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ZOOSYST – COMPUTER SYSTEM DESTINATED FOR THE ANALYSIS OF THE PRODUCTION POTENTIAL OF RUMINANT SPECIES

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Abstract

In order to carry out an efficient and competitive activity, livestock holdings must follow both the technical efficiency, respectively the physical result per unit of the source's effect, as well as the economic efficiency of the activity and join the trends regarding the promotion of qualitative factors, among which they are part the application of modern technologies and computerization. The IT product ZooSyst is a web application intended for the analysis of economic efficiency for sheep, goats, bulls, and buffalo species, through which farmer users will have the possibility to calculate the economic efficiency for the specific activity and to choose the optimal option in the specific branch of activity, ensuring a more judicious matching of objectives with resources. This IT product made available to farmers raising sheep, goats, taurine, and buffalo species offers the possibility of calculating the technological estimate, the income, and expenditure budget, and economic efficiency indicators, for the milk or meat production activity. The online monitoring of agricultural expenses and income is of great interest due to the integration of information and communication technology with agricultural sciences, being based on specific concepts: client/server architecture, integrated platform software, decision support, remote relational communication with bases of web-distributed data, object-oriented programming, econometrical modeling, interactivity, etc. The ZooSyst computer system was designed and realized by the ADER 24.1.2 Project - "Research on the economic efficiency of raising sheep, goats, dairy cows, cattle and buffaloes".

Key words**:** *ZooSyst, web, budget, indicators, technological estimate*

INTRODUCTION

The information society has become an undeniable reality of our days. Many economic activities are transforming to cope with the changes generated by the increasing role of information in traditional activities, such as agriculture [3]. The introduction of information technologies is often presented as one of the ways to transform agriculture into an economically efficient activity [2]. Information technologies can benefit farms, directly or indirectly, when used for precision agriculture, resource management, product marketing, financial management, or in agricultural higher education [6]. An analysis of the level of computerization in Romanian agriculture leads to the conclusion that a small number of farms use computer technologies to access, process, and use the information necessary for the decision-making process, whether it is the production activity or the economic-financial management of the activities carried out [8]. To increase labour productivity, it is needed to assure a modern technical endowment, the knowledge transfer to farmers, the increase of their training level and managerial skills, the intensification of the extension system services, the stimulation of young farmers and women to develop business in agriculture and traditional activities and services, the assurance of funding for investments and modernization, the creation of jobs and new income sources for the agricultural employees and rural population [11].

The purpose of this paper is, in general, the promotion of information technology, in various forms, in the production and management process of agricultural activities, and in particular of the IT product ZooSyst [12]. ZooSyst is a web application developed and produced for technical and economic analysis of the performances of animal farms and the efficiency of using the production factors in classic operating conditions.

The main structural elements [1], [5] of the informatics system are:
-technical basis or hardware system, which consists of all technical means for collecting, transmitting, storing, and processing data;
-software system, which includes all work modules built for the web operation of the product, according to the functions and objectives that have been preset;
-scientific and methodological basis,
which consists of econometrical models of economics, respectively methodologies, methods, and techniques for achieving information systems;
-information base, which includes data undergoing processing, information flows, systems and nomenclatures.

MATERIALS AND METHODS

From a technical standpoint, ZooSyst is an application built on a Server Side Scripting platform because it allows the creation of complex Web applications (Fig. 1) by processing data on the server and generating pages dynamically, ensuring increased speed and security.

Fig. 1. ZooSyst - main window.
Source: Own contribution.

In this way, Web applications can interface with database servers, having the possibility to access data read in HTML forms and to implement libraries to access external resources. As technologies for the development of the ZOOSYST product, we used the following languages/frameworks:
1. **PHP** – The programming language;
2. **CakePHP** – The back-end framework;
3. **HTML 5** and **CSS 3** – Front-end languages, **Bootstrap** – CSS framework;
4. **MySQL** – Database management system.

PHP ("**Hypertext Preprocessor**") is one of the most widely used server-side programming languages a general-purpose scripting language, especially suitable for developing Web applications, which can be integrated into HTML The popularity of this programming language is due to the following features [10]:
-*Familiarity:* the syntax of the language is very easy;
-*Simplicity:* the syntax of the language is quite free, without including libraries or compilation directives;
-*Efficiency:* PHP uses resource allocation mechanisms, very necessary in a multi-user environment such as the web;
-*Security*: PHP provides a flexible and effective set of security measures;
-*Flexibility:* PHP is modularized to keep pace with the development of different technologies and is integrated into many existing web servers;

-*Gratuity*: PHP is developed under the open source license, an aspect that determined its adaptation to the needs of the web, and the efficiency and security of the code.
PHP code consists of instructions - commands given to the interpreter, following which the desired tasks are performed. In creating the ZooSyst system, I used PHP mainly to generate HTML code, which contains instructions for displaying, connecting to databases, reading/writing/manipulating files, warning, sending messages, and others (Fig. 2).
PHP allows describing control structures, procedures, and user functions, being focused on the component interface of the program and providing the ability to create the source code for Windows-standard interfaces, such as windows, buttons, lists, etc.

