PIAF

Planning-, Information- and Analysis-System
for Field Trials

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Abstract

PIAF is a program system for the administration of arbitrary factorial trials in the fields of crop farming and plant protection.

The development of PIAF is based upon a model project of the BML (Federal Ministry for Agriculture of Germany) that was carried out by the Institute of Agrarinformatik at the Westfälische Wilhelms-Universität Muenster, together with representatives of individual states of Germany and the BSA (Bundessortenamt). In the context of this model, a standard analysis system for the analysis of single and serial trials was developed.

In phase II of the project, a planning and data recording module will be developed. Contained in this module, are interfaces to the industry and the BSA, reporting capabilities and an analysis module for simple standard trials. The PIAF database contains codes and standards on the basis of the EPPO guidelines and the specifications of the BSA. Phase II is to be concluded in September 1999.

In phase III, the analysis system PIAF 1.1, developed in the model project, will be coupled with the planning and data recording program. Beyond this, a scheduling module on the basis of SAS, an interface for mobile data recording and a module for the harmonization and administration of analysis series will be developed.

The central module of PIAF is the planning and data recording program and the underlying database. Data can be imported, for example, from mobile data recording and exported via interfaces into other systems. In the area of analysis, emphasis was put on the interface to SAS. With the help of PIAF, SAS datasets for single and serial trials can be produced, which can then also be analysed using custom analysis routines.

1 Introduction

1.1 pro_Plant GmbH

In 1989 the „Institut für Agrarinformatik" was founded in Münster as a joint venture between the „Landwirtschaftskammer Westfalen-Lippe" and the „Westfälischen Wilhelms-Universität". Besides the development of a plant protection advisory program the institute carried out a lot of smaller projects which were in connection with the agricultural administration of the „Landwirtschaftskammer" or the consultation activities of German agriculture officials.

In 1996 the pro_Plant GmbH was founded by the members of the staff of the „Institut für Agrarinformatik", the „Landwirtschaftskammer Westfalen-Lippe", the university of Münster and the two directors of the institute. One of the objectives of the foundation was to promote the development of the existing products and to distribute those products.

1.2 History and objective of PIAF

In 1995 PIAF was launched as a model project financed by the BML (Federal Ministry for Agriculture of Germany).

Participating members of the model project were representatives of the German agricultural officials for crop trials, the BSA („Bundessortenamt") as representative for the BML and the „Institut für Agrarinformatik an der Universität Münster". In the model project the representatives of the German agricultural officials for crop trials were responsible for the technical specification whereas the „Institut für Agrarinformatik" was responsible for the implementation of the specification.

The following aspects can be seen as the two main reasons for the launch of the model project:

1. As field trials result in very high costs, the department heads of the agricultural production of the federal state and the provinces have asked for an effective trial system. A cross regional sharing of the collected field data should contribute in cost savings. Up to that time only provinces which had used the same data recording systems have been able to share their data.

2. The data transfer between the provinces and the BSA was based (for 30 years) on interfaces on the basis of punched cards. This system didn't allow any format-driven dynamical data transfer. Therefore many special bilateral agreements between the BSA and the provinces were made and the maintenance of the data transfer became very expensive.

The provinces were using a lot of different systems for data input and statistical analysis of the field data. Many provinces were thinking about developing new systems. Therefore the idea of a common project has positively been appraised.

The aim of the model project was the development of a planning, evaluation and data recording system for field data („Planungs-, Auswertungs- und Informationssystems für das Feldversuchswesen" (PIAF)) for the field of multi crop trials. The system was to be designed to fulfil in form and content the requirements of the BSA. Moreover it should be able to deal with the special requirements of the provinces and be easily adaptable in case of future changes of requirements. In view of this, a universal data model for field trials as a basis for optimal information retrieval and transfer was to be created.

Within the context of the model project an evaluation system for multi crop trials was developed using SAS as tool. This resulted in PIAF 1.1. Included in this system were a number of evaluation routines (e. g. analysis of variance, Duncan, SNK and other tests) for single trials and series. The system is able to deal with one-factorial and a two-factorial plot designs.

