

WEB-BASED SWINE RATION BALANCING SYSTEM

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The Web-Based Swine Ration Balancing System is a server-side application whose purpose is to balance the swine rations. With such an application, building the ration recipe is faster and more likely free of errors that could be generated in manual calculations, or in general computer spreadsheet solutions. Integrated with proper software support, the described application may run even offline. It is a free application, available for all interested users. Furthermore, it is an open-source application, so potential developers may use existing code for modifications due to tailored demands and requirements. Web-Based Swine Ration Balancing System is an application developed in HTML and PHP programming languages and based on MySQL as a relational database management system.

Keywords: swine, ration, balancing

Introduction

Feed mixing in swine diet rations is the first step in feed technology, but not the least important for animals. Given the range of requirements that are considered in such a process nowadays, this is not a simple task. Manual calculation takes a lot of time and creates many opportunities for mistakes. Various software spreadsheet solutions for tabular calculations may be used, but even with such an approach, certain mistakes are possible. Large companies and entrepreneurs usually engage professional developers to build the tailor-made software, or buy available solutions on the market. But when it comes to the market, certain limitations may occur. Some desktop applications are free of charge, offering a perfect graphic user interface (GUI), but do not give the possibility of changing requirements [1]. Certain high-quality and very professional desktop solutions are available, but for a user, it is necessary to purchase a license [2]. There are also other suitable software products, but procurement of such may imply certain purchase fees [3, 4]. An alternative approach may consider free platforms based on an online web approach, free of charge and with a respectably designed GUI [5]. However, even with this application, there are limitations regarding the animal requirements editing. Therefore, the goal of this project was to build the open-source web-based application open for further development. It is the Web-Based Swine Ration Balancing System [6] available on request, and open for modifications and all users having their specific demands.

Materials and methods

Basic menu and navigation system was built in HTML as the standard markup language for Web pages [7]. Feed databases were designed based on both empirical values and those from information systems [8, 9]. As a relational database management system (RDBMS), MySQL was used [10]. Manipulations over the databases were performed by PHP as a server scripting language [11].

In code development, more attention is paid to functionality and simplicity than to design. The reason for such an approach was determined by the target group profile. The project is designed for professionals in swine nutrition, with proper skills. On the other hand, code is designed in an open open-source manner. Therefore, it is kept in a simple design so that any user interested in further development does not have to deal with reverse engineering. Animal requirements are based on official demands for swine feed mixtures on the Serbian market specified in the Rulebook of Animal Feed Quality, articles 49, 50, and 58 [12]. This generates additional importance of the project for the foreign companies in the animal feed industry and their business on the Serbian market. In that way, they may also have an efficient overview of market regulations in Serbia.

Given the fact that code itself consists of more than a thousand lines, it is not presented in this paper, but it is available and free on request, as well as the databases. Potential users can request the code and databases by

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contacting the corresponding author. Five databases (pigfeeds, pigfeedlib, requirements, pigrecip, and ration) make the system foundation, while the folder and file scheme are presented in Figure 1.

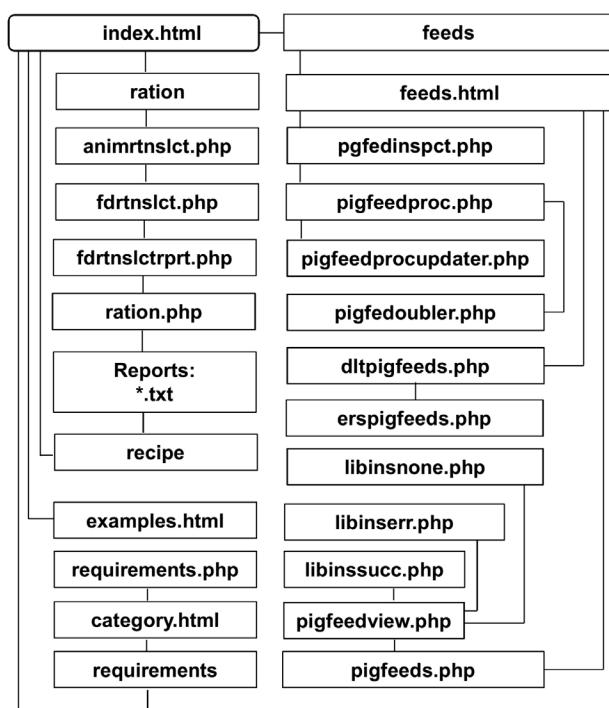


Figure 1. Folder and File Scheme

Results and discussion

On the first page, the initial menu is rendered. It is a menu with the items “Feeds”, “Requirements”, “Ration”, “Recipe”, “Ration Examples”, and “Terms of Use”. These are the links that lead to subsequent pages. Each of these has a specific purpose.

