Guidelines to the management simulator FARMASIM

Protection of copyright

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Software FARMASIM was developed with the support of the Technological Agency of the Czech Republic, program Zéta, project Management Simulator for Livestock Production – FARMASIM (TJ01000068).

The basic version of the software FARMASIM including the guidelines is freely available at:
http://farmasim.pef.czu.cz/

This is the direct translation from the Czech version. Some figures are not translated, however, the user interface of the simulator is completely in English.

Contents

1 Introduction

The software was developed with the support of the Technological Agency of the Czech Republic (the project Management Simulator for Livestock Production – FARMASIM (TJ01000068)). The project represents a direct response to the increasing complexity of decision making in the uncertain and very variable environment of small businesses in the area of livestock production. The project's objective was to increase the effectiveness of decision making using a simulator of managerial decisions and their impacts on the company. The use of the simulator of such a type helps to decrease uncertainty, increase flexibility, and finally, will have a positive impact on the competitiveness of small businesses.

A system approach and application of the principles of system dynamics allow managers to test the impacts of the proposed changes on the key indicators of the company health in the long-term outlook and from the point of view of various scenarios of market development. Applying this procedure, it is possible to strengthen sustainability of livestock production.

A computer simulation based on the principles of system dynamics may be used especially when modelling complex systems containing a number of feedbacks, lags, non-linearities. A big lag between the decision and its impact when it is not possible to accelerate it (as a typical example, an extension of herd by reproduction) and system inertia related to biological cycle are typical for livestock production. These aspects reduce flexibility when making decisions to manage a company. In addition, a small farmer, in the Czech environment, is the beneficiary of both inputs and outputs prices, with no greater possibility to have impact on them. Planning in the area of livestock production is of an interim and long-term character; small farmers have usually only their own opinion to make such decisions, with no support of a sophisticated tool.

The management simulator FARMASIM was developed applying the simulation software Vensim and add-ons for the development of the user interfaces Sable Developer.

1.1 Model in the background

If the reader is looking just for a guideline how to work with the software FARMASIM, it is possible to skip this chapter and continue directly in Chapter 2 Work with the simulator and interpretation .

A relatively simple causal-loop diagram was developed on the grounds of the interviews with the farmers, expressing the relations of basic variables in the system of livestock production (Figure 1). Each of the variables is further detailed in the model itself to a number of partial variables and parameters in order to be able to describe livestock production in a sufficient detail using the software.

The discussion resulted also in the identification of naturally exogenous variables such as soil. Compared with the other production factors, it is not possible to acquire land always when a company is in its growing phase, it is rather the opposite situation in agriculture – if a small famer has an opportunity to acquire a land that is in a reachable distance, the company will be extended (often despite an unfavourable economic situation at the concerned time as it is not sure that the opportunity to acquire land „next time" will repeat).

With regard to the fact that the guidelines do not deal with the explanation of system dynamics procedures, we will add a simple explanation using the following table (Table 1) and a brief text to the diagram. If you are interested in system thinking or if you would like to understand the simulator better, we recommend you to begin with the publication in the Czech language "Průvodce systémovým myšlením" (Guide through system thinking) by M. Šusta; for the readers who have a good command of the English language, Thinking in Systems: A Primer by Donella H. Meadows.

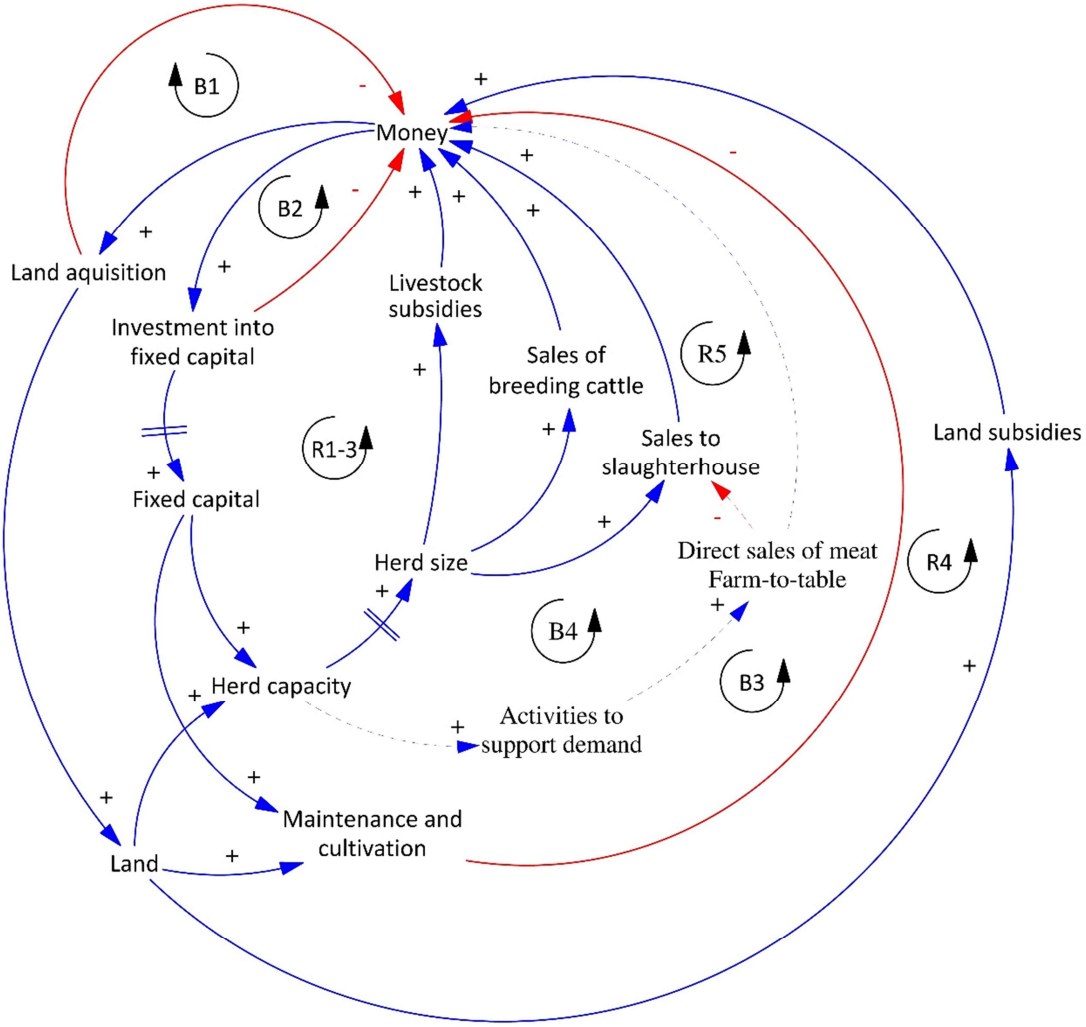


Figure 1: Basic causal-loop diagram

Self-reinforcing loop (also the term positive loop, standardly marked „R" as „Reinforcing" is used in the same meaning) expresses that the original value of a variable has a self-strengthening impact through several relations to other variables. For example, the more money deposited in the account, the higher interest rate credits the account and the more money is in the account; or the bigger number of animals in the basic herd, the bigger number of young animals and the bigger number of animals later in the basic herd.

On the contrary, *Balancing* loop (here, negative loop or goal-seeking loop is the synonym, standardly marked „B" as „Balancing"), is describing the situation when an increased value of a variable has a self-reducing effect within the loop. Every system consists of a number of such loops that are fighting for dominance, having impact on the system behaviour.

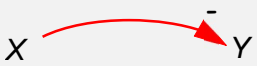
SYMBOLIC EXPRESSION	INTERPRETATION	MATHEMATICAL FORMULA
	Under otherwise invariable circumstances, with the growth of x, y is growing above the level where it would be if x is constant.	$\frac{\partial y}{\partial x} > 0$
	If y is a stock variable (accumulation): x is adding to y.	$y = \int_{T_0}^{T} x dt + y_{T_0}$
	Under otherwise invariable circumstances, with the growth of x, y is falling under the level where it would be if x is constant.	$\frac{\partial y}{\partial x} < 0$
	If y is a stock variable (accumulation): x is decreasing from y.	$y = \int_{T_0}^{T} -x dt + y_{T_0}$
	Indication of a lag	
	Reinforcing/positive loop	
	Balancing/negative/goal-seeking loop	

Table 1: Elements of causal-loop diagram

After conversion to the system of differential equations, the model has more than 1,800 variables and parameters (338 stock variables, 963 auxiliary variables, and 537 constants/parameters) and a corresponding number of the equations. The selected diagrams of stocks and flows and their interpretation are given at the end of the guidelines.

2 Work with the simulator and interpretation of results

2.1 Several introductory remarks

When developing a management simulator, it is always important to find an adequate limit between the detail described by the model and user- friendly environment. A user-friendly interface is sometimes at the expense of a small simplification or inaccuracy that, however, have no principal impact on the behaviour of the simulated issue.

For example, milk yield is set at the average milk yield in accordance with the order of lactation. The model does not work explicitly with dry period or with the development in the course of lactation as this would result into a significant worsening of the software user-friendly environment (the interim period

varies depending on species, production method, success of the farmer…) at the expense of a very limited calculation detailing. Instead of this, we assume approximately even distribution in the herd (we know that there are more advantageous and less advantageous months of calving, however, from the point of view of the model, this assumption means maximum a shift of a part of the profit by several weeks or by a month that has again no impact on the purposes for which the simulator is developed). The calculation of the aggregated receipts for the entire herd (made on the grounds of the average parameters) is not affected.

To ensure the user's comfort, also entering of the initial structure of the herd of dairy cattle is simplified. Only the number of cows after individual calving and in the individual categories (lactation, dry period, etc., the number is calculated proportionally in accordance with the period duration) is entered.

For poultry, we do not distinguish ranges and rest periods, we consider the average for the whole laying cycle. With regard to the necessary flexibility of the entire simulator, the terms may not necessarily correspond (for example, for poultry, we work with females and males as the model allows changing the parameters for various species of poultry, and then, for example, the term "kuřice" (chicken reared for laying) would not correspond to duck production).

The model works primarily with the average values so it is the most beneficial not to use whole numbers but to work with *decimal numbers* (for example, model will display 7.8 of goat or 11.6 of bull). It will actually not happen to you in reality, however, in the long-term perspective, the economic indicators will correspond to reality. And the lost information caused by rounding would result into a high inaccuracy of the calculations. We similarly allowed that certain values (available capacity of animal housing, available capacity of land, etc.) could fall under zero; in the course of the simulation, a warning red light will appear for negative available capacities. This is because of the fact that it is very often possible to have, for example, several redundant heads of cattle. However, it is very individual how many redundant heads are acceptable and we leave it up to the consideration of the user.

If you are still missing a certain aspect of your business in the model, it is probably possible to express it by the variable or fixed costs.

2.2 Work with the software FARMASIM

2.2.1 Software installation

Before starting the software FARMASIM and making various simulations of decision-making using the simulator and analysing their impacts on the company, it is first necessary to start and install the installation package **FarmaSimInstallation.exe** (Figure 2).

Figure 2: Installation package

After starting the installation package, it is necessary to agree on the licence terms (Figure 3) and continue using the button „Next >".

It is further possible to select the location of the software installation (Figure 4). However, it is not necessary to select the software location as the location address has been already primarily set, and if the user leaves it as it is, he can go on directly using the button „Next“.

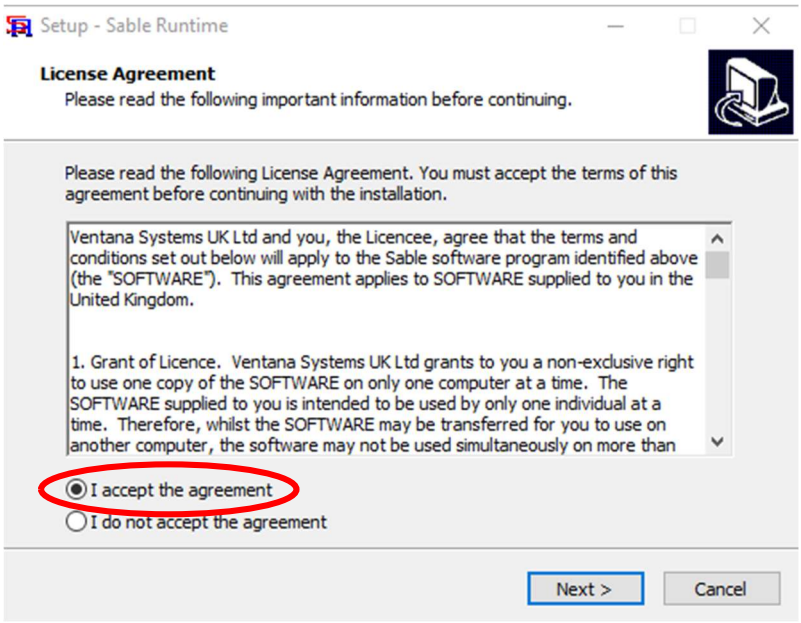


Figure 3: Licence terms

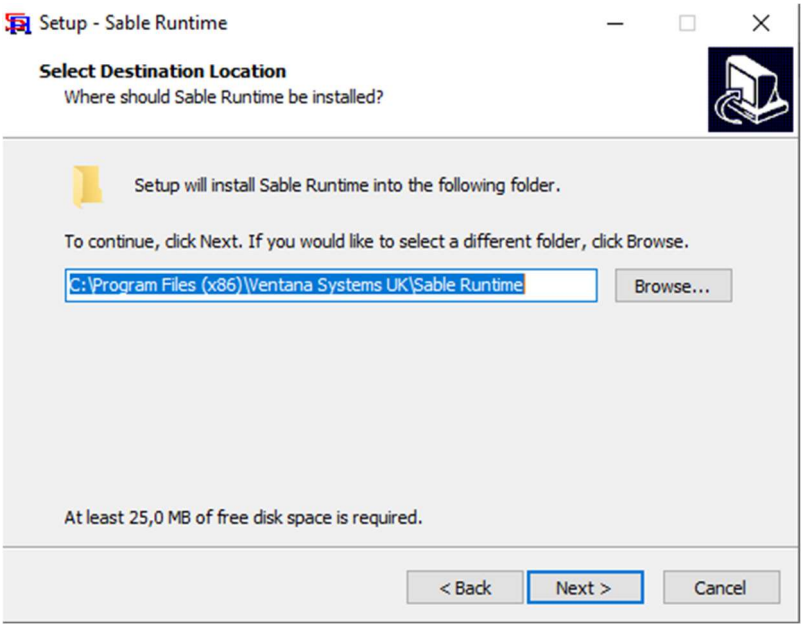


Figure 4: Directory of the installation location

The information is then displayed regarding the location of the icon of the installed installation package. It is necessary here just to continue using the button „Next >“ (Figure 5).