For data entry an interface using a standard format of the BSA, which can be written by all data recording systems in the context of multi crop trials, was implemented.

The system is based on a relational database. Data access is implemented via ODBC-drivers. In the context of the model project the database was installed on either an Oracle 7.3 Server or a Microsoft-Access database (2.0 and 7.0).

Besides the development of the program modules the codes used for multi crop trials have been revised. Moreover the code was harmonised for all provinces of Germany.

The development work for the model project was completed on 31th of March in 1998.

The work on a concept for a planning and data recording system started in 1996. This system was supposed to be based on the universal data structure of PIAF and was intended to replace many of the existing data recording systems. For this purpose a project team was established. Members of this project team were representatives of the plant protection offices, the chemical industry and the pro_Plant GmbH.

In spring 1998 pro_Plant was contracted to develop a data recording program for the official test of preparation. The project was financed by the IVA ("Industrieverband Agrar). Besides the gathering of the necessary master data for plant protection trials and the development of the data recording program, the contract included the implementation of an interface which could write an EDE-formated (electronic data exchange format) file and a standard trial report for the official test of preparation. The systems objective was to establish a consistent reporting of trial data in electronic form and on paper.

In the summer of 1998, in addition to the first contract, an order for the development of a planning and data recording program for multi crop trials ("Pflanzenbau") was placed. The numerous similarities between plant protection trials and multi crop trials were to be regarded and should result in a consistent user interface for all kind of trials.

In July 1999 the data recording system for plant protection officials was finished and distributed to the officials. The completion of the planning and recording system for the multi crop trials is due in December 1999.

Concerning the development of the two systems many functions (e. g. forms for planning and data recording, import, export, forms for master data maintenance) were implemented only once and used in both systems. Moreover, the integration of static data for both fields was pushed forward.

Since 1998 more modules have been ordered. These include summaries of trials and series, a connection of the program to SAS PIAF 1.1, retrieval functionality, an interface for mobile data input and the maintenance of evaluation series in the data model.

2 PIAF structure

2.1 Overview about PIAF
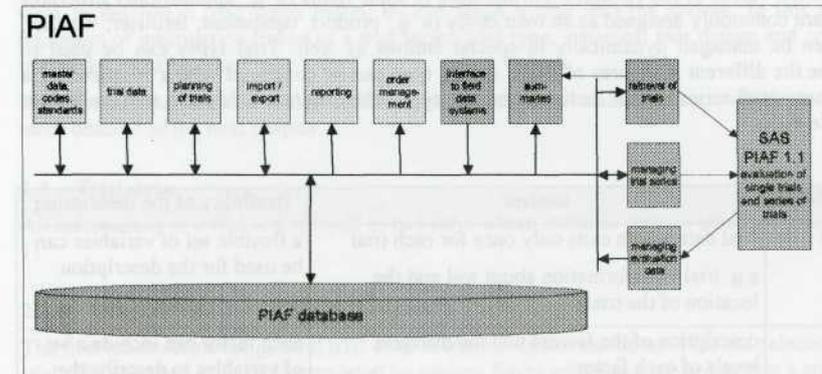
Figure 1: The PIAF system

Figure 1 shows the system architecture of PIAF. PIAF is a Client-server application based on a relational database including different modules for the management and evaluation of trials. For complex evaluations an interface to the statistic tool SAS is included in PIAF. The further chapters will explain the PIAF-System. Exemplary for the structure of PIAF the trial form will be explained more detailed.

2.2 Main structure of the system

The main components of PIAF are the trial types, the trial series and the trials. In this chapter this different components will be explained.