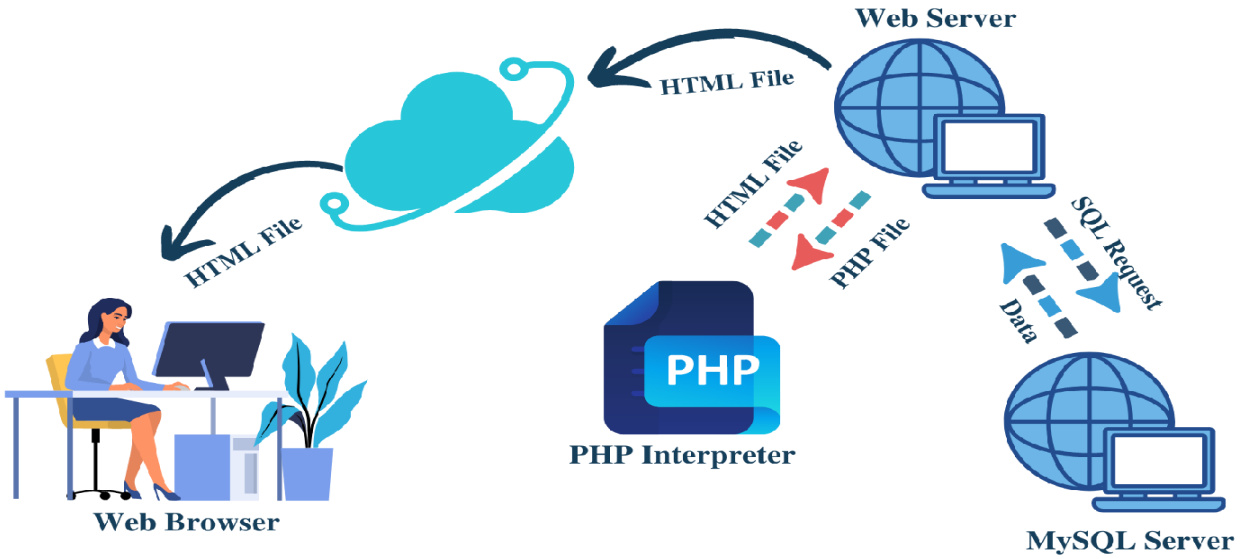

Fig. 2. Functional diagram of the PHP-HTML-MySQL web application suite
Source: Own contribution.

The databases were created and managed in MySQL (MyStructured Query Language), which is an open-source relational database management system. MySQL is an interactive system whose purpose is to act as a database manager, using the SQL language to manage data (specifically, entering, accessing, and processing it). The main qualities of MySQL [9] are that:
-it is distributed free of charge via the Internet;
-it is open source, meaning any programmer can modify its code;
-it allows the creation of any type of application;
-it has elevated security privileges;
-it is capable of handling large volumes of data;
-it has a large technical support capacity;
-it does not require many resources for operation, which induces low costs;
-its structure involves layers and modules, which gives it high stability;
-the data import and export process is simple.
The main database of the ZooSyst web application is the fodder database, containing a total number of 375 variants, sorted alphabetically, which resulted from the combination of two tables: the fodder table (160 variants) and the concentrating table (215 variants). This database relates to the database that contains the species/categories of ruminants (small - for meat/milk, respectively large - for meat/milk) and to the database that contains the expenditure categories.
CakePHP is an open-source framework for PHP, which facilitates the use of databases with active registration, respectively the use of the Model View Controllers architecture - that is powerful, easy to grasp, and guarantees a strict, but natural separation of business logic from data and presentation layers.

CakePHP is intended to make developing, deploying, and maintaining applications much easier. Other features are [10]:
-CRUD integration for simplified use of SQL databases;
-that it uses active records and Data mapper design patterns; it is fast and flexible, with a templating engine that uses PHP syntax and provides utility ("helper") classes that make formatting easier;
-that it works in any subdirectory as long as it is accessible via an HTTP server;
-its security components, rights management, and session management;
-the flexibility to hide views and actions;
-command-line scripts that allow automatic code generation from the physical data model.
HTML (HyperText Markup Language) is a mark-up language used to create web pages that can be displayed in a browser. The purpose of HTML is rather to present information – paragraphs, fonts, tables, etc. – than to describe the semantics of the document. In front-end web development, HTML is used in conjunction with CSS.
CSS (**Cascading Style Sheets**) is a language for styling HTML elements, practically in modern Web Design being used for styling web pages, from the color of the letters and the background up to the positioning of the elements on the web page. The introduction of CSS was necessary to separate the content of HTML pages from formatting or layout, and to allow for clearer and more user-friendly programming, both for the authors of the pages themselves and users while ensuring code reusability and ease of use maintenance.
Bootstrap is the most popular CSS framework used in developing responsive and mobile websites, for front-end components of websites and web applications.