The following step will display for the user the aggregate information on the location of the installation package necessary for the start of the software FARMASIM that has to be confirmed using the button „Install“ launching the installation itself of the installation package (Figure 6).

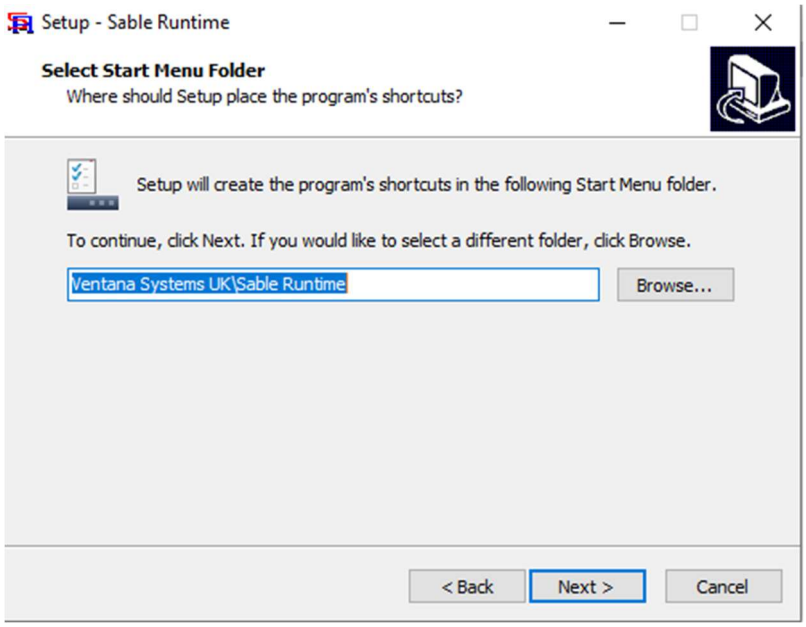


Figure 5: Location in Start Menu

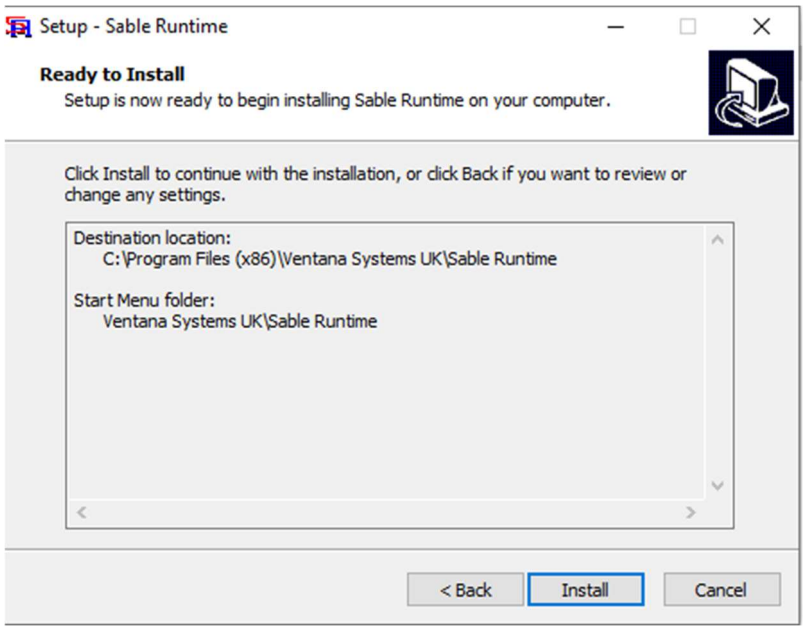


Figure 6: Installation start

Following the installation, the information will be displayed for the user about the successful installation of the installation package. It is good here not to tick off the option for starting the package (Launch Sable Runtime) but to leave this tick off button empty (Figure 7) and close the guide through the installation using the button „Finish“.

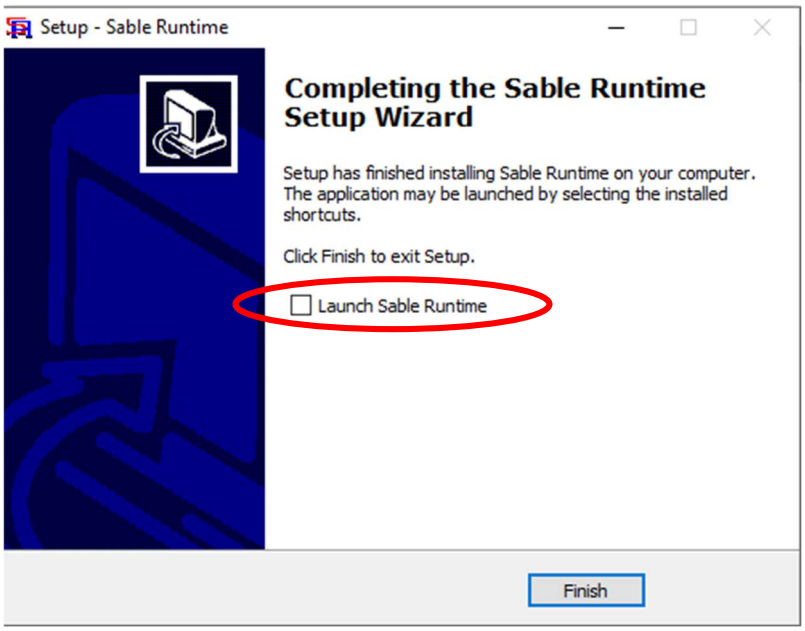


Figure 7: Installation completion

2.2.2 Start of the simulator

Following the installation of the installation package, it is possible to start the simulator FARMASIM itself in such a way that at the place of the location of the installation package, the file **FarmaSim.spk** (Figure 8) is located for starting the software FARMASIM when after its opening, the simulator is started.

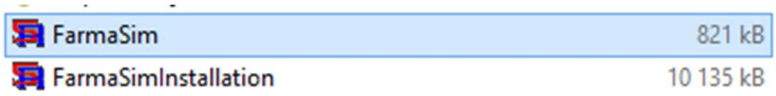


Figure 8: Starting the simulator FARMASIM

The simulator itself is then started using the button „START“ that is located in the middle of the introductory window of the simulator (Figure 9). Following its start, the user will get in the basic menu of the entire simulator (Figure 11).

When staring the simulator, two folders named **tempSubProj** and **tempModel** (Figure 10) are created at the place of the location of the installation file and FARMASIM simulator file serving the storage and management of supporting files, for example, the files of the individual simulation runs (datasets) with the suffix .vdf are stored in the folder tempModel; for more information about the management and use of datasets see Chapter 2.2.5.

The basic menu of the simulator FARMASIM that is displayed following the start of the button „START“ in the initial window of the simulator contains two rows of buttons (Figure 11). The upper row includes the buttons for setting the basic parameters of livestock production for the individual types of animals (dairy cattle, beef cattle, pigs, goats, sheep, poultry). The bottom row of the buttons contains the button „DATASET“ for the management of datasets, buttons for displaying the application description, licence terms, and the button „Default setting“ serving the deletion of all settings entered by the user and returning the values of all parameters to their original state. In addition, this row of the

buttons includes the button for setting finance and management, button „” START THE SIMULATION“ to start the simulation run itself, and the button to close the simulator.

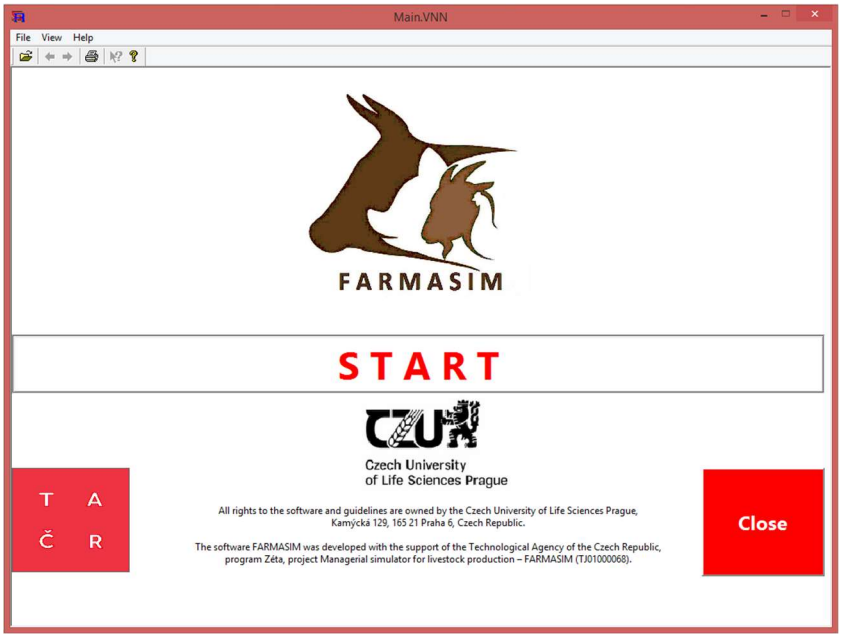


Figure 9: Introductory window of the simulator FARMASIM

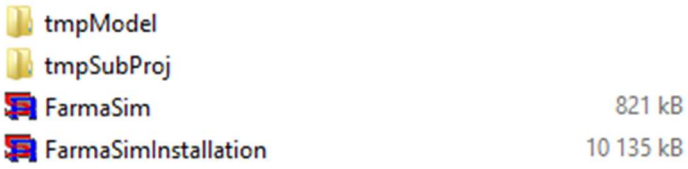


Figure 10: Created folders of the software FARMASIM

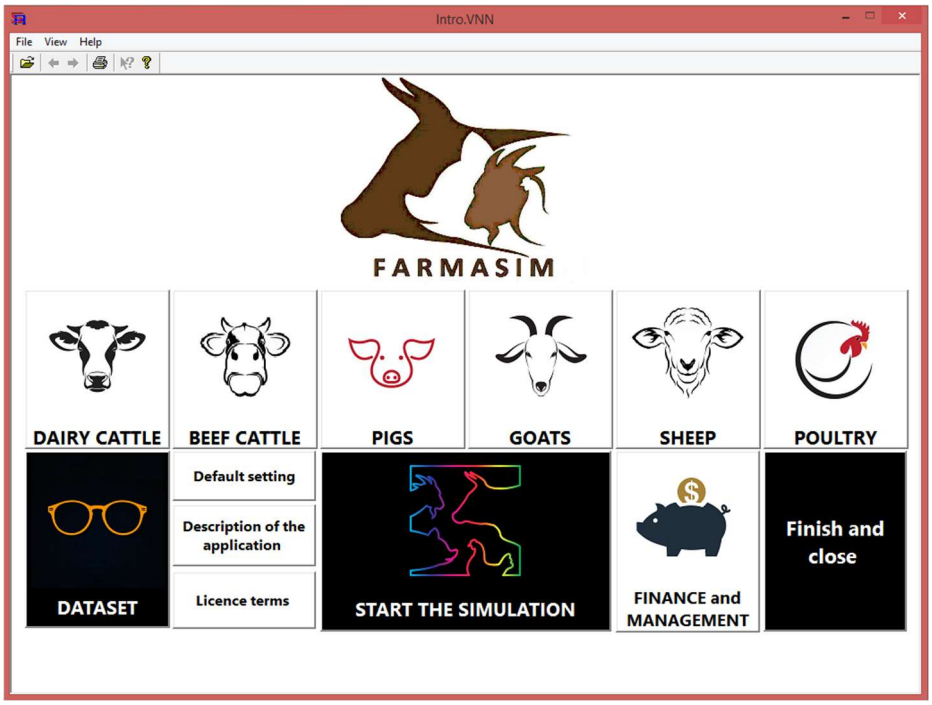


Figure 11: Basic menu of the simulator FARMASIM

2.2.3 Selection and setting of livestock production

As an example of the use of the simulator FARMASIM, let us imagine a simplified hypothetical situation of a small farmer who does not own a big land and is involved rather in the production of pigs. The farmer has his own farm buildings when in a certain part of them, he has an area reserved for housing of 25 pigs, however, the premises could otherwise serve housing of up to 15 livestock units (LUs) of animals. In addition, he has 1.5ha of the farmland from which, however, he does not consider the main income of his farm production. Let us show how he will set the simulator to simulate his livestock production.

First of all, the farmer will select, in the basic menu of the simulator in the row of the buttons (Figure 11) for setting livestock production for the individual types of livestock, the button „ PIGS“ to set the basic parameters of herd. The dialogue window for setting the basic parameters of livestock production for pigs has three main parts – Initial numbers of herd, Additional parameters of herd, Parameters of herd economy (Figure 12), and in the left upper part, it is possible to set the duration of simulation in years and the beginning month of the first year of simulation; in our example, the simulation was set for 3 years with the beginning in the first month of the first year of the simulation.

