1. Pavol FINDURA[1,3], 2. Oľga URBANOVIČOVÁ[1], 3. Pawel KIELBASA[2],
4. Miroslav PRÍSTAVKA[1], 5. Zuzana BAJUSOVÁ[4]

Slovak University of Agriculture in Nitra, Faculty of Engineering, Slovakia (1)
University of Agriculture in Krakow, Faculty of Production and Power Engineering (2)
Faculty of Agriculture and Technology, University of South Bohemia in České Budějovice (3)
Slovak University of Agriculture in Nitra, Faculty of Economics and Management, Slovakia (4)

doi:10.15199/48.2023.01.62

Fertilizer application monitoring with AgroDoc software for plant fertilization optimization

Abstract. *The article describes the construction and structure of a web application that allows optimizing plant fertilization and also creates documentation of the implemented treatments. To create the application, Microsoft Visual Studio and ASP.NET technology were used, and VB.NET programming language with HTML code elements. The structure was developed and the functionality of the system was designed, creating an environment for programming individual modules of the application. The created modules are connected to IS AgroCont, whether through created databases or through full administration and modification of created records. The application, thanks to its intuitive interface, can be used by a wide range of farmers and its mobility allows access from a cell phone. It is possible to record the consumption of fertilizers, seeds, chemical preparations and other important information and duties mentioned in good agricultural practice. In addition, the connection to IS AgroCont, allows you to edit the created records in electronic form, so that they meet all the requirements for keeping the recommended documentation for EU control authorities.*

Streszczenie. *W artykule opisano budowę i strukturę aplikacji internetowej pozwalającej optymalizować nawożenie roślin a także tworzącej dokumentację realizowanych zabiegów. Do stworzenia aplikacji wykorzystano Microsoft Visual Studio i technologię ASP.NET, i język programowania VB.NET z elementami kodu HTML. Opracowano strukturę i zaprojektowano funkcjonalność systemu, tworząc środowisko dla programowanie poszczególnych modułów aplikacji. Stworzone moduły są połączone z IS AgroCont, czy to za pomocą utworzonych baz danych, czy też poprzez pełną administrację i modyfikację utworzonych rekordów. Aplikacja dzięki intuicyjnemu interfejsowi może być wykorzystywana przez szerokie grono rolników a jej mobilność pozwala na dostęp z poziomu telefonu komórkowego. Można rejestrować zużycie nawozów, nasion, preparatów chemicznych oraz inne ważne informacje i obowiązki wymienione w dobrej praktyce rolniczej. Ponadto połączenie z IS AgroCont, pozwala na edytowanie stworzonych zapisów w formie elektronicznej, tak aby spełniały one wszystkie wymagania dotyczące prowadzenia zalecanej dokumentacji dla organów kontrolnych UE. (**Monitoring stosowania nawozów za pomocą oprogramowania AgroDoc do optymalizacji nawożenia roślin**)*

Keywords: web application, exploitation, precision agriculture, utility program
Słowa kluczowe: aplikacja internetowa, eksploatacja, rolnictwo precyzyjne, program użytkowy

Introduction

Modern agriculture has to cope with growing economic, social and environmental problems, which require technological innovations that enable cultivation with the least possible adverse impact on the environment, the introduction of advanced forms of management to optimize production and reduce costs, the collection of documentation to achieve complete traceability of the product creation process for the consumer and for environmental protection [1].

A complete integrated precision farming system is considered to monitor on-farm activities so that for each field procedure, the type of procedure, where it is performed, the people involved and the means of production are known [2]. Pedersen [3] states that the key task for most farmers is to stay in business. The extent to which a farmer will be able to improve economic benefits will be determined by the ability to apply advanced information and communication technology systems and precision farming technologies to the dosage of agrochemicals, as well as the ability to evaluate the strategy used. Nash et al. [4] point out that many standards in conformity assessment require that inputs be documented and all activities performed on the farm recorded. Holistic farm management is also presented by [5], which includes a description of the formal management strategy, management of objectives and technologies used.

Definitions of precision agriculture have evolved as we have come to understand what this technology brings. From the simple definition that it is management through the soil [6], it has moved to the definition that it is information-based management of agricultural production [7,8]. The modern farmer has to be a biologist, technician, trader, but also an IT specialist at the same time. The telematics system used on the farm comprehensively administers machinery while analyzing the economic effect. This is particularly important especially at the time of the piling up of field work, where efficient management makes it possible to perform all production activities during the agrotechnical period. A number of systems are used to manage the farm, which handle all the processes carried out. Figure 1 shows the interface of an example of Case IH AFS software.

