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COMPUTER AIDED DESIGN IN THE ORGANIZATION OF THE AGRICULTURAL TECHNOLOGY ON EXAMPLE OF THE OTR-7

Summary

This paper presents software supporting management of agricultural holding. Programs supporting farmer activity are divided into two groups: software for current farm management (record and reporting) and for planning and design. The Organizer of Agricultural Technology OTR-7 software is an example of the second group of applications. It enables to design a fleet for farm and to calculate a coefficients characterizing its production results.
***Key words**: farm machinery management, program for farmers, DSS, optimization*

KOMPUTEROWE WSPOMAGANIE PROJEKTOWANIA W ORGANIZACJI TECHNIKI ROLNICZEJ NA PRZYKŁADZIE PROGRAMU OTR-7

Streszczenie

Przedstawiono oprogramowanie wspomagające zarządzanie gospodarstwem rolnym. Programy do wspomagania działalności rolnika podzielono na dwie grupy: programy do bieżącego zarządzania gospodarstwem (ewidencyjno-sprawozdawcze) oraz do planowania i projektowania. Przykładem drugiej grupy aplikacji jest program Organizator Techniki Rolniczej OTR-7. Program umożliwia zaprojektowanie parku maszynowego dla gospodarstwa oraz wyliczenie wskaźników charakteryzujących jego wyniki produkcyjne.
***Słowa kluczowe**: zarządzanie techniką rolniczą, programy dla rolników, system wspomagania decyzji, optymalizacja*

1. Introduction

Proper management of agricultural holding necessitates possession of good knowledge and up-to-date data [1]. The principle of operation of computer systems supporting decision process is based on the interaction between the man and the computer. Computer, along with the software, provides useful information which constitute the basis for making decisions significant for its user. Computer, which previously carried out primarily comparative analysis, currently possesses mechanisms, which enable exploring knowledge bases and inferring on the basis of data found there [6]. The area covered by the software (e.g. plant production, livestock production, machinery stock management) can be one of the criteria on the basis of which software supporting the management of agricultural holding can be further divided. The next one can be the complexity of the system, i.e. size of the area covered by the software. Application may solve a single problem related to the agricultural activity, such as calculation of operation cost of a single machine or analyze the production cycle in the entire facility. Considering software designed for comprehensive farm management the following can be distinguished: record and reporting software and applications for planning and design of production. [2]. The majority of the available programs belong to the first group, which stems from greater demand for control and reporting of current activity. Their greater availability is also caused by the possibility to use standard information technology solutions using for instance experience acquired in creation of applications for enterprise management. As an example of the second group we could cite here Organizer of Agricultural Technology (OTR-7), which is intended for design of already existing farms as well as those which will be built in the future.

2. Farm management software

The topic of computer support for agricultural production is discussed by numerous authors. A review of publications covering the field was compiled by Kozłowski and Weres [3] who analyzed 310 publications, published in the period between 1990 and 2011. The authors divide the publications into three groups: range of subject matter covered, areas of practical application and support of selected processes of agricultural production.

Dividing programs for comprehensive farm management into record and reporting software and applications for planning and design of production it should be mentioned that programs belonging to the first group do not allow to design and issues of farm machinery are often marginalized in them. On the other hand, software which is supported by manufacturers of agricultural machinery and excellently cooperates with software of on-board computers for obvious reasons does not enable farmer to design machine sets which would include equipment from competitive manufacturers.

Record and reporting programs are primarily used to gather information on the managed facility. Therefore, their primary part is database and system for its management. Interface includes forms which enable entering data and searching for useful information. Usually these programs do not contain advanced calculation methods, and calculations constitute primarily easy and comfortable searching through the resources with the use of built-in SQL queries. Data gathered in the program concern events, which occurred earlier or current events. Results obtained from calculations can constitute basis for settling payments with cooperating institutions or institutions supervising farmer. The basic problem in these databases consists in proper mapping of all the necessary information about farm. It is not an easy task due to the diversity of data and processes of agricultural production. It is also

difficult to reconcile the ease of use with large amount of data entered into the program. As a consequence these programs often possess quite complex interface, which makes them difficult to work with for less advanced users [6]. Bitfarma, AgroAsystent or Agrar-Office are among others programs, which can be included in this group.