RESULTS AND DISCUSSIONS

Presentation of the results of the ZOOSYST web application

ZOOSYST offers the possibility to calculate the technological estimate, the income and expenditure budget, and the economic efficiency indicators, for the milk or meat production activity.

→ ***The technological estimate*** constitutes the basic document for the elaboration of the annual production plan, the income and expenses budget, as well as for the preparation of operative plans. It is a technical-economic document that is drawn up for each category/species of animals, practically an instrument that highlights the technology of raising animals, the productions obtained, and the expenses determined by them. The main elements found in the technological estimate are [4]: the level of the average production and, respectively, the average daily gain, in the herds intended for fattening;
-duration of growth and exploitation, depending on the species and product;
-the initial and, respectively, the final weight of animals subjected to fattening;
-quantitative and qualitative structure of daily feed rations, corresponding to each species, age category, destination, and production level;
-the necessary medicines and sanitary-veterinary material related to the practiced technology;
-consumption of fuels, fuels, electricity;
-the constructive types of shelters in which the activity is carried out.
→ ***The income and expenditure budget*** represents the final document, which expresses the efficiency of the general activity of the farm, by accumulating income, expenses, and production results. The budget is designed in the form of a balance sheet, containing the expenditure part and the income part, also including the recorded financial results - respectively the profit and its distribution method.
Within expenses [4] two important groups are distinguished: variable expenses and fixed expenses:
-*The main variable expenses* are: expenses with feed, expenses with biological material, expenses with electricity and fuel, expenses with medicines and sanitary-veterinary materials, other material expenses, supply quota, and insurances.
-*The main fixed expenses* are: labor expenses, general expenses, interest expenses on loans, and depreciation expenses for buildings and utilities.

→ ***The technical-economic indicators*** are tools for monitoring, evaluation, forecasting, and decision-making support for the farmer, which quantify both the efforts made to obtain the respective production and the effects resulting from these efforts. Practically, to determine the efficiency of animal production, indicators are used that reflect the influence of different factors on the production process. The profitability of an economic unit is expressed through a system of indicators because no indicator or economic category can perfectly, complexly, and completely reflect reality, phenomena, or economic processes. The system of profitability indicators is characterized by a higher degree of synthesis, and reflection of the economic and financial results. They must be correlated with the other indicators of economic efficiency - from the various subsystems - which constitute factors that determine the amount of profit and the level of the rate of return.

From a constructive point of view, the IT system is made up of three categories of elements:

(1)*Input data = information entered by the system user*

(2)*System constants* = nomenclatures, internal tables, and tables of links to the program:

-the table with categories of animals (classified into small ruminants and large ruminants),

-the feed table (which contains the fodder and concentrate categories),

-the table with the calculated values of the Standard Output coefficients (Table 1).

Table 1. Standard-Output coefficients

	Name of species/category of animals	SO coefficients (Euro/head)
1	Dairy cows	1,200.46
2	Cattle for meat	344.4
3	Female buffaloes for milk	1,200.46
4	Dairy sheep	54.91
5	Sheep for meat	26.72
6	Dairy goats	112.98

*Note: SO = coefficient value*number of heads/series
Source: own contribution.

(3)*Output data* = reports generated after loading input data and constants, previously defined, based on calculation algorithms specific to each design module:

-technological quote/category of an animal;

-income and expenditure budget/ animal category;

-technical-economic indicators.

I. Description of the informational flow of the ZOOSYST web application

Step 1. User authentication

- username and password are entered, which are received by the previous request to the administrator of the ZOOSYST site.

Step 2. Completion of elements for a technological estimate

- choose the **Categoria de animale (**Category of animals**)** from the list (they are 6 categories: dairy cows, cattle for meat, female buffaloes for milk, dairy sheep, sheep for meat, and dairy goats);

- enter the value for the **Numar de capete** (Number of heads);

- enter the value for **Productia medie** (Average production);

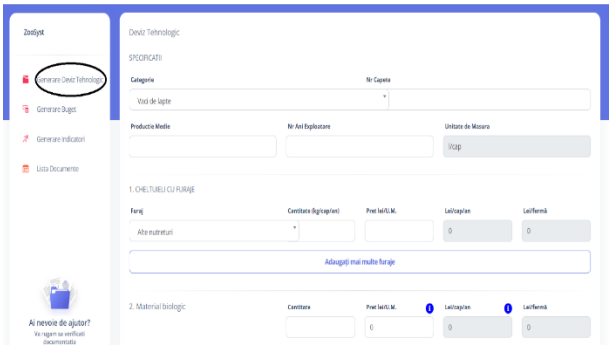

Fig. 3. Production features window.
Source: ZOOSYST.