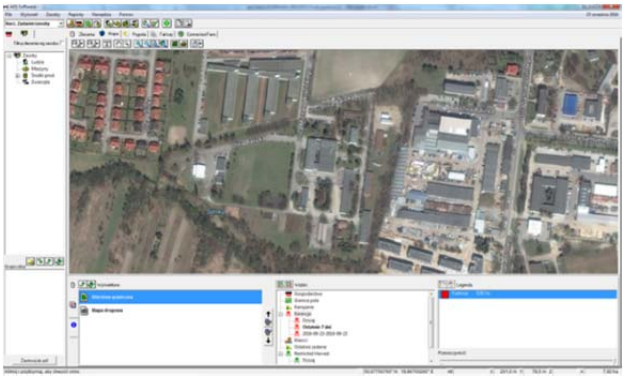

Fig. 1. AFS software window view

Council Directive 91/676/EEC on the protection of waters against pollution caused by nitrates from agricultural sources (the Nitrates Directive) is one of the EU directives focused on the protection of water and the management of water resources. The Nitrates Directive aims to reduce water pollution caused by nitrates from agricultural sources and to prevent further such pollution. This is necessary not only to ensure the availability of good quality drinking water, but also to limit eutrophication of surface waters and the sea. The problem of non-compliance with these standards is that the standard speaks of net nutrient content, which does not always correspond with the fertilizer doses applied by farmers. The AgroDoc software is intended to help farmers to self-monitor and at the same time data can be exported from it to the inspection authorities [9].

Material and methods

In agriculture, the material flow of information is very important and accessible anywhere with the help of a web application. When creating a web application, we must choose the right procedure so that the development and programming of the application itself is as simple as possible, but at the same time it can satisfy the high demands of users. To get ready to start building a web application, we'll cover the following steps: (a) choose the necessary technologies for creating a web application, (b) create a procedure for creating a web application. Application Lifecycle Management (ALM) has evolved from the early days of process improvement to provide a comprehensive software development methodology that provides guidance and requirements gathering, development design, and application deployment. In practice, ALM targets a wide range of organizations and can manage all software and systems delivery efforts. ALM helps us create faster and better solutions by providing the necessary structure for the entire systems development software, including concrete details of roles, functions, responsibilities, and key milestones that help stakeholders track progress. Application Lifecycle Management (ALM) is the specification, design, development and testing of a software application.

Application life cycle in individual steps:

- analysis of client requirements,
- design and specification of functionality,
- implementation of the proposed solution,
- application testing,
- starting sharp operation,
- system maintenance.

Based on the obtained information and the created analysis of the main parts of IS AgroCont, we will create a proposal for the structure of the individual modules of the web application (fig.2). The proposal will consist of three separate modules that will be directly connected to IS AgroCont. Two of these modules should form the registration part of the web application, and the third module should be used to manage the created records. We named the modules according to their function and characteristics, and they will serve as an extension of IS AgroCont. Based on the obtained information of the modules of the web application, we will evaluate internal company analyses.

We named the proposed modules of the web application:

- AgroCont module – Agronomic record.
- MZ module – Reports of work.
- Administrator module

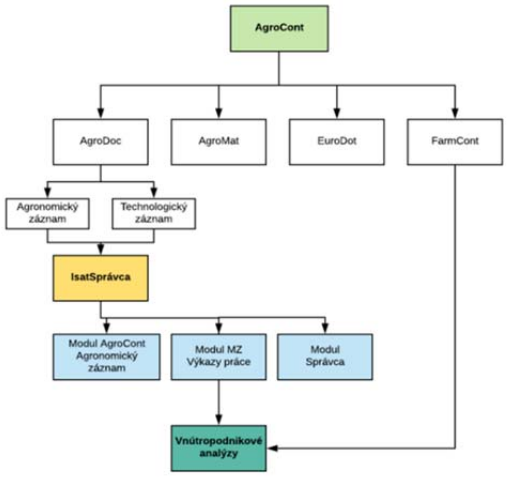

Fig. 2. Example of creating an ASP.NET project

Results

The basic template of the entire web application is created using Microsoft Visual Studio, it is a kind of standard when creating an application using ASP.NET (fig. 3). The created template will make it easier for us to create the source code and the visual page, because it already contains predefined selected parts of the system. On the other hand, it is necessary to master these parts and adapt them to our requirements so that we can control all parts of the web application system.

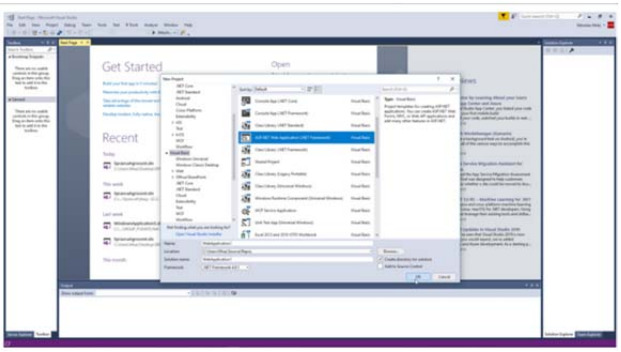

Fig. 3. Example of creating an ASP.NET project

In order to have an idea of how programming and creating a web application in ASP.Net works, we can divide MS Visual Studio into the following parts (fig. 4):

- user environment,
- toolbar,
- application explorer,
- properties.