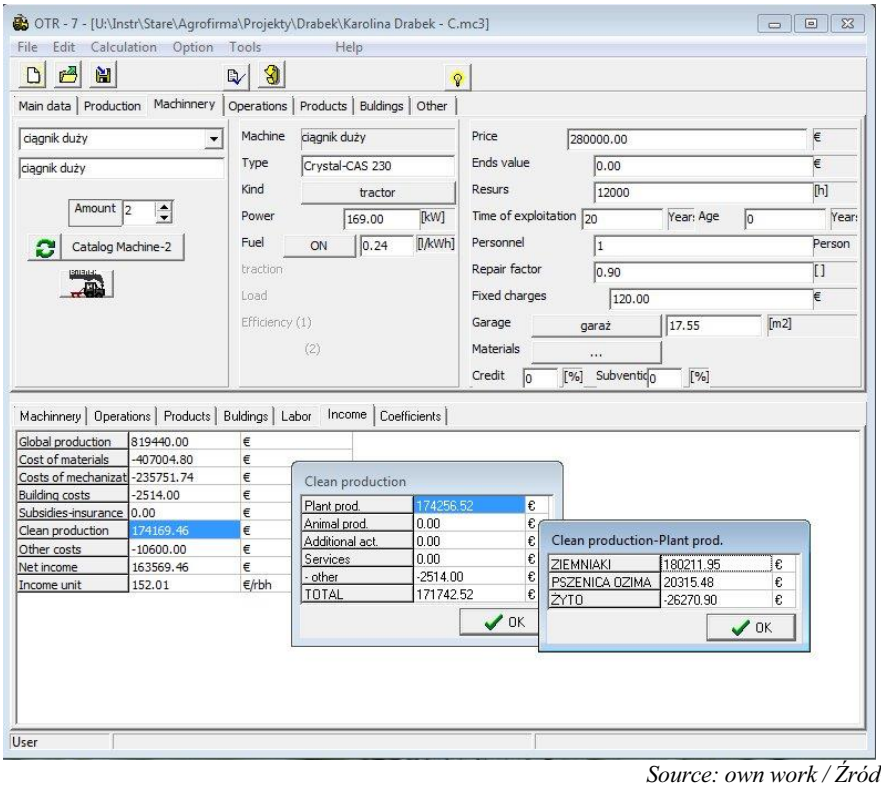
The second group of applications (i.e. for planning and design of production) may base on historical or current data, but their basic feature is that the calculation results relate to closer or further future. As a consequence, on this basis decisions can be made which will have effect in the future. These programs must gather data on the analyzed facility, but the basic calculation modules are based on advanced algorithms, which, on the basis of the provided data enable simulations of results of changes occurring due to decisions of the farmer. Results of such simulations cannot constitute documents for reporting to institutions supervising the farmer, however, they can assist in reasoning an application for funding purchase of a machine. OTR-7 or DoZeM-2 [6] can be examples of programs belonging to this group.

Design and forecasting in agriculture are usually rather complicated processes and it is not always possible for them to use methods proven in other parts of the economy. As a consequence, applications supporting design often use complicated calculation algorithms, which are developed specifically for the aims of a given application. Because of the specificity of agricultural production, to cover entire farm is difficult for a project and despite the existence of a range of applications enabling solution of selected, single problems of agricultural production support, there are very few of these which cover farm as a whole. On the other hand, the occurrence of factors characterized by high variability in the environment of designed facility causes forecasting to bear high uncertainty of the obtained results. High diversity of projects also hinders the use of artificial intelligence methods, which is becoming more common in other areas of forecasting.

3. Farm machinery design with the use of OTR-7 software

The Organizer of Agricultural Technology (OTR-7) program has been developed for many years, tested by, among others, students of Faculty of Production and Power Engineering and subsequent versions are published at www.cupial.mcpk.net. It is a Delphi application made available to users free of charge. Apart from the instruction manual for the program, persons who would like to learn farm machinery design may use animations showing the design method of the OTR-7 program. Application cooperates with several additional programs and among others there are: Nawozy-2, Herbicyd-2, Maszyny-2 and Maszyny-3, Agregat-2, Bilenero. Sample screenshot of the OTR-7 is shown on Figure 1.