At first glance, there is nothing on the “Feeds” page that the other free alternatives do not have [1]. In some systems, there are options for the feed editing [5]. However, Web-Based Swine Ration Balancing System offers animal requirement code editing possibilities due to its open-source nature. There are four menu items on the “Feeds” page. These are “User Feed Library”, “Master Feed Library”, “Delete User Feeds”, and “GO BACK”, where the last one is a navigation link.

The first step that the user should perform in this menu is to enter into “User Feed Library”, to find out whether there are any feeds in the user feed library. The original feeds are stored in the Master Feed Library. These feeds cannot be edited and include over 60 common feeds used in swine nutrition in the Western Balkans region. However, to use these feeds or to edit them, it is important to transfer them from the master feed library to the user feed library. Only in this library can feeds be edited. “User Feed Library” and “Master Feed Library” correspond to database tables “pigfeedlib” and “pigfeeds”, respectively. The reason for that is that feeds can be

edited in “User Feed Library” and not in “Master Feed Library” to maintain their original chemical composition. Such an approach is quite improved compared to the other similar software products [1].

If there are no feeds transferred to the user feed library, a user will be prompted to get back to the “Feeds” menu, and transfer feeds from the master to the user feed library. It is a “User Feed Library” menu item where feeds transferred to the user library may be viewed or edited in Editor and Viewer of Feeds. On this page, a tabular overview of feeds in the user library is rendered, with their ID in the corresponding database (pigfeedlib), group in which feeds are classified, along with a feed name, feed chemical composition, and energy value. For the chemical composition, the most important parameters are rendered. Dry matter content (DM) is expressed as a percentage of feed, while other parameters of feed chemical composition are expressed as relative content in dry matter (%). Those are crude protein (CP), lysine (Lys), methionine and cysteine (Met+Cys), crude fat (Fat), crude fiber (Fiber), and crude ash (Ash). An energy value is presented as metabolic energy for piglets (ME piglets) and for growing or adult swine (ME), in MJ/kg of DM, in both cases. In a table header, there is a column indicated by a glass magnifier icon (Figure 2). In this column, the user can click on a button with a double greater-than symbol icon. It is important in cases when additional data on chemical composition are required and/or these should be edited.

ID	🔍	Group	Feed	DM, %
386	>>	Grains	Barley Grain, Market	88.00
387	>>	Grains	Corn Ear, Market	86.00

Figure 2. Feed Overview and Editing

The click on the above-described button leads to the page “Feed Viewer and Editor” where more detailed parameters of chemical composition (minerals and vitamins) can be viewed and/or edited (Figure 3).

Update Edited Feed

ID: 386

Group: Grains

Feed: Barley Grain, Market

Dry Matter (DM), %: 88.000000

Crude Protein (CP), %DM: 12.500000

Lysine (Lys), %DM: 0.430000

Methionine (Met), %DM: 0.190000

Cystine (Cys), %DM: 0.260000

Fat, %DM: 2.200000

Fiber, %DM: 5.450000

Ash, %DM: 2.800000

Ca, %DM: 0.095000

P, %DM: 0.381000

Na, %DM: 0.032000

Cu, mg/kg DM: 6.586000

Figure 3. Feed Viewer and Editor

In addition, at the bottom of the page, in the left corner, there is a check box, and next to it a button with a copy icon (Figure 4). Box checking and button clicking duplicate the viewed feed. It is useful when building some feed is necessary, but with minor changes in chemical composition compared to the original for duplication.

**Figure 4.** Feed Duplicating

Feed editing is restricted only to the feed ID number and feed group. In the first case, because the ID number has an index property in databases. Restriction for the feed group is given because it is highly determined by feed origin and chemical composition. The capacity of any software for animal nutrition balancing is highly determined by feed editing options. Some solutions do not have the abovementioned proper capacity [1], while others are limited [5].