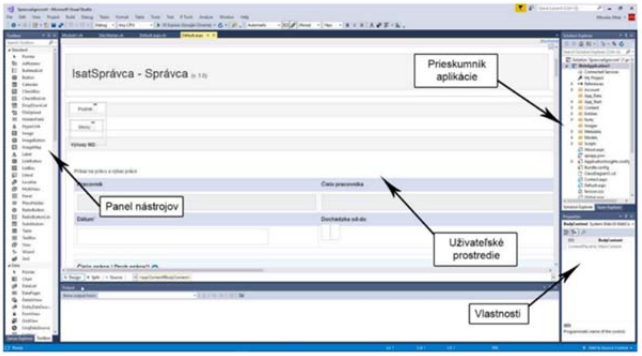

Fig. 4. Microsoft Visual Studio development environment

The user environment is a link between the source code and the visual page of the application, which are interconnected and we can further modify them according to our needs, with the help of VB.Net or e.g. HTML code. The entire system is made up of individual sub-pages ending with e.g. Domov.aspx, which we can create as needed and each subpage can define a certain part or functionality of the system. In order to be able to move between individual subpages and the entire system of the web application, we use the application explorer panel.

Based on the analysis of IS AgroCont, we found that for the web application to work properly, it is necessary to first prepare all the necessary databases, which are located in the Overview and editing of code lists. We will use these codes as input data, which are interconnected and on the basis of which, as in the case of AgroCont, records will be created in the individual modules of the application.

Overview and modification of the dials consists of the following dials:

Type of work – all work operations performed at the company are created and recorded here and serve as input data for the creation of an electronic work report. Each type of work is specific in its own way, and some of them are conditioned by special cards that must be filled in in order to create
a correct record for the control authorities. These cards must be filled in for the following types of work:
Fertilization – the proposed net nutrient content card should contain all the necessary data to check the nitrate directive, which includes the conversion of net nutrient percentages such as N, P, K, per kg/ha or control of exceeding the maximum allowed one-time dose per ha (fig.5).

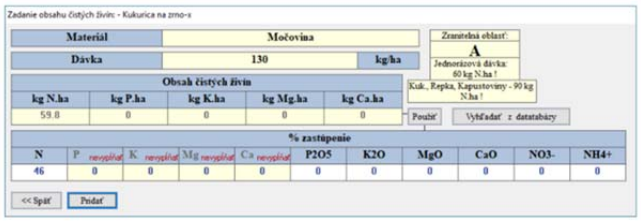

Fig. 5. Example of the net nutrient content card

Spraying – the chemical card is used to record additional information that must be entered when creating a record in order to meet all the necessary regulations for control authorities. These data include e.g. the choice of the vegetative stage of the crop, the harmful agent, the type of spraying and the amount of water used (fig.6).

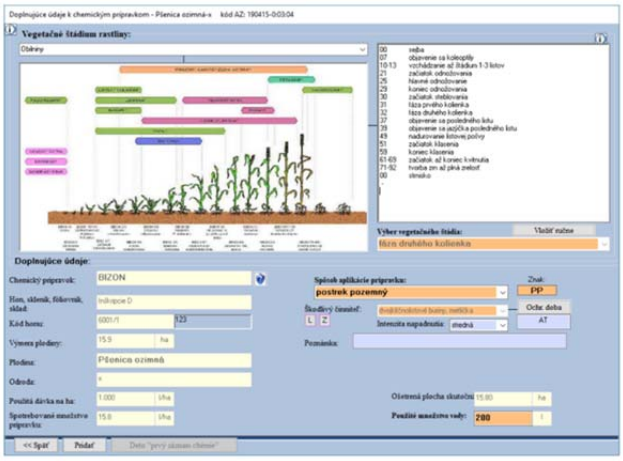

Fig. 6. Example of the chemical card

Material – this code is used to record all used materials purchased in the current financial year divided by type, such as:

- Fertilizers.
- Organic fertilizers.
- Pesticides.
- Seed.
- Consumables.
- Other etc.

This codebook serves as a basis for the creation of agronomic records, because based on the amount of material consumed, the necessary outputs are created that serve as a basis for the control carried out by the EU authorities, but also as a basis for the company's financial statements.

Name of the parcel – it is the main code of the entire IS AgroCont, because based on the created sowing procedure, we can use the created data to create agronomic records, work reports or as a basis for requesting direct payments for individual plots. The entire agronomic documentation is created according to the individual soil blocks that form the basis of this code and must contain the following data, such as:

- Part code – LPIS.
- Parcel number.
- Parcel name.
- Crop - Variety.
- Crop area and others.