Process sheets for plants, animals and additional activity are the basis for calculations in the program. On their basis process sheets for all activities found in the facility are calculated. The program is based on a modified method of decade peaks, which allows for calculation of minimal number of machines for plant production. The addition of possibility to design machine sets for livestock production as well resulted in the fact that necessary was also elaboration of new methods and, as a consequence, dedicated calculation algorithms. In the program calculation of minimal machine number is only the first stage of design, and the most significant are economic analyses for the whole farm, distinct branches of production, single plants or groups of animals or machines. Calculation of actual use in different variants of operation provides the possibility to obtain information on costs of machine operation split into components. Analysis of costs allows for an optimal selection of machine set which constitutes factor determining obtaining a good balance for the whole farm [4, 5].



Source: own work / Źródło: opracowanie własne

Fig. 1. Screenshot of the OTR-7 software
Rys. 1. Zrzut ekranu programu OTR-7

Table 1. Results of exemplary model calculations in OTR-7
Tab. 1. Wyniki przykładowych obliczeń modelowych w programie OTR-7

Specification		Average	Min	Max
Surface area	[ha]	73,5	30	150
Labor expenditures (A)	[h]	1213	377	2801
Increase of income (A to B)	[thous. PLN]	69,18	0	416,51
Increase of income (B to C)	[thous. PLN]	22,16	0,51	62,58
Increase of income (A to C)	[thous. PLN]	91,34	2,25	459,44
Share of mechanization costs in costs (A)	[%]	58%	17%	78%
Share of mechanization costs in costs (B)	[%]	51%	16%	75%
Share of mechanization costs in costs (C)	[%]	50%	16%	77%
Decrease in share of mechanization costs (A to B)	[%]	7%	0%	16%
Decrease in share of mechanization costs (A to C)	[%]	8%	-5%	29%
Unit cost of tractor (A)	[PLN]	133,1	83	341
Unit cost of tractor (B)	[PLN]	112,1	59	316
Unit cost of tractor (C)	[PLN]	112,9	52	357

Source: own work / Źródło: opracowanie własne

Table 1 shows selected results of optimization of 30 model agricultural holdings, where for each facility 3 versions were elaborated (as a result 90 projects were obtained). First version "A" signifies holding without optimization activities, version "B" consisted of modification of fleet and production technology while retaining the remaining factors, such as surface area, structure of sowings, crops and materials expenditures. In version "C" mechanization services were added.

As a result of optimization a mean increase of income of 91,000 PLN was obtained. Share of mechanization costs in general costs decreased from 58% to 50% on average and ranged in the analyzed facilities from 16% to 78%. Table shows also the cost of one operation hour of a basic tractor.

The OTR-7 program was used both for design of newly built farms as well as for optimization of those which already existed. Creation of new facilities provides more possibilities of selection of equipment and allows for obtaining diverse models of technical equipment and, as a consequence, different financial results. On the other hand, modification of an existing farm is limited by the available resources, which can be modified only to a limited extent. However, such use of the program seems to be the most valuable from the point of view of farmer, who, as an owner of a farm is interested in improving its financial situation. Despite numerous advantages of the use of IT tools in the design of agricultural holdings, also restrictions of their use should be mentioned. As the production cycle in agriculture is long (much longer than in industry) and at the same time it strongly depends on external factors which are farmer-independent, high risk exists that a project may differ from targeted actual state. Weather conditions, prices of crops and production resources undergoing significant and unforeseeable fluctuations can be such factors. The necessity to possess significant specialist knowledge, essential for proper design is another important restriction. Programs for reporting do not require such knowledge.

4. Summary

Despite the existence of numerous applications for farmers, the occurrence of both programs is necessary for current farm management (record and reporting) as well as for design and planning. Even though a vast majority of programs belong to the first mentioned group, applications supporting design are necessary in the role of supplements. Proper design of machine set and production technology allows for efficient use of resources available to farmers and obtaining desired results at minimal costs. Main restrictions to the use of information technologies for support of farm machinery design result from low availability of such software and also high variability of the conditions of the surroundings, which have effect on the end result of calculations. However, it can be stated that increasing competition in the market and the necessity for optimization of production systems will force farmers to use such type of software in the future.

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