When the user enters the “Master Feed Library” menu item, the feeds stored in the corresponding library will be displayed, in separate boxes, given the group in which they are classified (Figure 5).

Transfer selected feeds to user feed library

Grains

- Barley Grain
- Barley Grain, Market Supply
- Corn Ear
- Corn Ear, Market Supply
- Corn Grain

Grain Processing Byproducts

- Wheat Bran
- Wheat Bran, Market Supply
- Wheat Middlings

Figure 5. Master Feed Library

Every box is equipped with a vertical scrollbar in cases when there are a lot of feeds in a group, and there is a check box on the left of every feed. By checking these, feeds that should be transferred to the user feed library are being marked for transfer, which occurs upon the click on the transfer button. Feed grouping in divisions is a common approach in other applications [1,5]. It is the same with the here analyzed project. The reason for this is that the master feed library in this project may be overwhelmed with various feeds, not all of which are commonly used.

“Delete User Feeds” menu item leads to Feed Delete Panel (Figure 6), in which the user just has to check feeds if they should be removed from the user library.

- Barley Grain - Grains
- Barley Grain, Market Supply - Grains
- Corn Grain - Grains
- Corn Grain, Extruded, Market Supply - Grains
- Corn Grain, Market Supply - Grains
- Soybean Meal, 44% CP - Oil Seed Processing Byproducts
- Sunflower Meal, 33% CP - Oil Seed Processing Byproducts
- Extruded Full-fat Soybean, Market Supply - Other Plant Products
- Soybean Meal for Piglets, Market Supply - Other Plant Products
- Full-fat Milk Powder, Market Supply - Animal Origin Feeds
- Calcium carbonate - Vitamin, mineral and protein supplements
- Dicalcium phosphate dihydrate - Vitamin, mineral and protein supplements
- Premix for Finishing Pigs over 60 kg, Tailor Made - Vitamin, mineral and protein supplements
- Premix for Pigs 15-25 kg, Tailor Made - Vitamin, mineral and protein supplements
- Premix for Suckling Piglets, Tailor Made - Vitamin, mineral and protein supplements
- Sodium chloride - Vitamin, mineral and protein supplements

[Delete](#)

Figure 6. Feed Delete Panel

If there are no feeds in the User Feed Library, the user will be informed in this panel. The option to delete feeds from the User Feed Library is very important. It is quite surprising that some alternative solutions [1] lack this functionality. Such an approach can ultimately result in a significant database size increase. Although it does not necessarily present a direct problem, the main trouble in this situation could be difficulty in navigating the

feed selection.

The various applications usually present animal requirements in ration balancing panels [1,5]. It is a regular approach, but the additional and separate rendering of requirements is useful. This is the solution applied in the project analyzed in this study. In this way, the user is able to have an overview of animal requirements before ration balancing. In addition, the platform is more valuable for users who are interested in an overview of Serbian market regulations for swine feed mixtures rather than in ration balancing. Animal requirements differ across various norms. These are based on market regulations in Serbia [12] in the platform analyzed in this study, and they are not the same as in the other widely used norms [13]. Therefore, the analyzed platform, as a free open-source code, is available for adjustments for all users. By entering to “Requirements” menu item, users are faced with an interface with a drop-down list that enables animal category selection and, on submission, renders animal requirements. As a result of animal requirements, there are minimal and/or maximal constraints and tolerable deviations in brackets.

In the “Ration” menu item, the user is prompted to choose the swine category and feeds that will be the ingredients of the ration, and finally gets directed to the ration balancing page. There are left and right panels on

this page. On the left panel (Figure 7), there are input tags for selected feed amounts and a button for calculation of the ration given the input values.

Barley Grain, Market Supply:	20
Corn Grain, Market Supply:	50
Soybean Meal, 44% CP:	15
Sunflower Meal, 33% CP:	10
Dicalcium phosphate dyhidrate:	0.33
Premix for Finishing Pigs over 60 kg, Tailor Made:	2.7
Sodium chloride:	0.5

Calculate

Figure 7. Left Panel

In the right panel, there is a table rendered with the columns named Item, Ration, Requirements (Deviations), Balance, and Indicator, in the table header (Table 1).