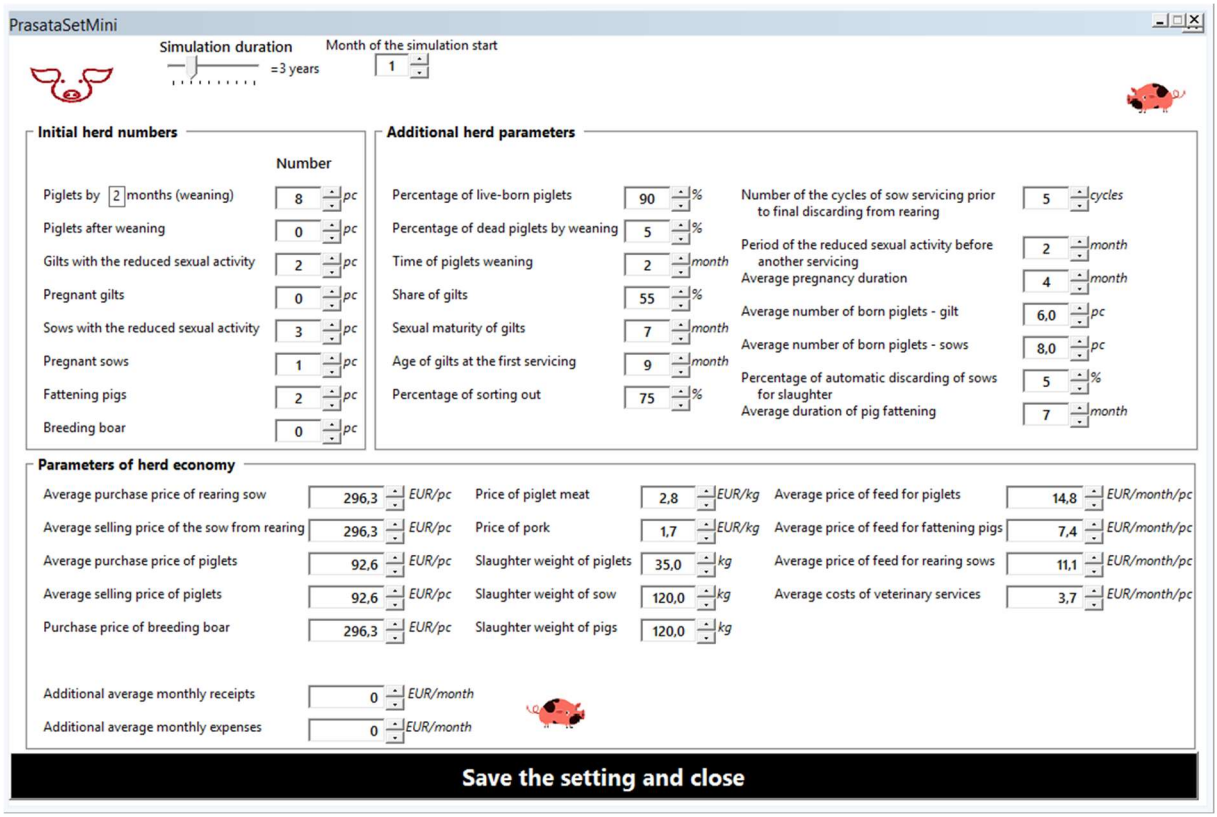


Figure 12: Basic setting of livestock production – pigs 1

In the section Initial herd numbers, it is possible to set the initial values of the numbers of animals of various categories. Our farmer has 8 piglets before weaning, 2 young sows with the reduced sexual activity, 3 sows with the reduced sexual activity, 1 pregnant sow, and two fattening pigs. To make it simple and user friendly, the parameters are set in accordance with the average values so it is not further distinguished here at what stage of fattening those two pigs are found, and to make it simple, only total number of fattening pigs is given, etc. The additional herd parameters by the percentage of live-born piglets, through the number of cycles of sow servicing up to the average duration of pig fattening, may

be set in the section Additional herd parameters. The parameters of herd economy relating to financial indicators may be set in the bottom part of the dialogue window in the section Parameters of herd economy. The farmer will set here, for example, slaughter weight of pigs when selling them to slaughterhouse, or the average price of 1kg of live weight of pig when being sold to slaughterhouse, etc. The farmer has to further set the basic parameters regarding finance, fixed capital, and subsidies; he therefore has to push the button „Finance and management “ in the bottom row of buttons of the basic menu of the simulator (Figure 11). The menu for Finance and management (Figure 13) will be displayed consisting of the buttons for setting finance, fixed capital, subsidies, and loans.

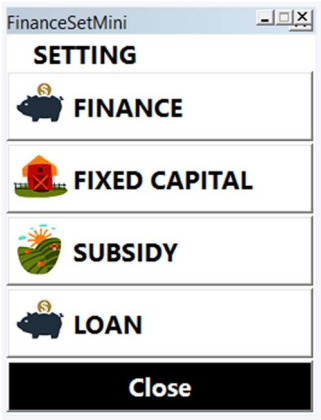


Figure 13: Menu Finance and setting management

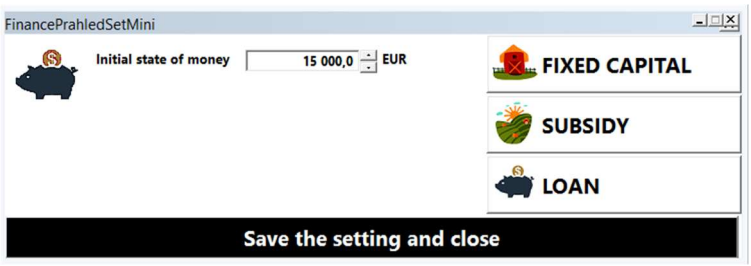


Figure 14: Money setting

In this way, the farmer may gradually set the parameters in accordance with his situation. In this hypothetical situation, the farmer set the initial state of his financial means at 15 thousand EUR (Figure 14). In the menu for fixed capital (Figure 15), he will gradually select and set the basic parameters of fixed capital.

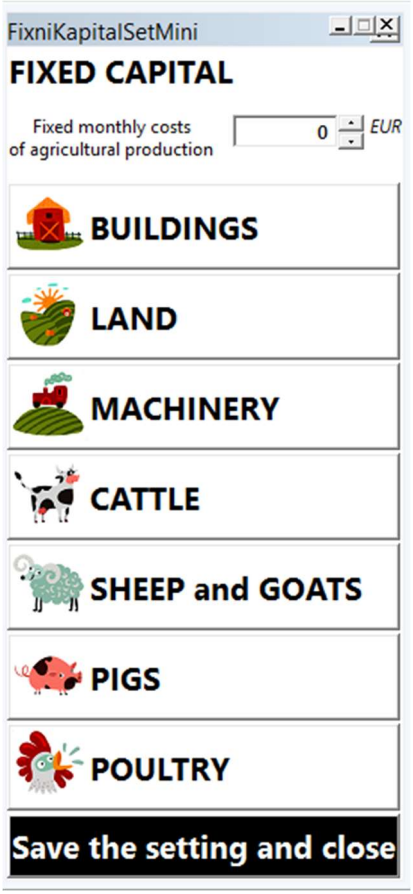


Figure 15: Menu Fixed capital

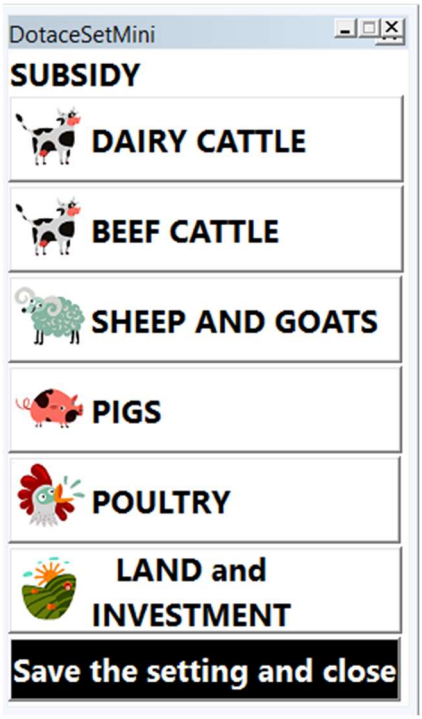


Figure 16: Menu Subsidies

He will set the capacity of storage premises for LU at 15 and make estimate of the duration of the storage capacities building at 1.7 years (Figure 17).

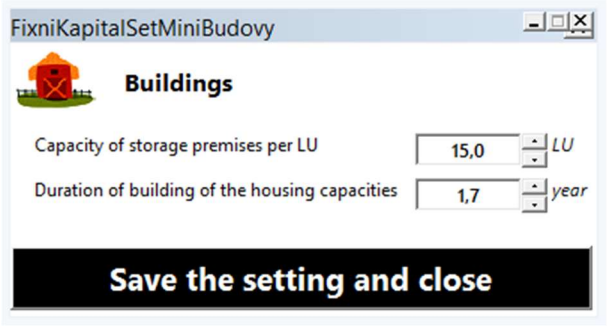


Figure 17: Buildings

For the land, he has opportunity to set the area of own (1.5ha) or rented (0ha) land. The costs of land, and last but not least, also the multiplier of land capacity (Figure 18). The multiplier of land capacity expresses how many LUs is possible to have on one hectare of land.

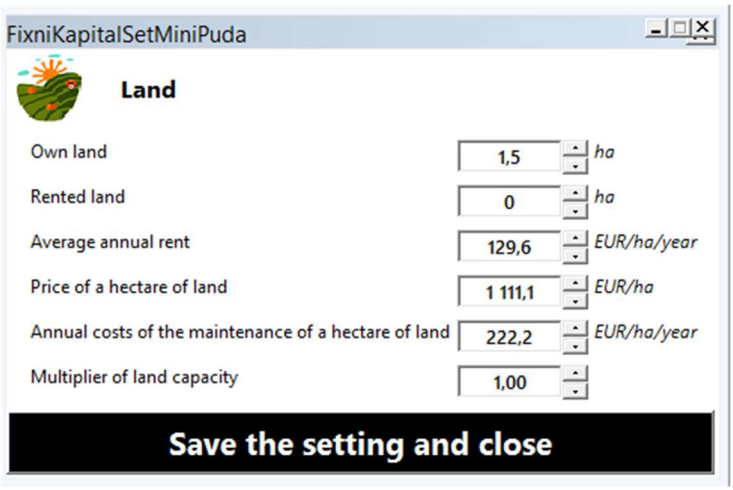


Figure 18: Land

In our simplified hypothetical situation, the farmer estimated the value of his equipment used for livestock production at EUR 20.7 thousand (Figure 19).

Figure 19: Machinery and equipment

The farmer then had to set only the parameters concerning the area of fixed capital directly for pigs, for example, he set the capacity of pig housing at above 25 heads (Figure 20) of pigs when the farmer set also the coefficients for the calculation of housing capacity use, for example, the piglets take less than one tenth of the area for adult pig.

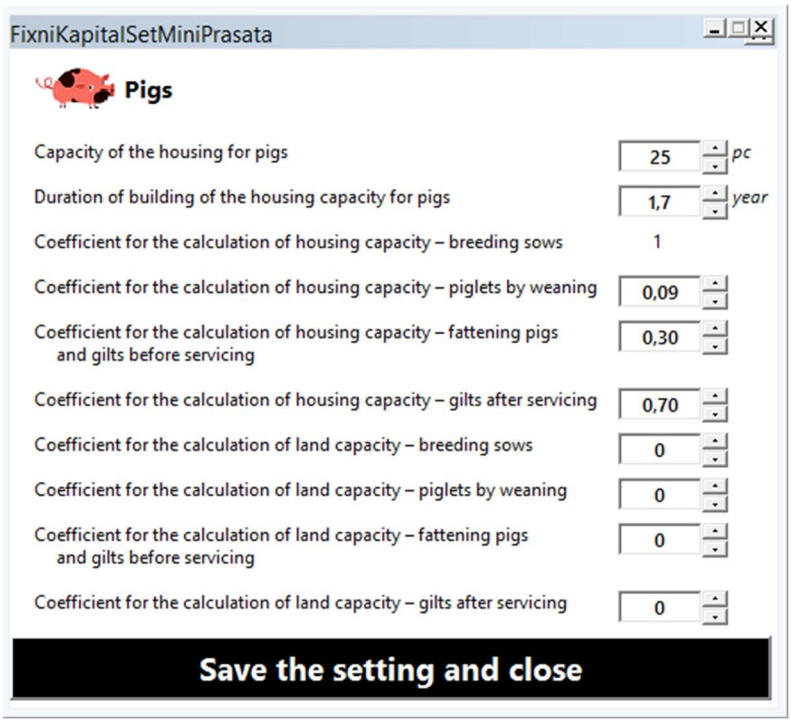


Figure 20: Fixed capital – pigs

In the menu for subsidies (Figure 16), the farmer selected the concerned button to fill in the subsidy parameters. In our hypothetical situation, the farmer set May, it means the 5th month, as the month when he will receive the subsidies paid for animals, he filled in the cocnerned amount of subsidies per LU and current reference number of pig LUs for which he currenly receives subsidies. He also filled in the coefficients of conversion for the individual categories of pigs for the conversion to LU (Figure 21).

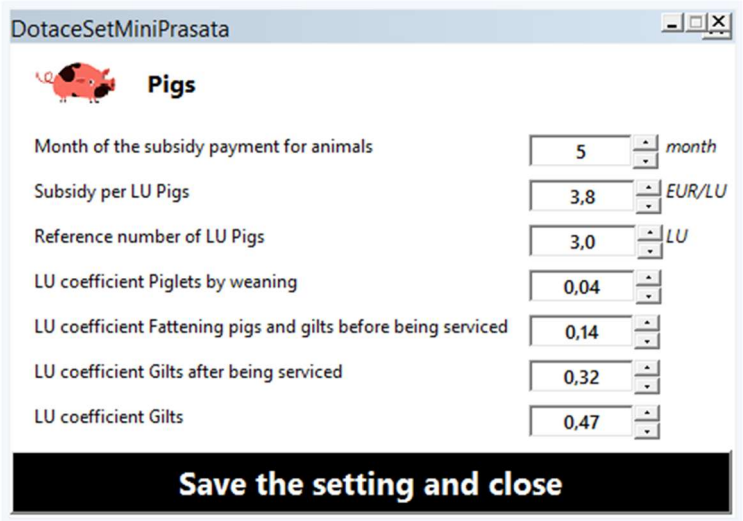


Figure 21: Subsidies - pigs

By closing, the farmer entered also his existing loan that he is currently paying for. It concerned EUR 13 thousand borrowed at 3.5% p.a. for 60 months when he is currently in the 26th month of the loan payment (Figure 22).

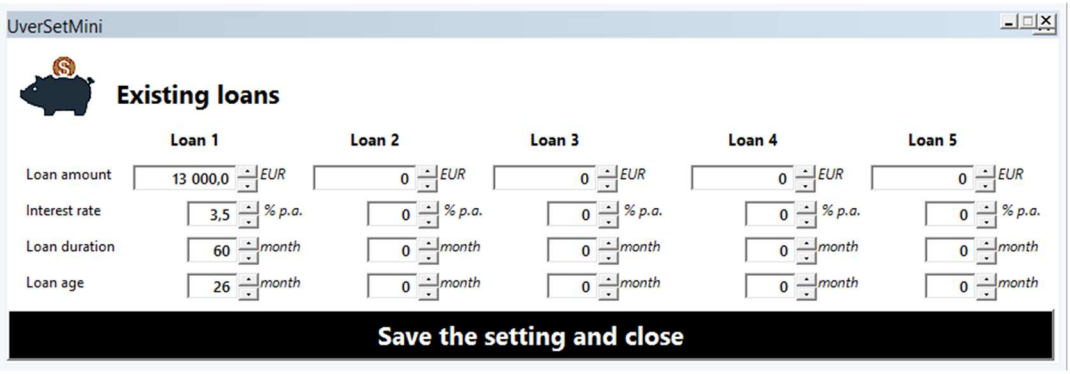


Figure 22: Loan setting

All settings of the parameters in the setting before starting the simulation run or subsequently also in the decision settings in the simulation run may be carried out either by entering the numerical values from the keyboard or by the mouse using the buttons arrow up or arrow down immediately next to the fields for entering the values of parameters.

