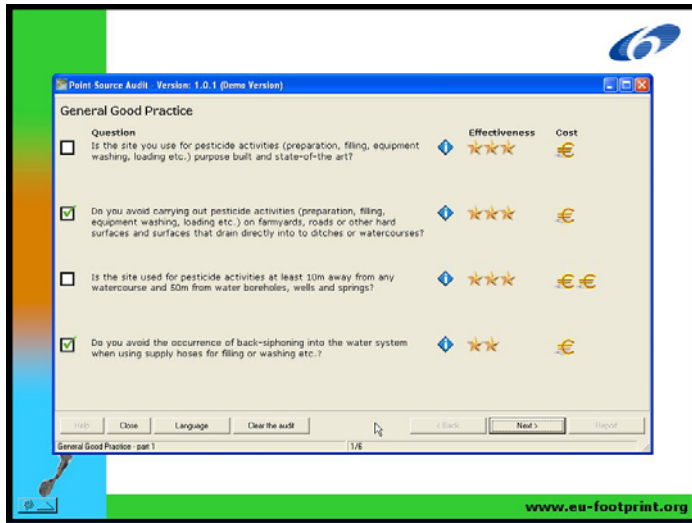
3.4.1. Point Source Pollution Audit

This tool provides a simple 'stand-alone' check-box questionnaire to assess the practices on the farm in relation to the potential risk of causing point source pollution from pesticides. It covers general practices, pesticide storage, preparation and waste management. The user simply 'ticks' the boxes that apply to their practices.

The Information Icon provides access to various additional information specific to the question including best practice definitions and photographs.
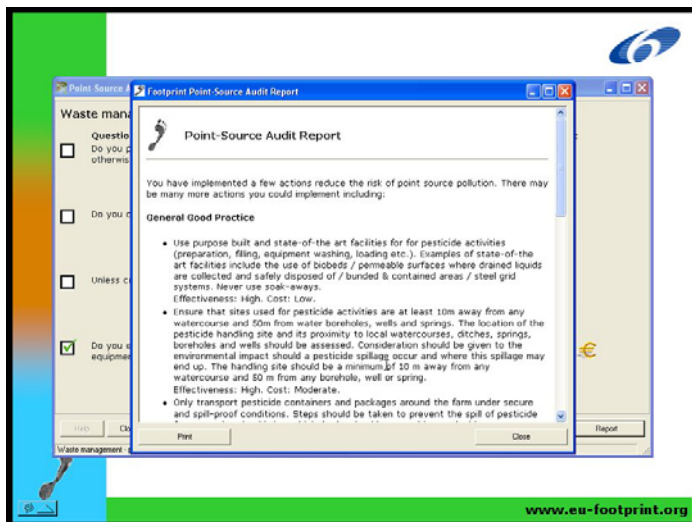
Figure 17: The Point Source Pollution Audit

When complete a report is displayed highlighting where improvements could be made and the likely cost and effectiveness of implementing the suggested practices.

Figure 18: The Point Source Pollution Audit Reporting

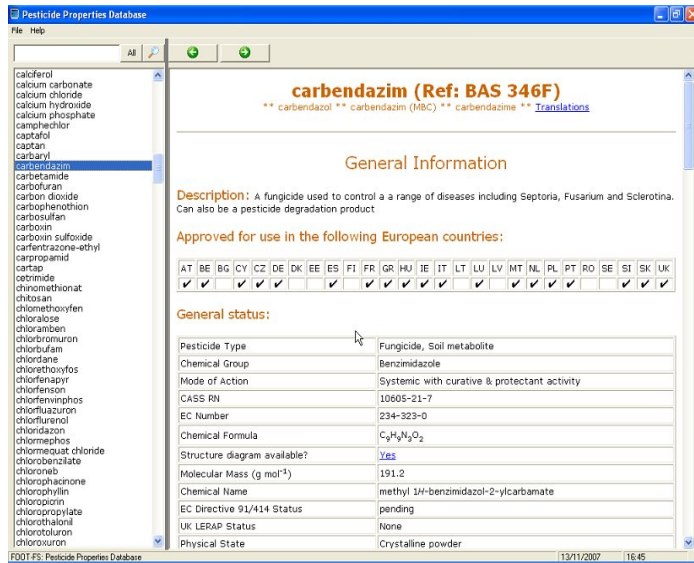## 3.4.2. FOOTPRINT Pesticides Properties Database (PPDB)

Figure 19: The Pesticide Properties Database

The FOOTPRINT Pesticide properties Database (PPBD) is described in detail in FOOTPRINT deliverable DL24.

This facility provides direct access to the PPDB via the FOOT-FS Shell.

The user can choose to either access the online version of the database - which is then displayed in a web browser - or they can view the database that is installed locally on their PC as part of the FOOT-FS software. Viewing the local database will display the pesticide data that is used within the risk assessment modelling. Viewing the online database will display the most up-to-date data for the pesticide as it is updated on a daily basis.

Access to the local database is provided using a simple interface. Down the left side of the interface is an 'A to Z' of all the pesticides in the database. Clicking on an item in the list will show the data for that pesticide on the right. The user can also search for a pesticide by entering a search term in the top left and clicking on the search button.

3.4.3. FOOT-FS set up facility and language interface

The software has many default settings which help simplify its operation. This facility allows the user to over-ride some of these setting:
- Default fate and toxicity parameters taken directly from the PPDB can be over-ridden with the users own data.
- Change the operating language. (NB. This is not available in the beta version of the software as, to avoid repeating the exercise, it can only be produced when the final version is agreed).
- Select various options for displaying the modelling and interpretation data. Options range from simple graphical and pictorial/icon representations of the data to the full quantitative modelling results including Toxicity : Exposure ratios (TERs), Predicted Environmental Concentrations (PECs) and risk scores. These can all be displayed for each active substance applied to the selected field and any significant metabolites identified.

3.4.4. User support, documentation and user guides

Various facilities for supporting the user and aiding the use of the FOOT-FS tool will be included in the software. This will include:
- Video type presentations of how to use individual modules
- A software updating facility. This tool will check to see the version installed on the users computer is the most current version. If it is not, then the updates available can be displayed and then downloaded from the internet.

- Simple user guides and documentation.

4 UPCOMING WORK

The next stage in the development process of the FOOT-FS software package is its evaluation and piloting as part of Work Package 6. This process will generate feedback regarding: i) the functionality of the software; ii) bugs, crashes and errors; iii) user-friendliness; and, iv) practicability and suitability of the recommendations contained in the tool.

This feedback will then be used to upgrade, polish and refine the FOOT-FS tool. As a consequence the screen shots described within the present document may not be the same as that provided in the final version of the tool. Facilities to change the language and user support and documentation will be added to the system once the final version of the main system is completed.