- the input categories (Figs. 3 and 4) are completed with values: **Furaje** (Fodder)**, Material biologic** (Biological material)**, Energie si combustibil** (Energy and fuel)**, Medicamente si material sanitar** (Medicines and sanitary material)**, Alte cheltuieli material** (Other material expenses)**, Asigurari** (Insurances)**, Cheltuieli cu forta de munca** (Labor costs)**, Cheltuieli generale** General expenses)**, Dobanzi la credite** (Loan charges), **Amortisment** (Depreciation).

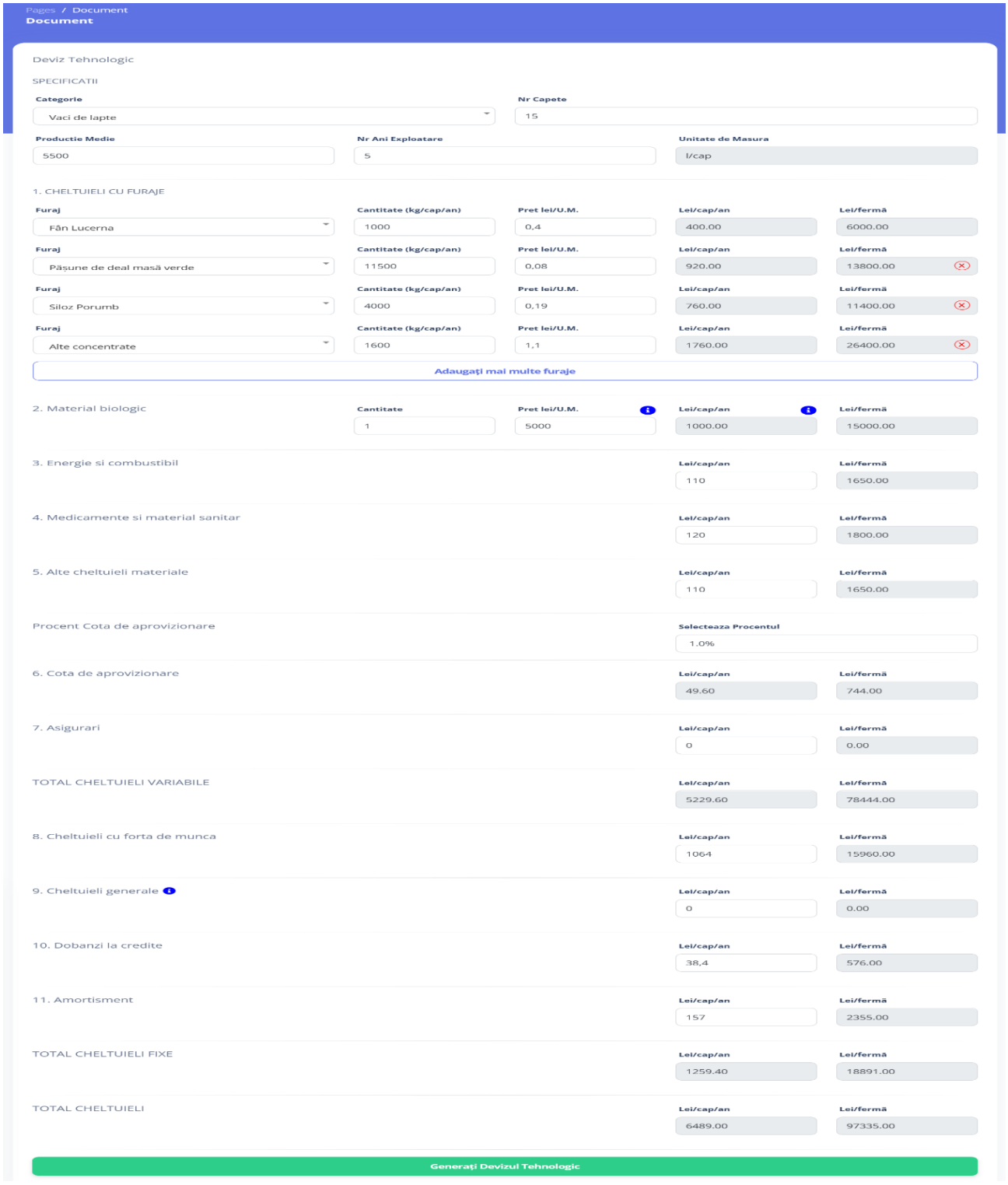

Fig. 4. Data editing window for the technological sheet estimate.
Source: ZOOSYST.

- after all the categories of expenses incurred in the production process for the respective species/category have been completed, the technological estimate (Table 2) can be generated, which will appear in an Excel spreadsheet format.