It is necessary to refer here to the number of all parameters and settings that the farmer, in the role of the user of this simulator, has to set and enter. To maintain the user-friendly interface, the degree of detail captured by the model was reduced, however, despite this fact, it may appear that the user has to provide a big volume of the information about his livestock production and fill in a number of parameters. In this respect, the simulator is helpful to the user by pre-setting a number of parameters (almost all of them) and the user sets, respectively changes, only the parameters where he has different parameters compared with the entered pre-setting.

If the user would like to delete, at any time, all his settings and return to the entered primary pre-settings, it means to so called „default setting“ of the simulator, it is enough just to press the button „Default setting“ in the bottom row of the control buttons in the basic menu of the simulator (Figure 11).

2.2.4 Simulation

Following the setting of all parameters, the user may start the simulation run using the button „START SIMULATION“ found in the middle of the bottom row of the control buttons of the simulator basic menu (Figure 11).

All dialogue windows created for the management of simulation run are indicated with the label **SIMULATION** in the right upper corner of the window.

Following the start of the simulation run, the window of the simulation run basic menu is displayed (Figure 23). In the upper row, the buttons to manage the simulation run of livestock production for the individual types of animals (dairy cattle, beef cattle, pigs, goats, sheep, poultry) are found. The bottom row of the buttons contains the button „DATASET“ to manage the datasets and „Finance and management “ to manage the parameters during the simulation run. Following the start of the button “PIGS“, our hypothetical farmer will get access to manage the simulation run for herd management (Figure 1), respectively the management of pig production.

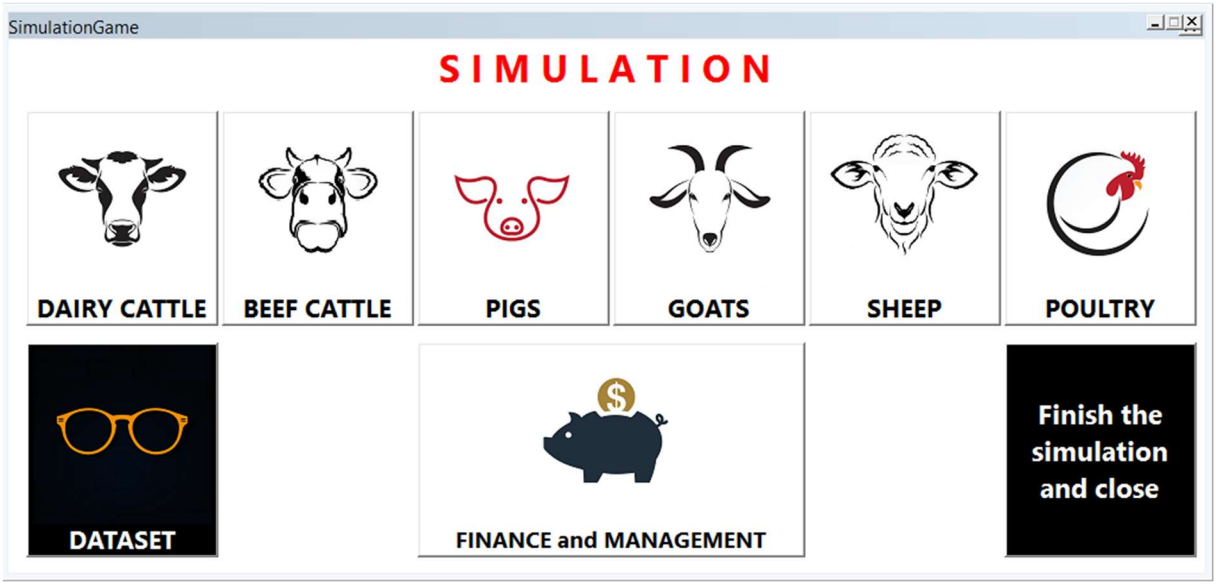


Figure 23: Basic menu of simulation run

In the dialogue window for the management of pig herd (Figure 24), the farmer see the course of the simulation run in the first year of the simulation run (the current time of simulation is displayed always on the left, up), the simulation proceeds in the steps per month forward by the button „=>“. In the left part of the window, the farmer sees the numbers of the individual categories of animals; in the middle of the window, the control elements for the creation of managerial decisions (purchase and sale of the individual categories of animals) are found; the right upper part provides the overview of the LU numbers and individual available capacities (available capacity of the buildings to store LUs, available capacity of pig housing, and available capacity of land). The indicators of available capacities are provided here with the light signalization of green colour if the capacity is available; of orange colour if the capacity is zero, and of red colour if the available capacity is negative. Negative capacity means that it is possible to have, for a certain period of time, several redundant heads of pigs. However, it is very individual how many redundant heads is acceptable and we leave it to the consideration of the user.

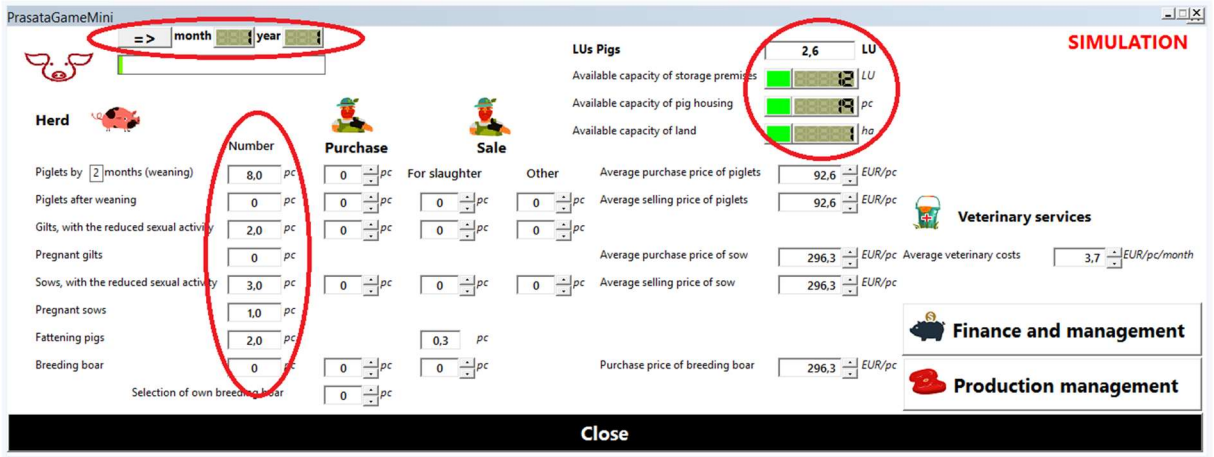


Figure 24: Herd management – pigs 1

In the dialogue window, it is further possible to change the purchasing and selling prices of the individual categories of animals, and in the right upper part of the simulation, the buttons are found to start the

work with finance and management during the simulation run and the button „“Production management“ to display the window of production management; for pigs, it concerns meat production.

In our hypothetical situation of a small farmer, let us assume that during several first months, the farmer did not consider any significant decision to be made, and by the repeated pressing of the button „=>“ forward, let us shift the simulation time to the fifth month of the first year of the simulation. The state in the fifth month of the first year of the simulation (Figure 25) shows how the numbers of the individual categories of animals changed and especially the decreasing available capacity for pig housing; this was caused by the birth of new piglets and increasing age of the piglets already born.

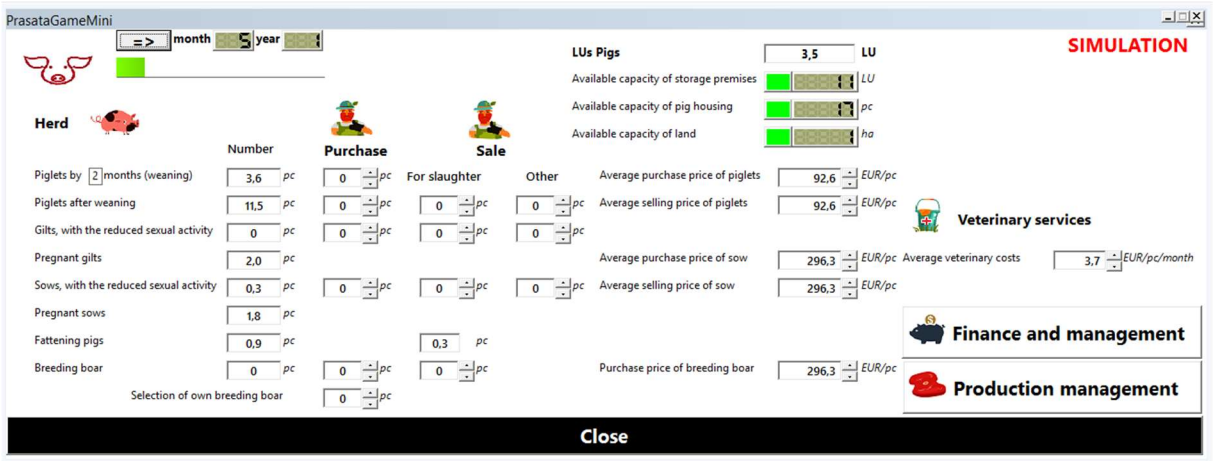


Figure 25: Herd management – pigs 2

If the capacity is approaching zero or is negative (the red warning light would be seen), the farmer could increase the capacity for pig housing by pressing the button „Finance and management“ -> „Fixed capital“ -> „Buildings“, respectively „Pigs“, either directly by acquiring storage capacities or by building storage capacities (Figure 26); however, at this moment, the available storage capacities are sufficient, it is not necessary to increase them.

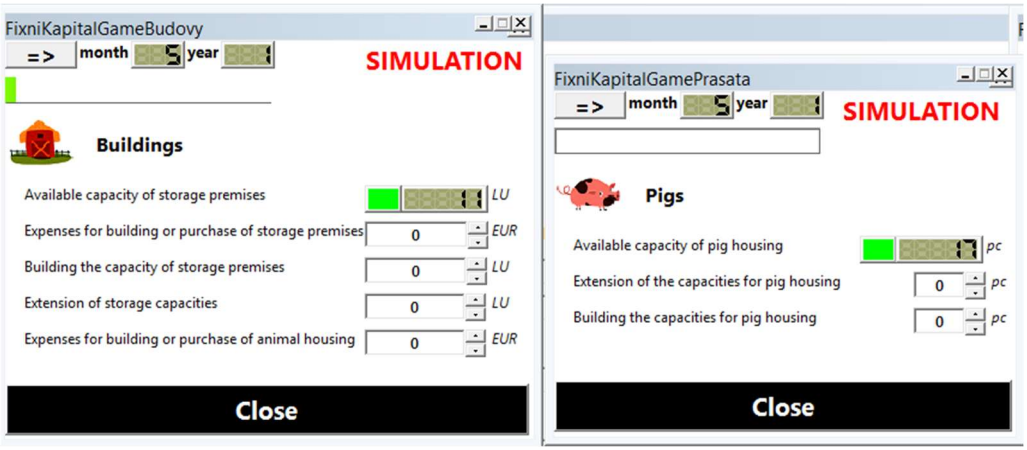


Figure 26: Increase in the capacities – pigs

In the dialogue window of herd management (Figure 27), on the right, in the bottom, the button „Production management“ is found using which the farmer gets in the window for production management. The farmer then sees here the heads in the individual categories of pigs intended for slaughtering and has opportunity on the left, in the bottom, to set the slaughter weights and purchasing prices. In this window, there is also the first button to manage feed and there is the option to enter also

the aggregate average value of the additional monthly production or costs of livestock production (on the right, in the bottom). Using the button „Finance and management“ -> „Loan“, it is possible to get the information about total annuity monthly amount or to negotiate another loan (Figure 28), respectively „Finance“ and to get the information about total receipts, expenses, and state of finance (Figure 29), the development of this quantity may be displayed using graphs.