Figure 2: The main structure

2.2.1 Trial types

One feature of PIAF is the flexibility it offers for the description of trials. This flexibility can be achieved by defining only some fixed structures in the dynamic field of the data model. Many of our describing attributes can be stored as a record in special tables containing the Id's and the values of the variables. Furthermore in some fields (e. g.: applications) structures which are commonly designed as an own entity (e. g.: product, equipment, fertiliser, weather, soil) can be managed dynamically in special entities as well. Trial types can be used to describe the different structures of trials. A trial type can be compared with a template for a trial. Every trial series or trial includes one trial type. The different fields of a trial are shown in Table 1.

trial field	content	flexibility of the description
general trial data	trial data which exits only once for each trial e.g. trial id, information about soil and the location of the trial	a flexible set of variables can be used for the description
factors	description of the factors und the different levels of each factor	each factor can include a set of variables to describe the different factor levels
timing overview	overview about all timings which has been used in the field of timing data, application data or raw data / calculated data	
timing data	description of timing data where only one record is needed for the description e. g. equipment, soil and weather at the day of application	different timing fields can be defined each timing field can include a set of variables
application data	description of the products of an application or maintenance applications which allows more than one record for each timing (e. g. tank mixes), in the case of applications a record refers to a factor level	different applications can be defined each timing field can include a set of variables
plot design	description of the plot and the plot design	
raw data / calculated data	includes the description of the assessment types and the raw data /calculated data of the different assessments	default sets of assessment types can be defined
comments	general comments and comments referring to a factor level (e. g. treatment)	

Table 1: Trial structure

2.2.2 Trial series

Trial series can be used for the planning of trials. The structure which is defined by the assigned trial type can be modified by adding or deleting variables in different fields. Furthermore defaults for a trial (e. g. values of all included variables, assessment methods or

activities) can be given. In some cases (factor levels, assessment methods) it is possible to vary between different trials of a trial series.

2.2.3 Trial

Every trial is assigned to a trial series. Sometimes a trial is not planned and a user does not want to describe a trial series before he can insert a trial into the system. In this case a minimum of information (name of a trial series, trial type, statistical plot design and crop) of trial series must be described.

The general structure of a trial is similar to the structure of trial series and will be described more detailed in the next chapter.

2.3 Trial data

All information of a trial is displayed in one form which includes various tabs (see also Table 1)

2.3.1 General trial data ("Versuchsdaten")

The first tab contains the general trial data. A trial navigator can be used for the selection of a trial. The selection of trials is supported by various filters which can be used within a query.

In Figure 3 and Figure 4 two examples for a one factorial herbicide trial and a multi factorial crop trial are displayed.

Figure 3: Tab general trial data for a one-factorial herbicide trial

Figure 4: Tab general trial data for a multi factorial crop trial

The left side contains attributes of a trial which are the same for every trial (e. g. trial series, location, trial Id, objective, responsible person, statistical design). On the right panel the variables which are defined within the trial type are shown. The description of the variables also includes the location within the form. The variables and the location can differ a lot between different trial types (see Figure 3 and Figure 4).

In the master data field of the database codes can be assigned to a variable. In this case a choice list is available for the data input. Other variables can have a format (e. g. number, char) a field length and range values which are checked during data input. Furthermore variables can be defined as mandatory. All this possibilities are always available whenever dynamic variables are used in the system.

If necessary, the variables and the location of the variables can be modified individually within a trial. This function can be used when a user wants to give information which is usually not necessary within this trial type.

2.3.2 Trial factor ("Faktoren")

Figure 5: Tab trial factor

The following tab contains the factors and factor levels of a trial. In this case one factor ("Herbizid") with 12 factor levels is defined. If a factor is a treatment, further particulars can be inserted on the application tab. If necessary, variables like variety and seeding date can be defined to describe a factor level in more detail.

2.3.3 Trial timing ("Termine")

Figure 6: Tab trial timing

The tab timing contains an overview about all timing records which are used within the activities of a trial. Activities can be applications, estimations cuttings and harvest dates.

Timing records can be defined as a default in trial series. Usually at trial series level the date of a timing record is not known and will be inserted at trial level. The planned crop stage often is known at trial series level and can be defined. Furthermore each timing record can get a description at trial series or trial level.

2.3.4 Timing data ("Angaben zum Termin")

Timing data like weather, soil or equipment data is managed on the next tab. The different fields and their variables can again be defined within a trial type. By inserting new timing data an existing timing record can be used or a new timing record can be defined. A new timing record will be shown afterwards in the timing overview.