Organization – the names of individual organizations of the agricultural enterprise, or companies for which the enterprise provides services, are added to this codebook. Based on this data, we can create a work report for the center or company where the registered work was performed, or issue an invoice for the services performed.

Worker – this codebook serves as a card for personal data and other important information that every worker must fill in when creating a timesheet. Each worker is assigned his own identification number, to which additional information is assigned, which we can use in various modules of the information system.

- Rate – with the help of this codebook, we set internal company rates for individual work operations, or workers. It is a code book where all the necessary basic rates are set, based on which, we can calculate the worker's salary for the work performed, or post it and send it to the economic program.
- Center – with the help of this codebook we can record the individual centers of the company, each center is assigned
a number. The number is used when creating work reports, because for each work operation or a center is assigned to the type of work.
- Performance – the codebook serves as a list of individual crops, respectively groups of equipment, works and crops that are produced at the enterprise and to which a center number and output are assigned. On the basis of performance, we can record costs according to individual groups of the company, which is used, for example, for recording costs in the economy. Since the economic closure is conducted on the basis of a calendar year and not an economic one, as is the case with agronomic records, we can determine the costs of the crop, machines and overheads on the work sheet based on the center's performance (fig. 7).

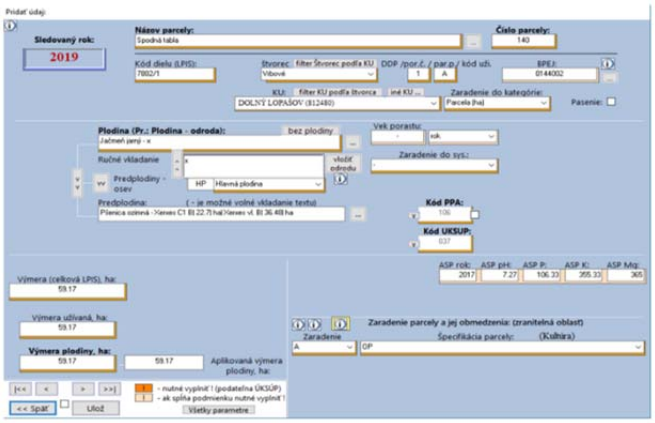

Fig. 7. Example of creating a parcel in the codebook Name of the parcel

All selected codebooks will be created and edited using IS AgroCont and sent to pre-created databases on the SQL server, which will allow us to have up-to-date and accurate data for creating agronomic records and work reports through the web application.

Conclusion

The module was created based on the analysis of the IS AgroDoc module, we tried to implement all parts for creating agronomic records into the web application, thereby ensuring the possibility of creating agronomic records at the enterprise. Thanks to this module, using a mobile phone, tablet or computer, through a web browser and the Internet, we can record the consumption of fertilizers, seeds, chemical preparations and other important information and obligations listed in good farming practice. It is connected to IS AgroCont, thanks to which we can take over and edit the created records in electronic form so that they meet all the requirements for maintaining the prescribed documentation for the EU control authorities.

After the successful implementation of the design of the web application linked to the AgroCont information system, the basic objectives of this application were met, which include:

- The same user interface anywhere without the need to install special software.
- It works on all platforms (Windows, IOS, Android), on all mobile phones with a web browser that requires an Internet connection.
- We can constantly manage and keep under control current information from IS.
- Create documentation with subsequent connection to IS and the possibility of final processing of final outputs.
- We can use information from several IS.
- We can manage and manage several businesses at the same time.
- Based on the obtained data, we can optimize costs

Financed by a subsidy from the Ministry of Education and Science for the Hugo Kołłątaj University of Agriculture in Cracow for 2022.

***Authors**: Pavol Findura Professor, Slovak University of Agriculture in Nitra, Faculty of Engineering, Department of Machines and Production Systems, Nitra, Slovakia, E-mail: pavol.findura@uniag.sk; Oľga Urbanovičová Professor, Slovak University of Agriculture in Nitra, Faculty of Engineering,* Department of Machines and Production Systems, *Nitra, Slovakia, E-mail: olga.urbanovicova @uniag.sk; Paweł Kiełbasa Associate Professor, University of Agriculture in Krakow, Faculty of Production and Power Engineering, Balicka Av. 116B, 30-149 Krakow, E-mail: pawel.kielbasa@urk.edu.pl; Miroslav Prístavka PhD, Slovak University of Agriculture in Nitra Faculty of Engineering, Department of Quality and Engineering Technologies, Nitra, Slovakia, E-mail: miroslav.prístavka@uniag.sk; Zuzana Bajusová, PhD., Slovak University of Agriculture in Nitra Faculty of Economics and Management Nitra, Slovakia, E-mail: zuzana.bajusova@uniag.sk;*

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