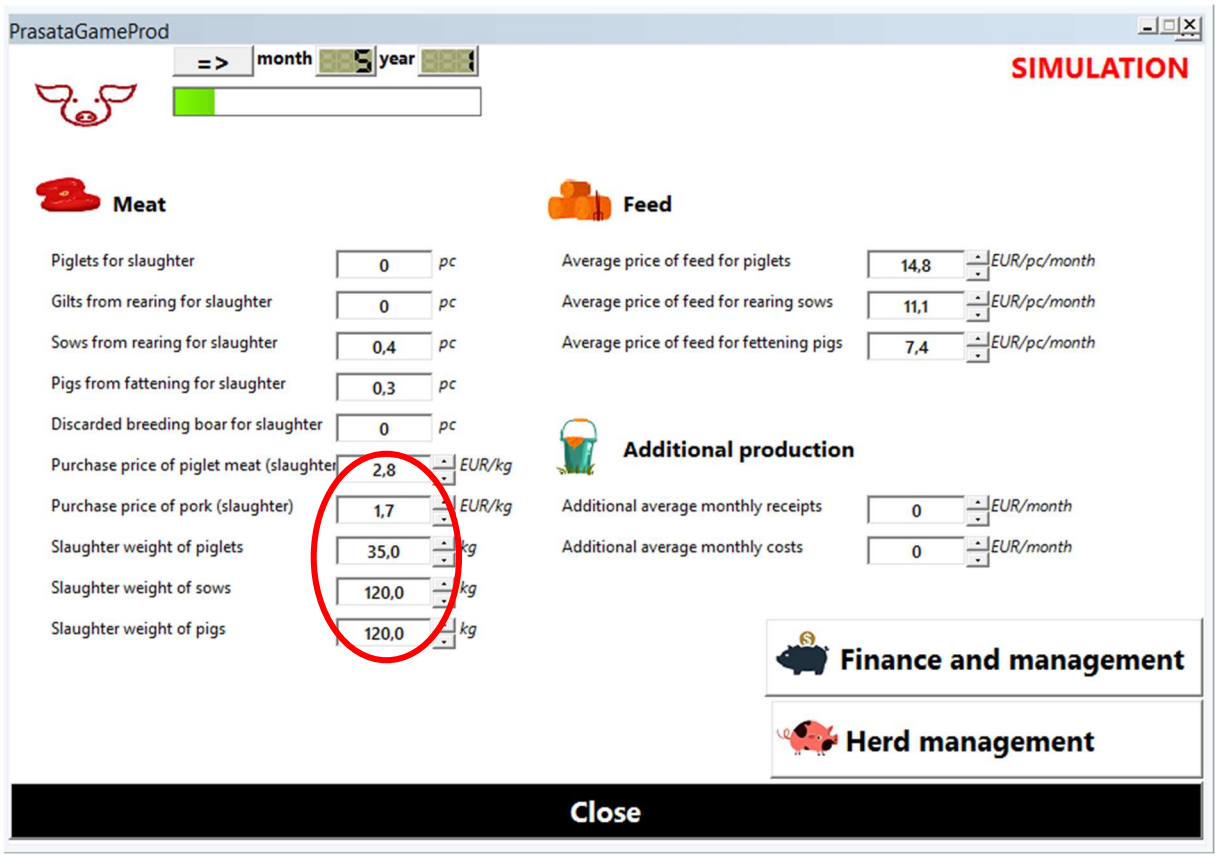


Figure 27: Production management – pigs

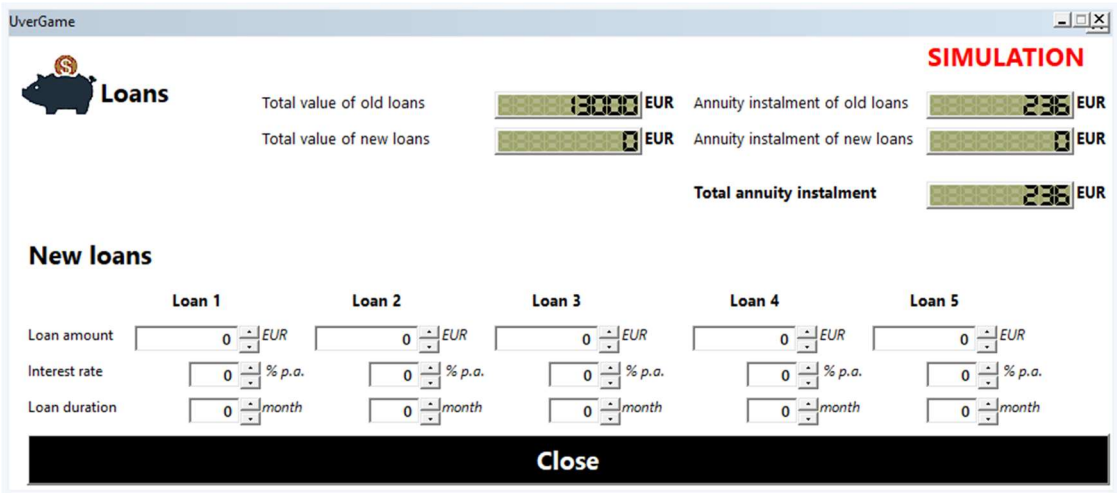


Figure 28: Loan repayment

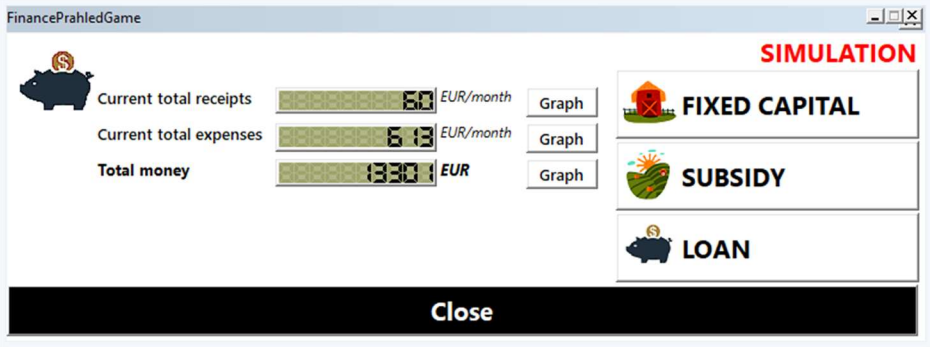


Figure 29: Overall overview of finance

In the eighth month of the first year of the simulation run, our hypothetical farmer made decision to start selling, every month, 5 piglets on average to slaughterhouse, the option to set animals for sale, respectively purchase, is in the dialogue window for herd management in the middle (Figure 30). Setting of purchase or sale works in such a way that when the user sets the respective control button at the concerned value, the respective decision will be executed in the following step of the simulation run, it means after starting the button forward „=>“. However, the set value stays the same and if the user does not want to sell, respectively purchase in the following step, he has to repeatedly delete the respective value from the control button; it means to set the button at zero. All control buttons work in this way when it is possible to control them during the simulation run and set them at the concerned values expressing the user's decision.

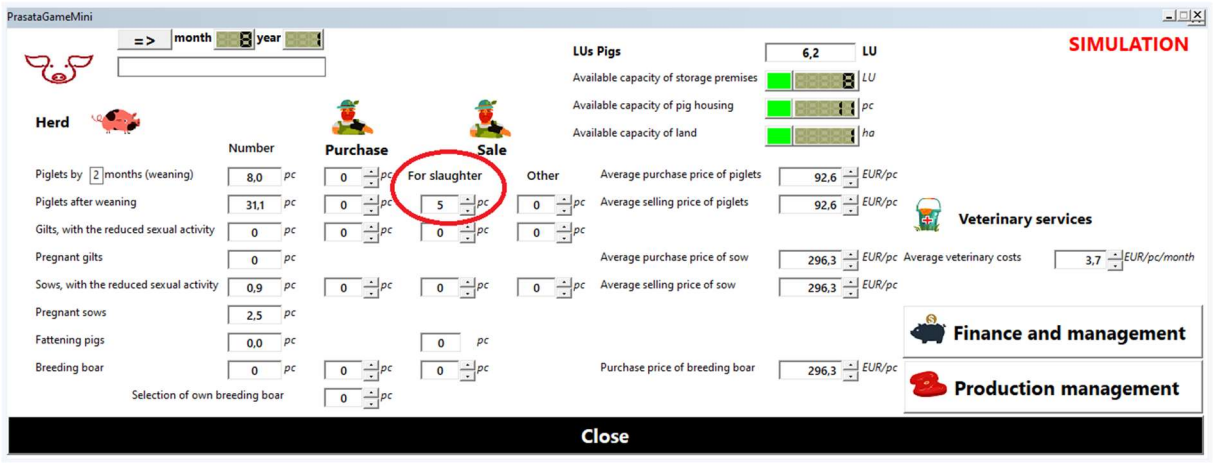


Figure 30: Herd management – pigs 3

Our farmer will also change his subsidy page in such a way that he will increase his reference number of pigs (in accordance with LU) to obtain subsidies for LUs from the initial 3 LUs to the current 6 LUs; he will do so again using the button „Finance and management“ -> „Subsidies“ (Figure 31).

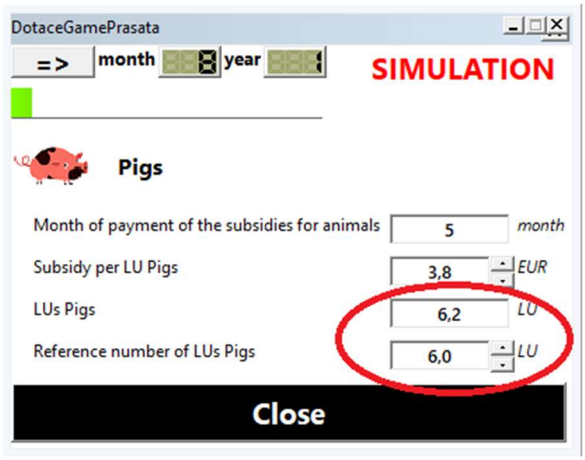


Figure 31: Setting subsidies during the simulation run

All buttons and settings within the simulation run can be controlled in a similar way. Let us assume now, in our very simplified hypothetical situation, that our small farmer is satisfied with his decisions and that he is not going to make any additional critical decisions, and let us shift the simulation to its end, it means to the twelfth month of the third year of the simulation run (the simulation was in the beginning set only for the duration of 3 years). We are therefore at the end of the simulation (Figure 32) that is shown to us also by a small dialogue window indicating the end of the simulation („The simulation has finished.“) and it is necessary to finish it by pressing the button „OK“. Following the end of the simulation, the user has, of course, the opportunity to see all values of variables and numbers of his herd including the financial aspect of his decisions during the simulation run.

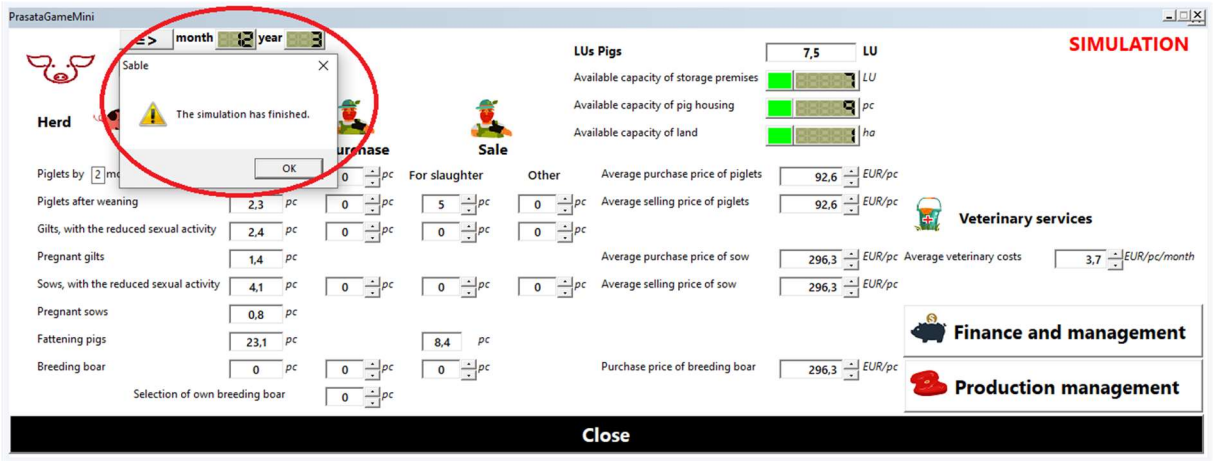


Figure 32: Herd management – pigs 4

Nevertheless, let us not finish the simulator as our hypothetical farmer is actually eager to learn and wants to test a similar situation, however, with a rather more productive breed of pig, so after closing the basic run of the simulation run by pressing the button „Finish the simulation and close“, he will open again the simulation setting for pigs (Figure 33) and set higher numbers of born piglets for sows and gilts, save the setting and start simulation again using the button „“TO START SIMULATION”.

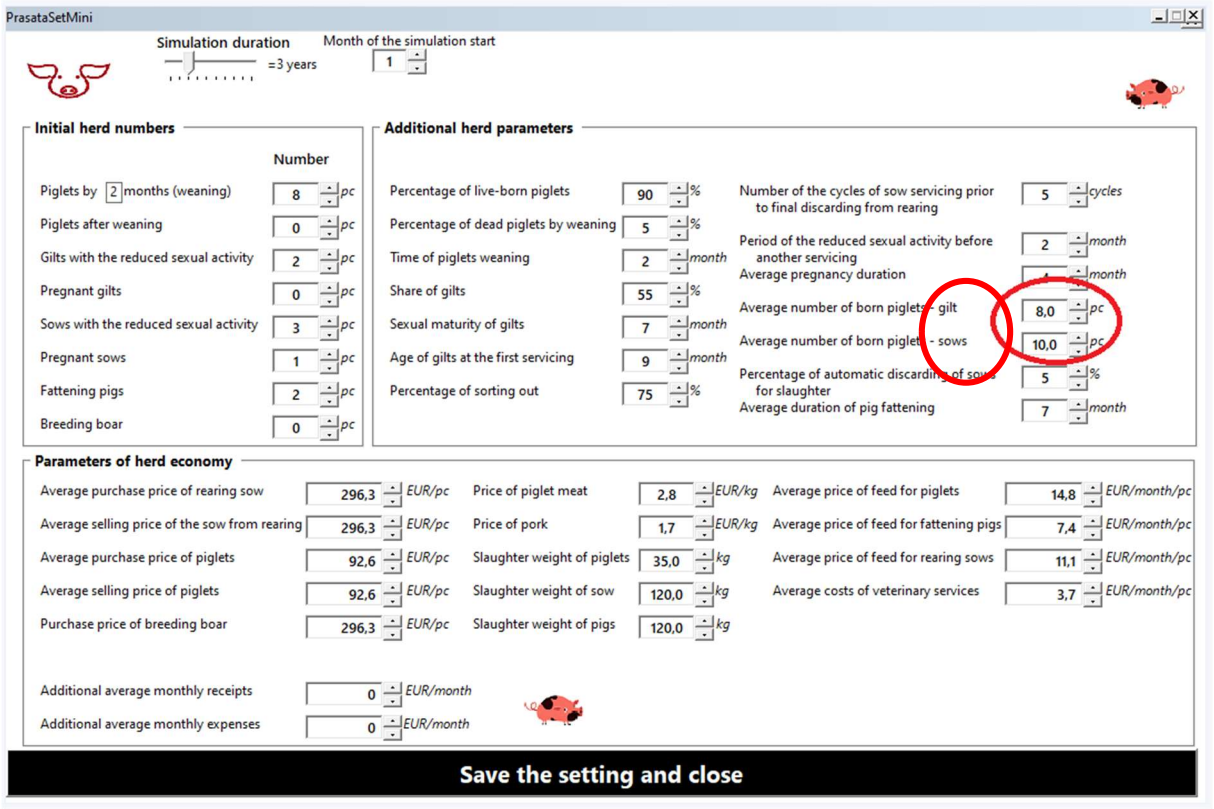


Figure 33: Basic setting of livestock production – pigs 2

Nevertheless, following the start, a message appears at that moment whether we want to overwrite the existing dataset (dataset = a time line of data of the simulation run); it is necessary to choose the option "NO" ("Ne") (Figure 34). The option then appears to name and save the new dataset; our farmer saved the new dataset with the name simulation2. After naming and saving the new dataset, the course of the simulation run including its control is the same as described above.