2.3.5 Application ("Behandlungen")

Figure 7: Tab trial application

Figure 7 shows the application tab. The structure of applications is similar to the timing data structure. With a radio group the user can switch between maintenance applications and applications referring to various factor levels. The used application fields (e. g.: fertiliser, fungicide, herbicide) and their variables are again defined within the trial type.

It is always possible to store more than one product for one application (e. g. tank mix).

2.3.6 Plot design ("Lageplan")

Figure 8: Tab general trial data for a one-factorial herbicide trial

The tab plot design contains the description of the plots and the plot design (see Figure 8). The plot design can always be created or modified manually by a user. Furthermore there are some more functions to create a plot design.

- a function to randomise the plots automatically,
- an import function of ASCII files which contains the description of a plot design and
- a choice list of plot design descriptions which are stored in the master data field of the database.

The plot design dialog can also be used to show and modify assessment data.

2.3.7 Raw data/calculated data ("Versuchsergebnisse")

Figure 9: Tab raw/calculated data

The next tab allows raw data entry and displays the calculated assessments (see Figure 9). Assessments are shown in the columns of the table, plots are shown in the rows. Sub sample data can be inserted in a special dialog.

The user can define filter and sorting criteria.

The actually displayed information can be printed out as a report or can be exported in an Excel format.
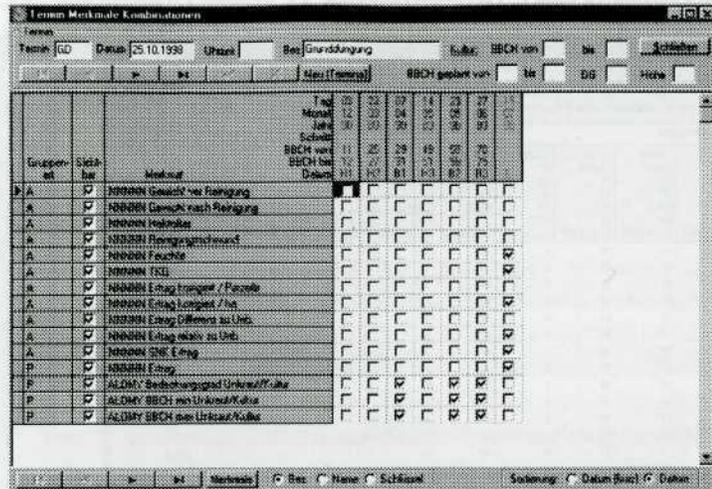
Figure 10: Dialog assessment timing combination

The assignment of assessment types to timing records can be done in a further dialog (see Figure 10). In a cross table this dialog shows all estimation, cutting and harvest timings and the assessment types which have been defined for the trial. The user can set check marks to define new assessments. If necessary, new timing records can be included within this dialog.

2.3.8 Comments

The last tab contains the comments on a trial. Usually a comment refers to a whole trial. The user can also assign comments to the various factor levels.

2.4 Planning of trials

The trial planning module is almost similar to the structure of the trial module.

2.5 Master data, codes, trial types

The PIAF system offers the possibility to store different codes and variables in the section of master data. This data can be defined and maintained by the user. The user-defined codes and variables can be distributed to other users via export functions.

There are used different codes in plant protection and multi crop trials. In PIAF, each code is assigned to a variable. Trial types for each field of trials can include different variables and therefore the system can display the right code in each single trial.

If possible the definition of codes in PIAF was based on existing codes (e. g. EPPO-, BBA-, BSA-codes).

Table 2 shows examples of codes included in PIAF.

Code	Owner of the code
crop	EPPO, BSA
variety	BSA
soil type	BSA
soil moisture	BBA
application timing	BBA
pest	EPPO
weed	EPPO
disease	EPPO

Table 2: Examples of codes included in PIAF

2.6 Additional functions of the PIAF-System

Besides the modules for the maintenance of master data, standards (trial types), trials and trial series additional modules are planned or have already been developed.