Remarks:

✓ The value for the **Producția medie** (yield) is calculated according to inputs: **Sporul mediu zilnic** (Average daily gain), **Greutate la intrare** (Input weight), and **Valoare coeficient SO** (Value of the SO coefficient)

✓ **Cheltuielile cu furaje** (Feed expenses) made up of the total expenses corresponding to each feed category, selected according to the feed ration used in the farm. The values in the columns **Cantitate** (Quantity) and **Pret lei/U.M** (Price RON/ U.M.) are going to be entered by the user, while the values in the columns **Lei/cap/an** (RON/head/year) and **Lei/ferma** (RON/farm) are going to be calculated using **Numar capete/serie** (No. heads/series) in according to the following formulas:

Table 2. The technological sheet estimate

1	DEVIZ TEHNOLOGIC VACI DE LAPTE					
2			Total Capete	Productia medie		Ani Exploatare
3			15	5500	l/cap	5
4			ANUL			2022
5			U.M/cap			
6	SPECIFICARE	U.M.	Cantitate	ret lei/U.M	Lei/cap/an	Lei/fermă
7	1. Cheltuieli cu furaje	kg			3840	57600
8	Făn Lucerna	kg	1000	0,4	400	6000
9	Păşune de deal masă verde	kg	11500	0,08	920	13800
10	Siloz Porumb	kg	4000	0,19	760	11400
11	Alte concentrate	kg	1600	1,1	1760	26400
12	2. Material biologic	lei	1	5000	1000	15000
13	3. Energie si combustibil	lei			110	1650
14	4. Medicamente si material sanitar	lei			120	1800
15	5. Alte cheltuieli materiale	lei			110	1650
16	6. Cota de aprovizionare	lei			49,6	744
17	7. Asigurari	lei			0	0
18	TOTAL CHELTUIELI VARIABILE	lei	0	0	5229,6	78444
19	8. Cheltuieli cu forta de munca	lei			1064	15960
20	9. Cheltuieli generate	lei			0	0
21	10. Dobanzi la credite	lei			38,4	576
22	11. Amortisment	lei			157	2355
23	TOTAL CHELTUIELI FIXE	lei	0	0	1259,4	18891
24	TOTAL CHELTUIELI	lei	0	0	6489	97335

Source: ZOOSYST.

Lei/cap/an = Cantitate * Pret lei/U.M
Lei/ferma = Lei/cap/an * Numar capete/serie

✓ The value from the category **Material biologic** (Biological material) is entered according to the production category: meat or milk, as follows:

- for meat species, in the **Cantitate** (quantity) column has to be entered the value from the **Greutate la intrare** (Input weight).
- for dairy species, the user will input the production animal value on the column **Pret lei/U.M**. (price/measure unit), and the value in the column **Lei/cap/an** (price/head/year) is calculated according to the formula **Pret lei /U.M./nr. ani de exploatare a animalului** (Price RON/U.M./no. years of exploitation of the animal).

✓ The values for **Energie și combustibil, Medicamente și material sanitar, Alte cheltuieli materiale, Asigurari** (Energy and fuel, Medicines and sanitary material, Other material expenses, Insurance) are entered accordingly in the column **Lei/cap/an** (lei/head/year), and the value from the column **Lei/ferma** (Lei/farm) is calculated according to the formula above.

✓ For the **Cota de aprovizionare** (Supply Quota) choose the corresponding percentage from the list, after which the program will calculate the value **Lei/cap/an** (Lei/head/year), and the value in the column **Lei/ferma** (lei/farm) is calculated according to the formula from point 1. All the expenses specified above form the category of variable expenses, so the values for the columns **Lei/cap/an** (Lei/head/year), and **Lei/ferma** (lei/farm) from **TOTAL CHELTUIELI VARIABILE** (Total variable expenses) is calculated as the sum of the corresponding values.

✓ **Cheltuieli cu forta de munca** (Labor expenditures) will be calculated and updated for each year of production, based on changes that may occur in input values: **Numar muncitori/ferma** (Number of workers/farm), **Salariul brut/luna** (Gross salary/month), **Numar luni** (Number of months) and **Numar capete/serie** (Heads/series).

✓ For the **Cheltuieli cu forta de munca** (Labor expenditures), **Cheltuieli generale** (General expenditures)**, Dobanzi la credite** (Loan interest) **and Amortisment** (Depreciation), the user will enter the value from the column **Lei/cap/an** (lei/head/year), and the value in the column **Lei/ferma** (Lei/farm) is calculated automatically. All expenses from this point form the category of fixed expenses and the values for the columns **Lei/cap/an** (lei/head/year) and **Lei/ferma** (Lei/farm) from **TOTAL CHELTUIELI FIXE (**Total fixed expenses) are calculated as the sum of the corresponding values.