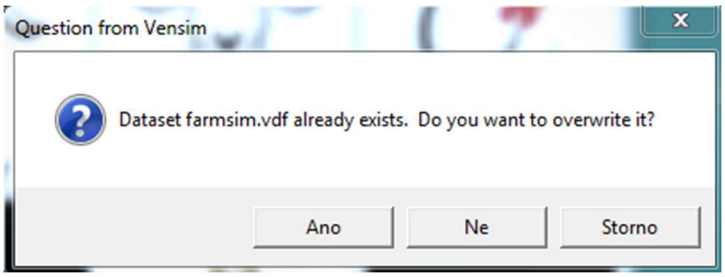


Figure 34: Saving of a new dataset

Decision making in the course of the second simulation run in our hypothetical situation of small farmer was again quite easy to make it simple. The farmer was selling 10 piglets on average every month from the fifth to twelfth month of the simulation, he then considered that it was too much and made decision not to sell the piglets for a certain period of time (for the next twelve months) at all by which, however, his available capacity of pig housing was significantly reduced so he decided to sell again piglets only, specifically 6 piglets every month till the end of the simulation run. In this hypothetical case, it resulted in the end of the available housing capacities, even in the significant redundant numbers of pigs, the available capacity for pig housing is -13 at the end of the simulation (Figure 35) that is, of course, quite unrealistic for the practice. However, it is shown here and should indicate for the farmer that he should

make decision to reduce the numbers of pigs, either by selling them or by increasing the housing capacities.

This example shows that the simulator allows the simulation of the situations realistic as well as not realistic in the practice; nevertheless, using the signalization colours (red), the simulator indicates for the user that something is wrong and that the situation requires his attention and a certain intervention in the form of making a certain decision.

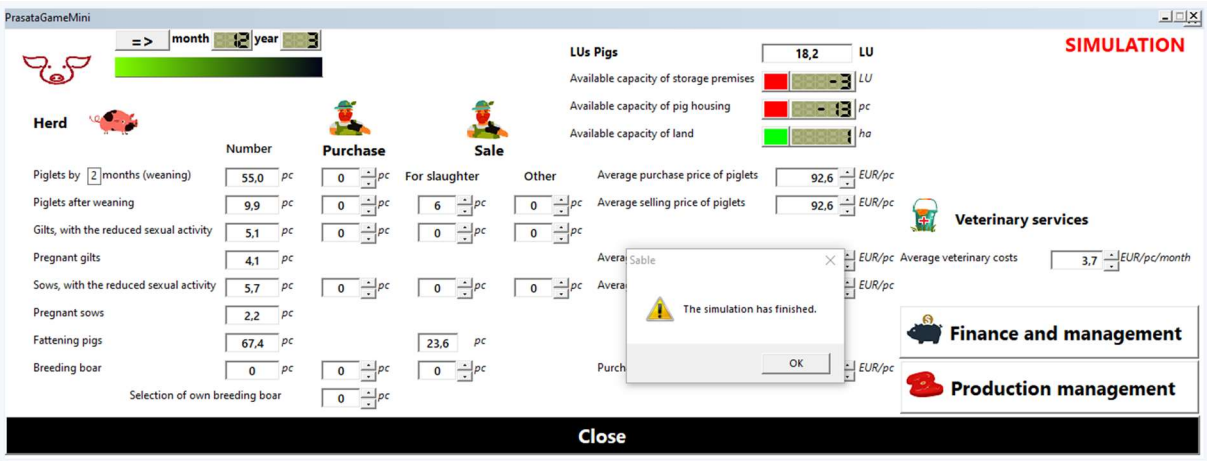


Figure 35: Herd management – pigs 5

Also here, following the end of the simulation run, our farmer has opportunity to display the numbers of the individual categories of animals and financial aspect of the simulation run. If the farmer would like to compare the financial results of both simulation runs (the course of monthly total receipts and expenses and development of cash in total), he can display them prior to closing the basic menu of the simulation run. It is possible to display them in the section „Finance and management“ -> „Finance“ following the start of the graph at the concerned financial indicator; however, to compare both courses of the simulation run, he has to activate both datasets. The management of datasets is described in the following Chapter 2.2.5 Comparison of results and management of datasets .

2.2.5 Comparison of results and management of datasets

Every simulation launching using the button „ START SIMULATION“ will generate the dialogue window (Figure 34) of the query for overwriting, respectively saving of a new dataset (data timeline of the simulation run) in which it is possible to overwrite, using the option „Yes“, the existing dataset with the new data from the new simulation run, or using the option „NO“, not to overwrite the existing dataset but create and name a new dataset for a new simulation run. If the user wants to compare the results of the individual simulation runs, it is necessary to choose the option „NO“ and create a new dataset. The individual datasets are stored in the folder **tempModel** and have the suffix .vdf.

To manage the datasets, the button „DATASET“ is used using which the user gets in the window containing the information about the current dataset (Figure 36), the figure displays the dataset name „sim.vdf“, and further using the button „Dataset management“, in the dataset management (Figure 37).

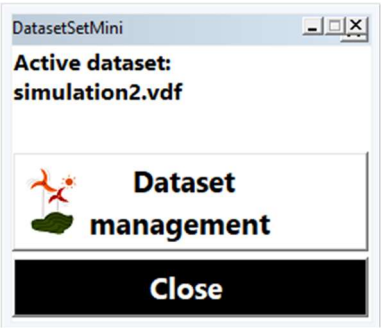


Figure 36: Active dataset

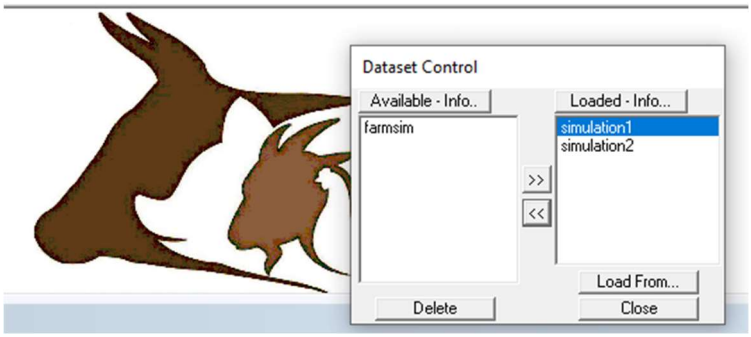


Figure 37: Dataset management

The dialogue window for the dataset management is divided in two basic parts: Available (the datasets are displayed here that can be loaded /activated) and Loaded (the datasets are displayed here that have been already loaded/activated).

In our hypothetical situation, our small farmer started the management of datasets and marked by mouse clicking the dataset named simulation1, and using the button „>>“, he shifted it from the part Available to the part Loaded by which he activated it to display the course of the quantity Total money for both simulation courses (Figure 38).

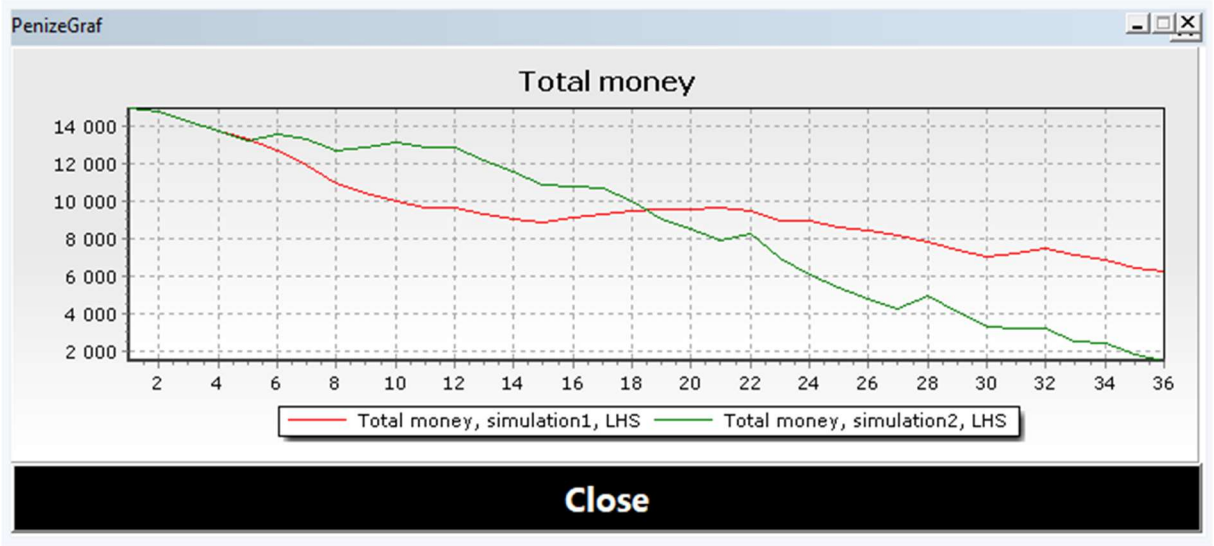


Figure 38: Result comparison

Following the shift of the datasets to the section Loaded, they are ready to be displayed. The user can close the dataset management, and using the button „Finance and management “ -> „Finance“, start the graph at the financial indicator „Total money“. In the displayed graph, he then sees the development of the indicator in the course of both simulation runs.

Similarly, if the user does not want to display the course of a certain simulation run (dataset), he can again, using „Dataset management “, deactivate the concerned dataset by shifting it from the section Loaded to the section Available using the button „<<”.

The datasets that are not activated (they are in the section Available) can be, using the dialogue window or the dataset management, also deleted, by selecting the concerned dataset by mouse clicking on the concerned dataset and selecting the button „Delete“ in the bottom part of the window under the section Available.

2.2.6 Closing the simulator

The simulation run is finished after pressing the button „Finish the simulation and close“ in the basic menu of the simulation run (Figure 23); if the user decides to finish the work with the simulator and close it all, it can be done using the button „To finish and close“ in the basic menu of the simulator (Figure 11). If the entire simulator is closed, a dialogue window appears (Figure 39) verifying if the user really wants to finish the work with the simulator; it is necessary to confirm the decision by choosing “Yes“ (“Ano”).

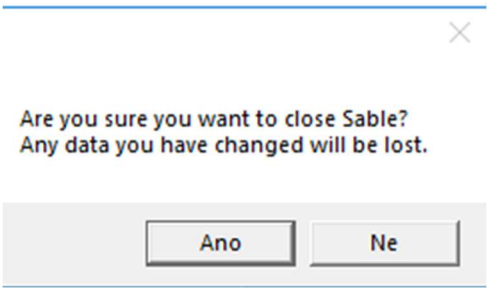


Figure 39: Simulator closing

After closing the simulator, only the datasets remain saved that can be managed with a repeated start of the simulator.

An example of the use of the simulator FARMASIM is provided in the following Chapter 3 Case study. It is good to study this case study also for the reason of obtaining the additional, more detailed information about the simulator functioning.

3 Case study

To provide an example of the use of the simulator FARMASIM, we will use the situation of one of the farmers who, in the course of the project resolving, provided us with the valuable information and feedback when modelling the production of beef cattle. The farm is located in the Region of West Bohemia and produces beef of organic quality. The farmer was interested if it is possible to reach an improvement in his economic results in a certain way.

The farmer extended its housing capacities 4 years ago and provided us with the data about the numbers and structure of the herd in the beginning of 2019 (Figure 40). Setting of the costs is relatively variable in the simulator; it is possible to convert all costs to variable costs per 1LU and not to use fixed costs or the costs of land cultivation, etc. It is therefore possible that in your case, setting of these parameters will appear significantly different at first sight (*if you want to be sure that you entered all correctly, we recommend to first simulate the historical period and compare the results from the simulator with the actual results of your business*).

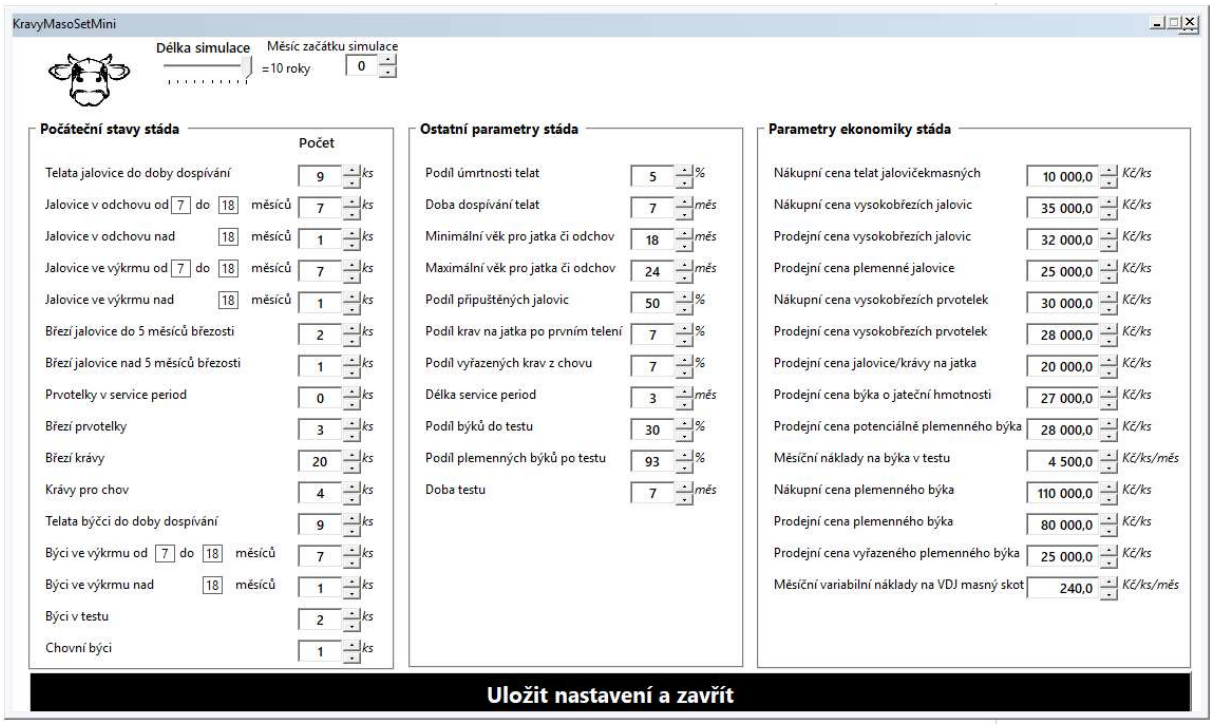


Figure 40: Basic herd characteristics

Setting of the capacities, finance, and subsidies is carried out after clicking on the field „Finance and management“ when the overview is provided on the following figure (Figure 41). The farmer has the land that has higher capacity than the maximum housing capacity is so the expenses per hectare are seemingly lower (a profit is reached on the remaining land). Multiplier of land capacity says how many LUs can be reared on one hectare of land; for this farmer, it is left equalling 1.