2.6.1 Mobile field systems

Many different mobile field systems are used in Germany at present. In order to import the data of those systems into PIAF, a flexible ASCII-interface is to be defined. With the help of header information this interface should be able to read different data formats to tranfer the data into the PIAF database. Moreover, the system must be able to write data into an ASCII-file which then can be imported into the mobile field systems.

2.6.2 Evaluation series

In addition to the evaluation of single trials PIAF 1.1 is able to work with trials summarised in an evaluation series. An additional module for the definition of evaluation series is under construction right now.

An evaluation series is often identical with a planned series of trials. The mostly homogenous trials of a series are evaluated together. PIAF offers the possibility of combining arbitrary trials in evaluation series. In this context the factor levels and the assessments of the concerned trials have to be mapped. This mapping process is performed as far as possible automatically by the system. The user can easily define mappings or adjust the system made mappings by himself.

2.6.3 Summaries for single trials and trial series

Based on single trials or evaluation series tables containing mean values can be created. So-called classification characteristics (e. g. year, location, factor$_i$, assessment) can be assigned to the different dimensions of the table (table, row, column, sub row, sub column). The defined mean values are displayed in the cells of the table. Moreover it is also planned to include results of statistical analysis in the table.

2.6.4 SAS evaluation system PIAF 1.1

The SAS evaluation system PIAF 1.1 includes a number of standard evaluation routines for one-factorial and two-factorial plot designs. Each evaluation is possible for single trials and evaluation series. The planning and data recording system has an interface which gives the possibility to make the gathered data available for the SAS evaluation system.

Besides the already predefined evaluation routines the user has the possibility to define his own evaluations on the data provided by the PIAF system.

For the year 2000 the integration of more predefined evaluation series into the PIAF 1.1 (SAS) system is planned.

2.6.5 Specific modules for plant protection trials

2.6.5.1 Order management

The module order management offers the possibility to administer orders of customers (e. g. of the chemical industry).

Each order is first of all assigned to a customer. Moreover one standard compound and one or more test compounds can be defined for the order. During the definition of a trial it is possible to reference the order information. Treatments of a trial can be assigned to the different compounds of the orders. By doing this it is possible to combine more than one customer order in one trial and still produce customer order specific reports.

In the context of reporting PIAF includes a standard trial report based on the data of one order. Moreover each order can be reported as EDE-file via the EDE-interface. The interface includes trial data as defined by the PIAF project team.

2.6.5.2 Anova for one factorial trials

As mentioned above the PIAF system contains an interface for data transfer to the SAS evaluation system PIAF 1.1. The official test of preparation usually only performs an analysis of variance on yield and on this basis a comparison of means. To avoid the licensing and installation of the whole SAS-program analysis of variance for one-factorial trials including a SNK test is included in the PIAF planning and data recording system.

2.6.6 Specific modules for variety trials

2.6.6.1 Interface to the "Bundessortenamt"

Especially for multi crop trials an interface has been defined (BSA-interface) which is used by all currently used data recording systems. Therefore it is possible to import already recorded data into the system. In future the exchange of data to the BSA will be carried out with the help of the existing import and export systems.

2.7 Development tools and system environment

The PIAF-System was developed with Inprise (Borland) Delphi 4.0 based on a relational database. At present the system is available for Inprise Interbase 5.x. Some tests have been made with Oracle 8.04 as database and for the future a PIAF version using Oracle 8 is planned.

3 Summary

The PIAF system can handle arbitrary defined trials. By special modules like order management or the BSA interface and the definition of master data and trial types for the field of plant protection and multi crop trials these two areas are represented best in the current system. Because of the high flexibility of the system (adaptations can even be made by users), assessment methods or master data that is not included in the system right now can easily be added later.

Since July 1999 the PIAF system is distributed for the field of plant protection. Until the end of the year the development of the entire planning and data recording system including the integration of PIAF 1.1 shall be completed. It shall then be distributed together with the necessary master data and trial types for the multi crop trials.

The system will first be put at the disposal of the officials in Germany. The licensing conditions for other interested customers are being prepared right now.

At present PIAF is available in German language only.