TOTAL CHELTUIELI = TOTAL CHELTUIELI VARIABILE + TOTAL CHELTUIELI FIXE

TOTAL EXPENDITURES = TOTAL VARIABLE EXPENDITURES + TOTAL FIXED EXPENDITURES

Step 3. Completion of elements for the income and expenditure budget

- in the window by Fig. 5 complete the inputs: N**r. vitei valorificati/ferma (No. calves recovered/farm), Pret în viu/cap** (Price/Live animal)**, Pret/cap reforma**

(Price/culled head)**, Cantitate gunoi grajd valorificat/ferma** (Amount of manure recovered/farm)**, Pret gunoi/tona** (Manure price/ton).

The data editing window for the secondary production is presented in Fig.5.

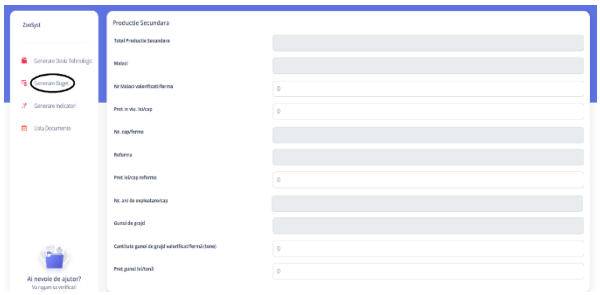

Fig. 5. Secondary production window.
Source: ZOOSYST

The data editing window for income and expenditure budget are shown in Fig. 6.

The values are taken and used in the calculation of the elements of the budget, as follows:

- enter the value for the **Subventii (**Subsidy) and **Pret piata** (The market price), respectively the value of the percentage related to the tax rate is chosen from the list.

to calculate the value of **Impozite si taxe (**Taxes and fees).

- all expenditure categories have been calculated or taken over automatically from the technological estimate and the budget can be generated (Table 3).

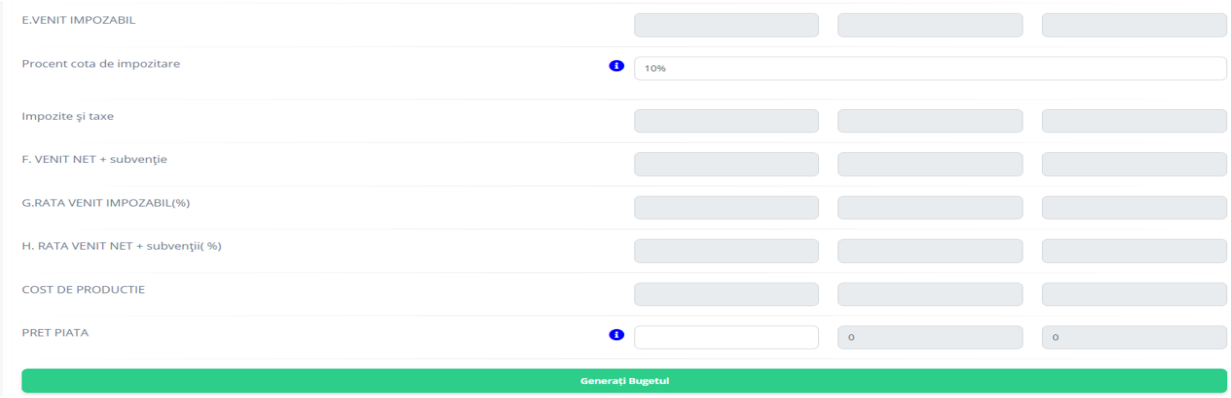

Fig. 6. Data editing window for the income and expenditure budget.
Source: ZOOSYST.

Table 3. The income and expenditure budget

DEVIZ TEHNOLOGIC VACI DE LAPTE					
		Total Capete	Productia medie		Ani Exploatare
		15	5500	l/cap	5
		ANUL			2022
		U.M/cap			
SPECIFICARE	U.M.	Cantitate	ret lei/U.M	Lei/cap/an	Lei/fermă
1. Cheltuieli cu furaje	kg			3840	57600
Fân Lucerna	kg	1000	0,4	400	6000
Pășune de deal masă verde	kg	11500	0,08	920	13800
Siloz Porumb	kg	4000	0,19	760	11400
Alte concentrate	kg	1600	1,1	1760	26400
2. Material biologic	lei	1	5000	1000	15000
3. Energie si combustibil	lei			110	1650
4. Medicamente si material sanitar	lei			120	1800
5. Alte cheltuieli materiale	lei			110	1650
6. Cota de aprovizionare	lei			49,6	744
7. Asigurari	lei			0	0
TOTAL CHELTUIELI VARIABILE	lei	0	0	5229,6	78444
8. Cheltuieli cu forta de munca	lei			1064	15960
9. Cheltuieli generate	lei			0	0
10. Dobanzi la credite	lei			38,4	576
11. Amortisment	lei			157	2355
TOTAL CHELTUIELI FIXE	lei	0	0	1259,4	18891
TOTAL CHELTUIELI	lei	0	0	6489	97335

Source: ZOOSYST.