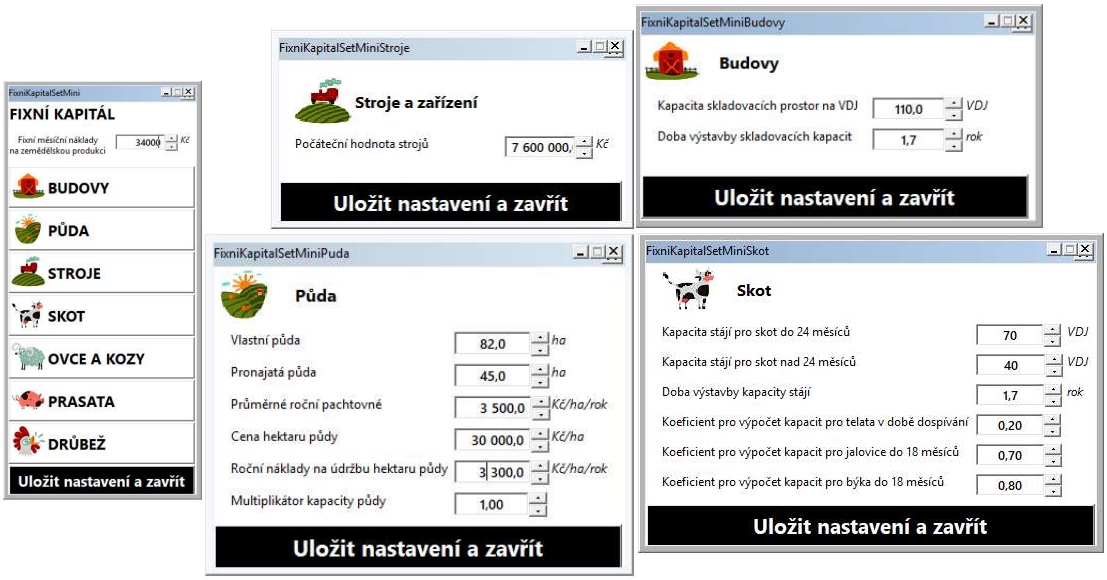


Figure 41: Setting of the farm characteristics

The farmer has two existing loans (Figure 42), setting in the software is easy; the software will calculate a monthly annuity instalment on the grounds of the parameters. In the beginning, the money is set at zero – it is a private issue of the farmer.

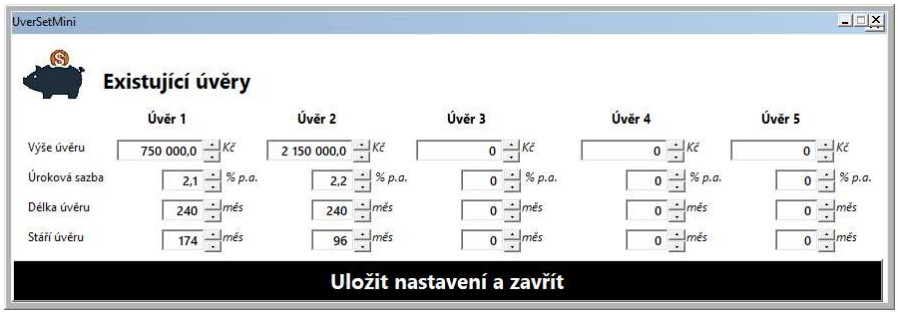


Figure 42: Setting of the parameters of the existing loans

Still in the same offer, it is possible to set the subsidy parameters (Figure 43). Here, we have to integrate some subsidies a bit, for example, the subsidies for land can be calculated in accordance with a number of characteristics; following several attempts, it appeared as the most user-friendly approach to enter the average subsidy per 1ha of land. In addition, the subsidy policy varies a lot; the software distinguishes the basic characteristics of herd for which it should be possible to calculate average subsidies. With regard to the fact that the number of reported LUs or suckler cows is registered only for a certain period of time, we assume as fixed a change every second year (the user will set new reference volumes in the course of the simulation).

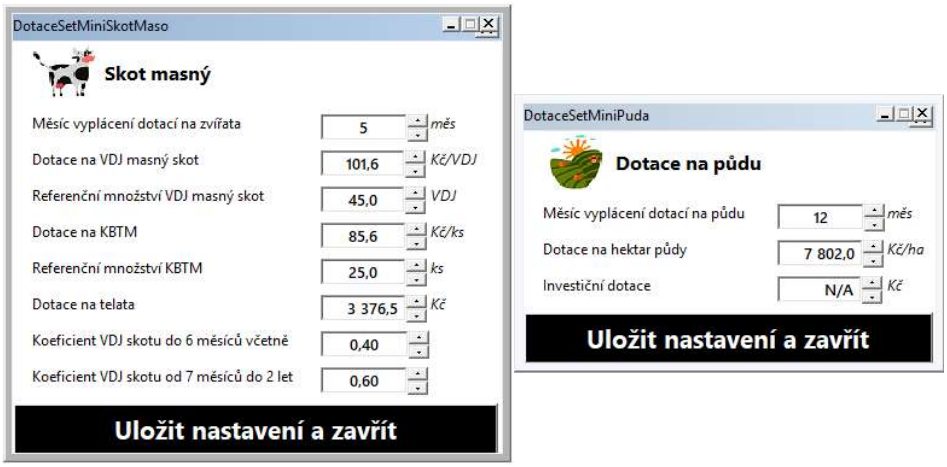


Figure 43: Setting of the subsidy parameters

After setting all parameters, a simulation run is started using the button in the middle „START THE SIMULATION“. For the needs of this simulation run, it was necessary to display the windows for herd structure, subsidies for setting reference volumes, and money (Figure 44), also the graph was displayed here to provide an overview.

The simulation goes on by monthly steps. The step is taken when clicking on the arrow that is marked by the yellow circle on the figure (Figure 44). Every second year, the farmer compares the actual numbers of LUs and suckler cows and adjusts the reference volumes for subsidies.

At the moment when the available housing capacity for the cattle older than 24 months (the purple ellipse) equals zero (the capacity for younger cattle does not fall to zero, we were discussing the setting of capacities with the farmer, however, he will use the available premises to make the organization of work easier), he sets the sale of breeding heifer at 1, if the capacity does not continue falling despite this, he will start selling also the heifers at the advanced stage of pregnancy. Because of the fact that the farmer is not able to always sell the heifer from his production as a breeding one (despite the fact that

her parameters would correspond), he reduced the average selling price to CZK 22,500. The simulator will not sell the heifers if they are not available (when there is not a sufficient number of heads in the concerned category or the necessary period of time has not elapsed yet), so it is possible to set selling until the time when the available housing capacity grows above the value zero. At that moment, the farmer will discontinue selling (he will set zero) and wait again for a drop in the available capacity.

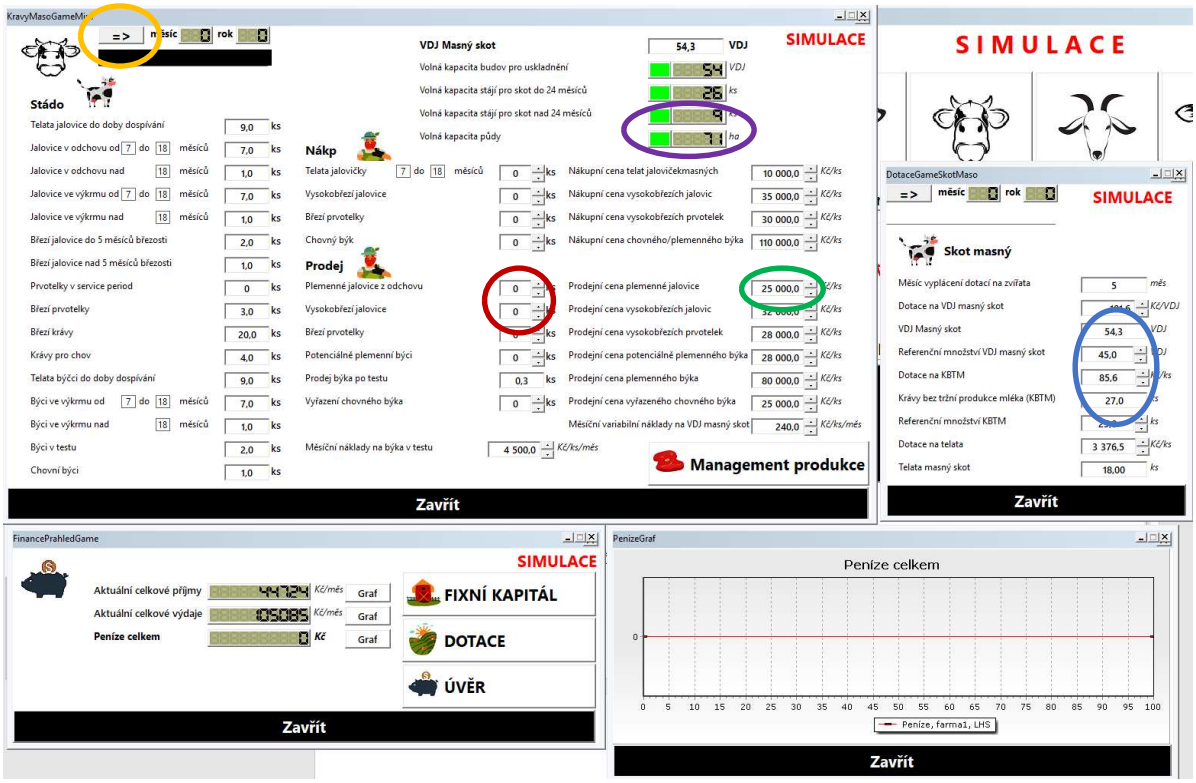


Figure 44: Beginning of the simulation

With the basic scenario, the housing capacities were fully used only in the tenth month of the sixth year. In other words, use of the housing capacities means that the farm capacity is not used to maximum.

The second scenario was different by the fact that immediately in the first year, in the first month, 5 heifers at the advanced stage of pregnancy were acquired. In this situation, the capacities would be fully used already in the beginning of the third year. Despite the fact that with time (at the moment when a stable maximum use of the farm production potential is reached), the flows of money would be balanced, total profit for 10 years in the nominal value is estimated at CZK 5,644,869 when maintaining natural reproduction of the herd and at CZK 6,446,262 when purchasing heifers at the advanced stage of pregnancy in the beginning of the simulated scenario (the difference higher than CZK 800,000, significantly manifesting already in the fifth year of the simulation).

The third tested scenario assumed that heifers at the advanced stage of pregnancy would be purchased using a loan (the button „Finance and management“ -> „Loan“; new loan would be set similarly as the existing loans, Figure 45). In such a situation, the estimated profit would reach the value of CZK 6,295,594 in 10 years.

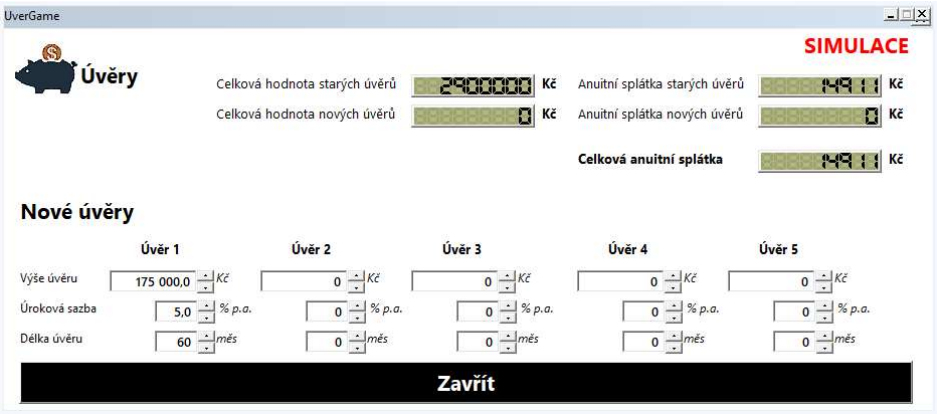


Figure 45: Getting a loan

The comparison of development of the financial indicator Total money is available for the farmer in the form of a clearly organized graph (Figure 46). The scenario „Farm 1“ represents a natural herd reproduction, „Farm 2“ the purchase of heifers for own money, and „Farm 3“ the course when purchasing heifers when using a loan.

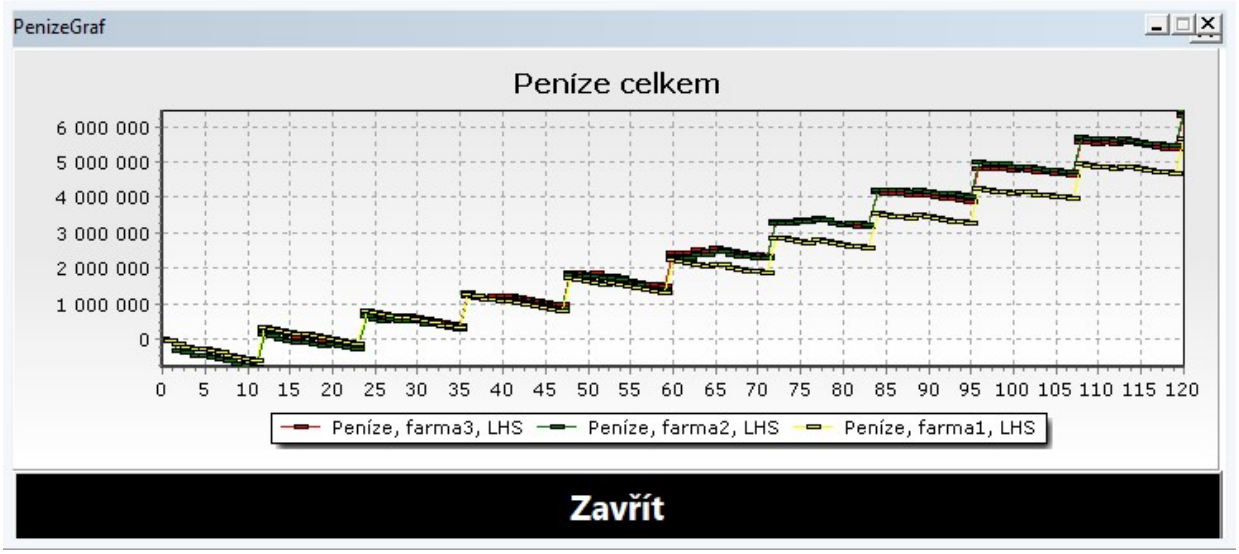


Figure 46: Comparison of the scenario course

It is, of course, possible to test various courses of heifer purchases (for example, 2 heifers annually, until the time when the maximum use of capacity is reached); it is also possible to test how the change of subsidy policy or purchase of new machinery will manifest.

To demonstrate the simulator use, we chose the case study where the tested scenarios were focusing on the description of the issue of insufficient investments. The farmer extended his capacities and is waiting for the maximum use of housing by natural herd reproduction. In this respect, beef cattle represent one of the most problematic issues of livestock production. It is even two years from the birth of calf until the time when heifer can become pregnant, following 9 months until the birth of another calf to this cow (at that time). However, this calf has to grow as well and become adult prior to being a member of the herd and/or going to slaughterhouse (to bring a profit). It is necessary to also realize that only a small percentage of born calves comply with the criteria to be included in the herd.

And guess what? Yes, this concerned farmer already bought additional heifers at the advanced stage of pregnancy.

4 Selected diagrams of the numbers and flows

While the causal-loop diagram represents the tool for the communication and expression of dynamic hypothesis about the main loops in the system, the stock and flow diagram represents the interim step between the graphical description and mathematical formulation of the model. This diagram is older than the causal-loop one, it is less clearly organized for a not trained user but distinguishes two important types of variables – stocks that are measured at a certain moment, and flows that are the input and output variables for the stock variables and that are measured in the same units as the stock that they enter/leave in a time unit (for example, litres per second).

SYMBOL	INTERPRETATION
Stock variable	Accumulation, level, supply, stock; a bath filled with water is a frequently used example. With regard to mathematical formulation, it is represented by a definite integral.
Flow variable	Flow is an input or output from accumulation, water coming from a tap may be an example.
	Clouds express a stock variable beyond the model border.

Table 2: Elements of the stock and flow diagram

In addition to the fact that stock variables are good start when creating a model, they have also a specific impact on the system behaviour. Stock variables represent delay; it means also the source of oscillation or going beyond the limits. Delay relates to the system inertia/memory that can result in conflicting results in a short- as well long-term period of time, their knowledge allows a long-term orientation and makes it easy. They characterize the system; their stock/level (for example, wealth, size of herd, etc.) has impact on decision making. Last but not least, the stocks are the source of flows and produce the mechanisms to reach balance.

Stock variable is mathematically expressed using a certain integral:

$$Stock_T = \int_{T_0}^{T} (Input\ flows_t - Output\ flows_t)dt + Stock_{T_0},$$

where T_0 is the initial time, T current time, and t the moment between T_0 and T.

The selected diagrams for the software FARMASIM are provided by the following figures. The Figure 47 is the unadjusted structure in the form of stock and flow diagrams used by the simulator to model main characteristics of the herd of cattle with the market production of milk. The Figure 48 expresses

the structure to model a sheep production, the Figure 49 for poultry production. If you are interested in the mathematical model itself, please contact the main project researcher.

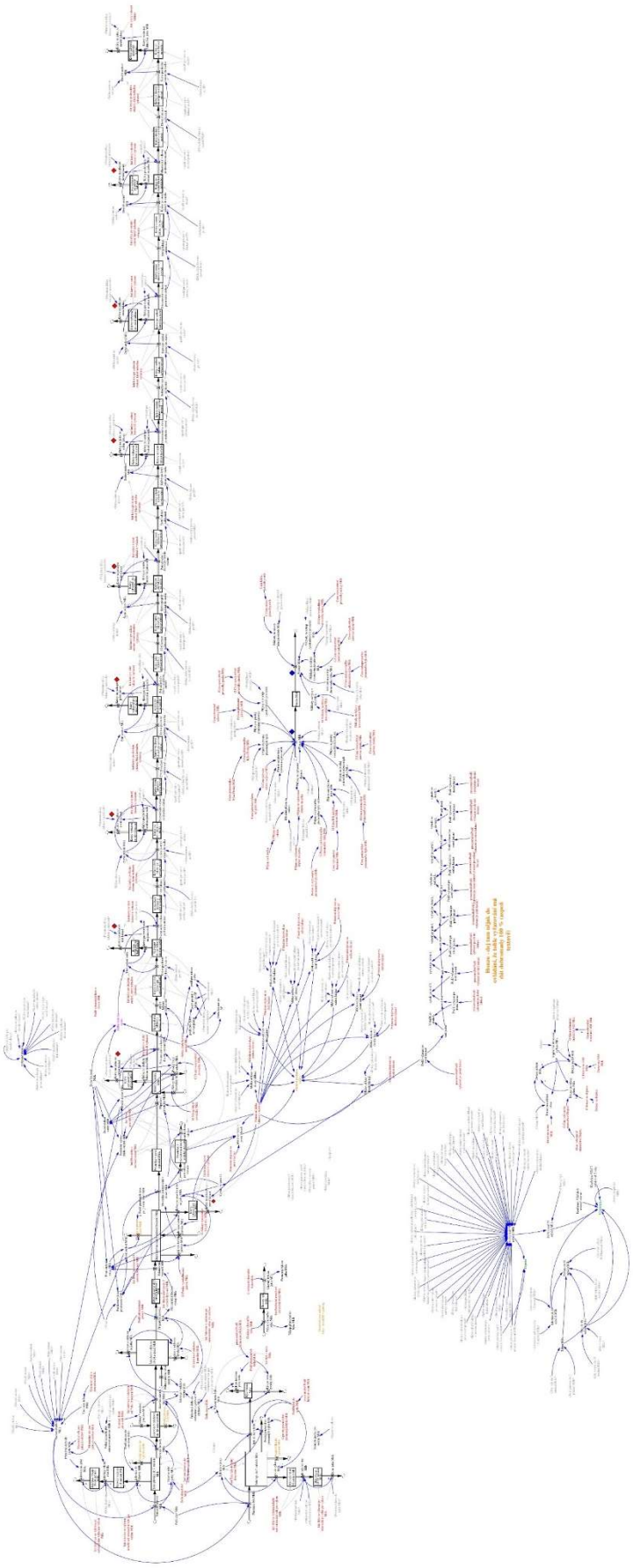


Figure 47: Stock and flow diagram for the herd of cattle with the market production of milk

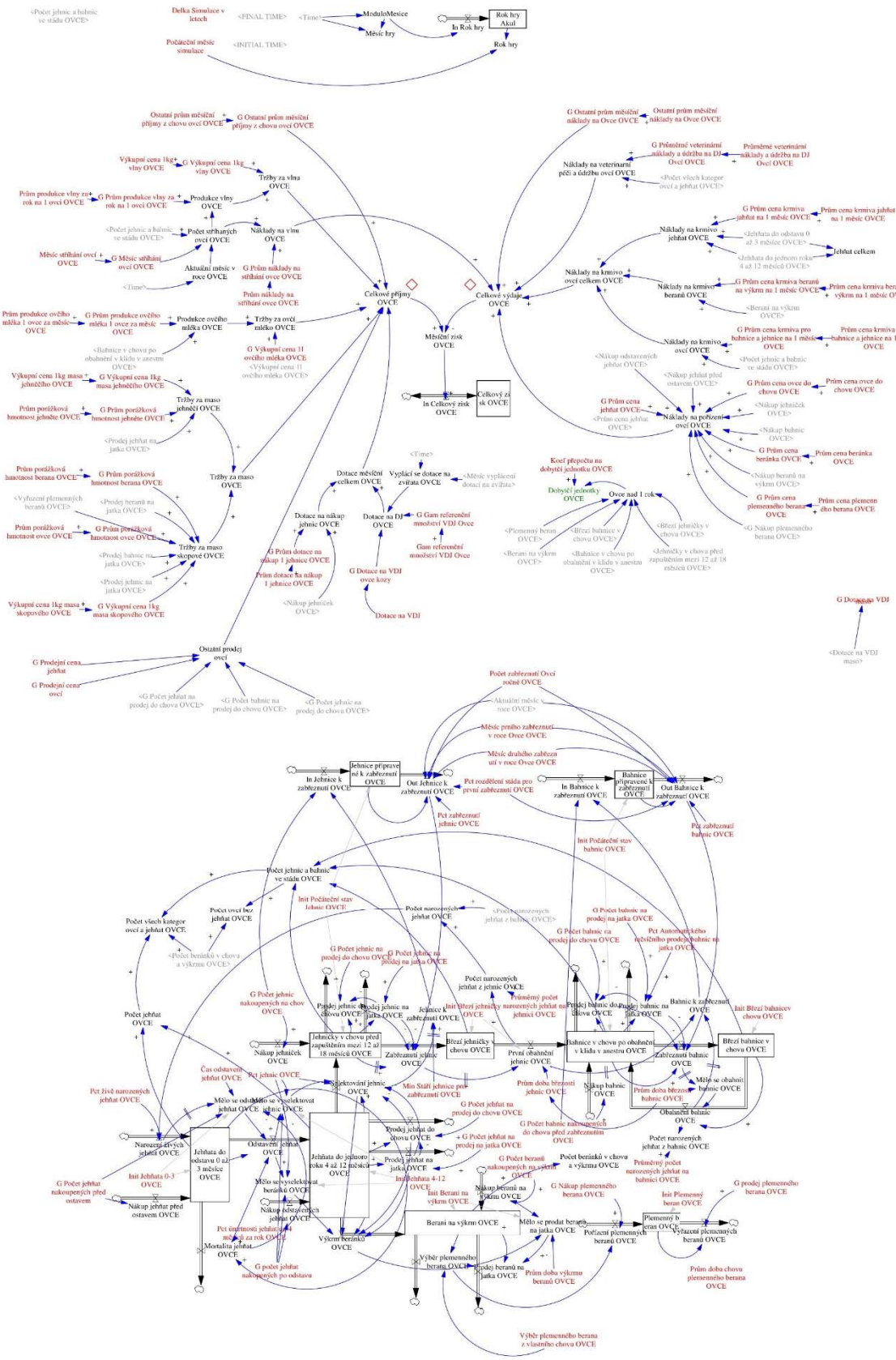


Figure 48: Stock and flow diagram for the herd of sheep

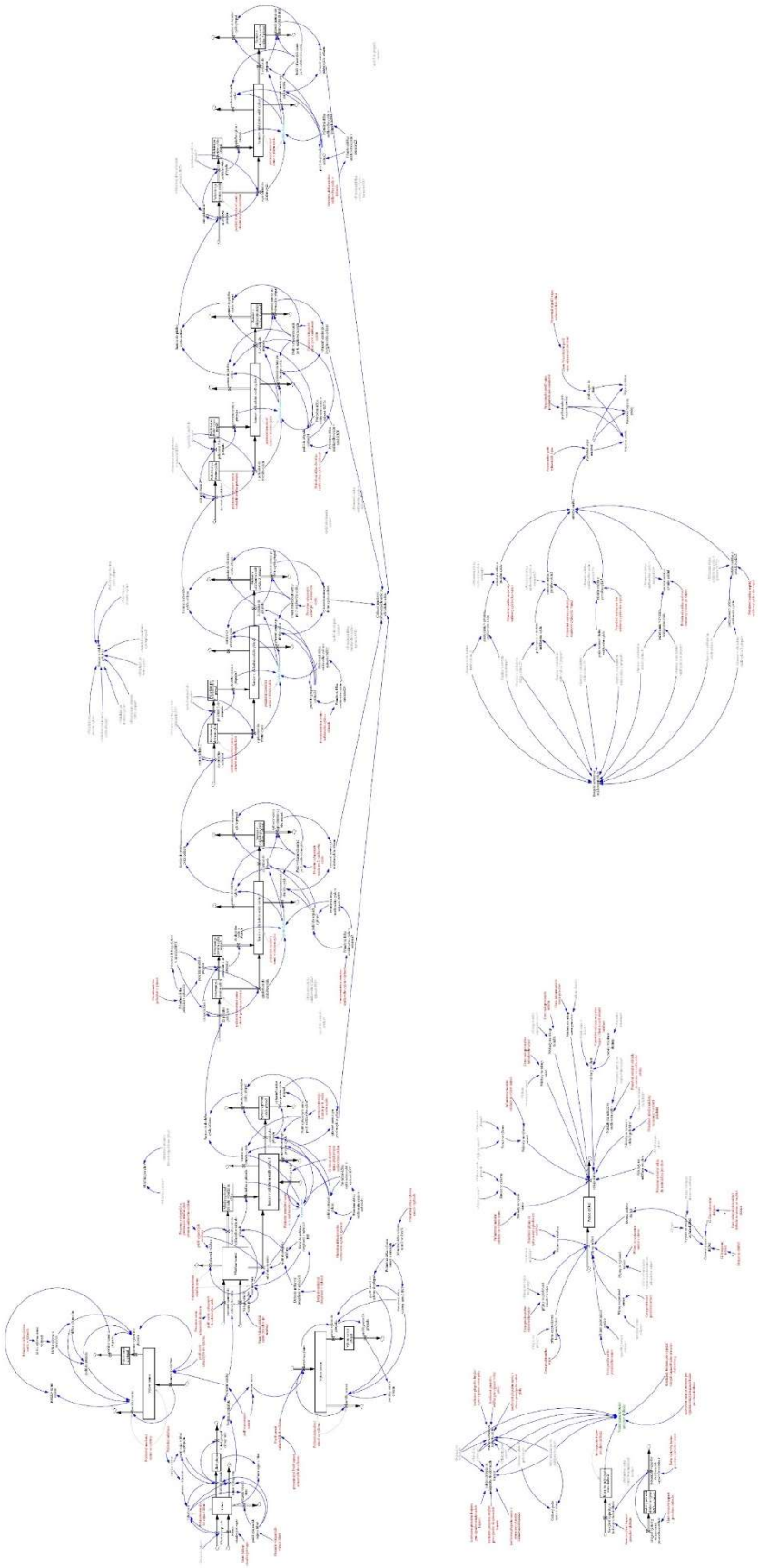


Figure 49: Stock and flow diagram for poultry production