Table 4. Technical-economic indicators

INDICATORI VACI DE LAPTE			
Nr. crt.	INDICATORI	UM	Valori
0	1	2	3
1	Producţia medie	l/cap	5500,00
2	Valoarea producţiei	lei/l	1,21
3	Valoarea producţiei principale	lei/l	1,10
4	Cheltuieli totale	lei/l	1,18
5	Cheltuieli pentru producţia principală	lei/l	1,07
6	Cheltuieli variabile	lei/l	0,95
7	Cheltuieli materiale	lei/l	0,92
8	Cheltuieli fixe	lei/l	0,23
9	Cheltuieli cu forţa de muncă	lei/l	0,19
10	Costul unitar	lei/l	1,07
11	Preţul de valorificare	lei/l	1,10
12	Productivitatea muncii în expresie fizică	Ore-om/l	0,06
13	Productivitatea muncii în expresie valorică	Lei/ora-om	17,19
14	Cheltuieli cu forţa de muncă la 1000 lei producţie totală	lei	159,84
15	Cheltuieli materiale la 1000 de lei producţie totală	lei	761,64
16	Cheltuieli la 1000 de lei producţie principală	lei	972,29
17	Profit sau pierdere pe unitatea de produs	lei	0,03
18	Rata rentabilităţii	%	2,85
19	Marja asupra cheltuielilor variabile (MCV)	lei	0,26
20	Marja asupra cheltuielilor variabile %	%	21,44
21	Pragul de rentabilitate în unităţi valorice PR	lei	5874,55
22	Pragul de rentabilitate în unităţi fizice PR	l	5340,50
23	Rata riscului de exploatare	%	97,10
24	Indicele de securitate (Is)		0,03
25	Poziţia absolută faţă de PR	lei	175,45
26	Poziţia relativă faţă de PR		0,03

Source: ZOOSYST.

Step 4. Completion of elements for the technical-economic indicators

- in the Work Productivity window (Fig. 7), fill in the inputs: **Nr. muncitori/ferma** (No. workers/ farm)**, Nr. zile lucrate/om/an** (No. days worked/ man/ year) and **Nr. ore/zi/om** (No. hours/ day/ man).

Fig. 7. Work productivity window.
Source: ZOOSYST.

- the computer system takes the values of the indicators obtained in the previous screen and then calculates the financial indicators, specific to the profitability analysis, which it displays in spreadsheet format (Table 4).

The window for generating technical-economic indicators is presented in Fig. 8.

Step 5. Document list view

After going through the steps described above, the program allows you to choose ***Lista documente*** (The list of documents) option, basically, a set that contains the technological estimate, the income and expenditure budget, respectively the technical-economic indicators, and which can be generated for each species/category among those analyzed within ZOOSYST.

The list of documents is presented in Figure 9.

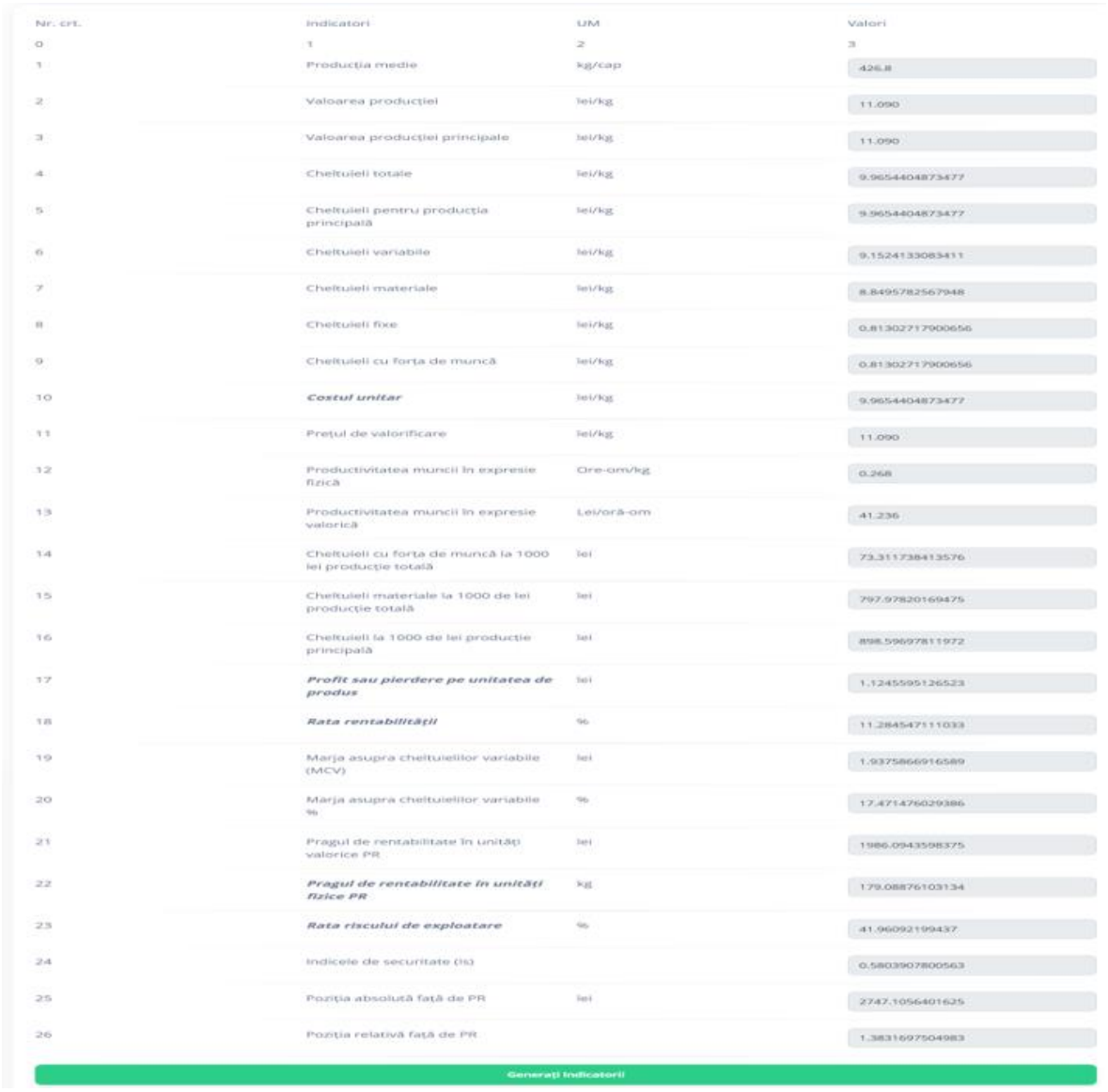

Fig.8. The window for generating technical-economic indicators.
Source: ZOOSYST.

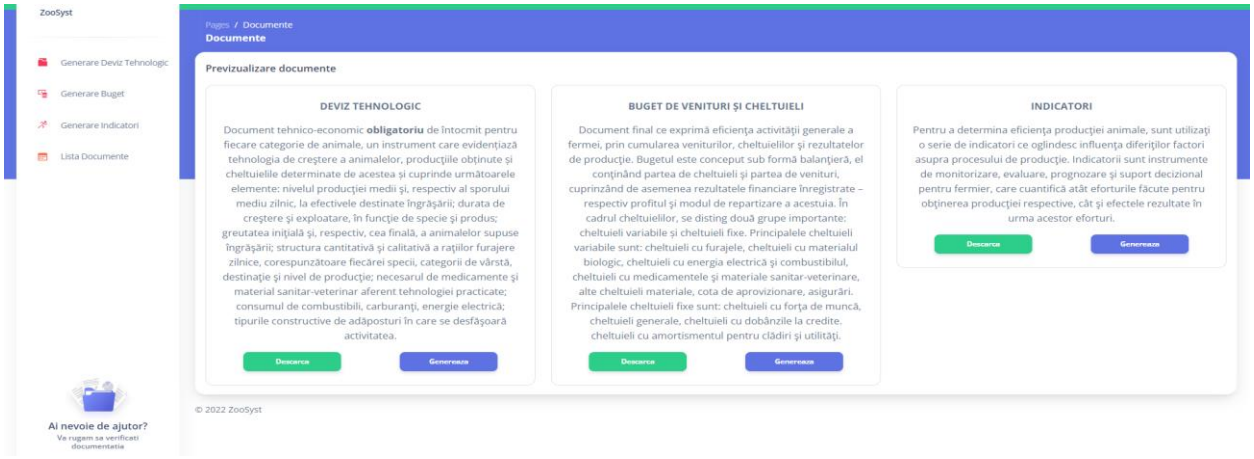

Fig. 9. Document list generation window.
Source: ZOOSYST.

CONCLUSIONS

The use of high-performance computer systems, adapted to the informational needs of farmers, can lead to the improvement of farm management and can contribute to the gradual transformation of agriculture from subsistence agriculture into a high-performance economic activity [7]. For this purpose, this paper proposes the development of computer systems accessible to small and medium-sized farms, which, at the same time, meet their special informational needs.

The ZOOSYST web application allows the analysis of production activity based on specific economic and technical indicators and provides management information necessary to plan the best allocation of resources. From an economic-financial point of view, this analysis can highlight correlations between revenues and expenses from the development production (grouped into variable costs and fixed costs) and allows the development of different hypotheses and simulations on the farm's profits. From the point of view of management, the analysis allows optimal sizing decisions on the production capacity and attracts investments for the development and modernization of the farm.

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