Table 1. Example of Right Panel

Item	Ration	Requirements (Deviations)	Balance	Indicator
Total, %	98.53	100(100)	0.99(1.00)	98.53
Moisture, %	11.55	≤13.50(14.50)	0.86(0.80)	
Crude protein, %	16.36	≥14.00(12.60)	1.17(1.30)	
Lysine, %	0.94	≥0.65(0.55)	1.44(1.70)	
Methionine + Cystine, %	0.57	≥0.40(0.34)	1.42(1.68)	
Fiber, %	4.83	≤7.00(8.05)	0.69(0.60)	
Ash, %	6.01	≤8.00(8.80)	0.75(0.68)	
Ca, %	0.71	0.50-0.70(0.35-0.85)	1.02-1.42(0.84-2.04)	!
P, %	0.50	≥0.50(0.35)	0.99(1.42)	!
Na, %	0.22	0.15-0.25(0.05-0.35)	0.87-1.44(0.62-4.33)	
Cu, mg/kg	25.15	≥20.00	1.26	
Zn, mg/kg	129.13	≥100.00	1.29	
Fe, mg/kg	118.65	≥100.00	1.19	
Mn, mg/kg	33.03	≥20.00	1.65	
I, mg/kg	0.57	≥0.50	1.13	
Se, mg/kg	0.13	≥0.10	1.30	
Vitamin A, IU/kg	8,058.10	≥7,000.00	1.15	
Vitamin D3, IU/kg	1,026.00	≥1,000.00	1.03	
Metabolic energy (ME), MJ/kg	12.89	≥12.50(11.88)	1.03(1.09)	

In the first row and column, there is a parameter entitled Total in percent, for all the components included in the ration. In the same row and the last column, there is a value for this parameter which must be 100. In the following rows, in the column entitled Item, there are labels for nutritional parameters, and in the next column (Ra-

tion), their values in projected ration, as well as a corresponding referential value required by proper national legislation [12] in the next column entitled Requirements (Deviations). Required referential values come before the brackets, while tolerable deviations come within brackets, as well as the marks for the referential limits.



These marks are presented as proper signs for maximal requirements (equal or less than), minimal requirements (equal or greater than), or a range (dash). The next column is named balance, and in its rows, the index of balance is presented, for a referential value before the brackets, and for a tolerable deviation in brackets. These indices represent relative efficiency of ration balancing, e.g., 0.99 means that 99% of requirements are satisfied given the exact ration composition, or 17% exceeded if the index value is 1.17. In the last column, there is an indicator of balancing efficiency. If it is empty, the ration is well balanced for the given parameter. In case there is an exclamation mark, it means that the ration values for the given parameter are close or within the tolerable deviation range, while two exclamation marks indicate rough deviations out of the acceptable range. PHP scripts that correspond to the page for ration balancing produce a series of text files in which the results of ration balancing are stored. Those are the elements of the ration report building, to which the user may access via "Recipe" item in the main menu.

In the main menu, there are two more items, "Ration Examples" and "Terms of Use". In the "Ration Examples" menu, examples of rations for different swine categories are presented. It may be useful for the practice in early application usage. In the "Terms of Use" menu, there are general considerations for users interested in further code development. All potential users interested in such a project are free to do it, due to the required prerequisites, and may obtain the source code on request, as well as application access credentials.

Although Web-Based Swine Ration Balancing System is a server-side web application, it doesn't have to run specifically online. On the contrary, offline mode is possible upon installing the proper software. One of the best solutions for this purpose is free XAMPP [14]. It is a well-documented application, with an intuitive GUI, and therefore a perfect platform for offline use of Web-Based Swine Ration Balancing System.

Conclusions

Nowadays, there is a significant necessity for free software for swine ration balancing. Such demands are true among both scientific and professional communities in the field of applied animal science. Now and then, demands for specific solutions may be noted, starting with technologists in animal feed production, through farmers and agronomists, and up to veterinarians. Not that some applications are not already available, but usually the cheaper ones are those whose functionality is less efficient. On the other hand, there are a lot of users with specifically tailored requests. However, such projects may require the collaboration of animal feed technology and animal science professionals with code development experts. While there is no inherent issue with it, multidisciplinary teams may waste considerable time trying to understand each other, whereas projects

could progress much faster if teams built upon existing knowledge. Existing open-source code, ready for further modifications and development, could seriously improve engagement on such tasks. Therefore, in this paper, one possible open-source solution is presented. A solution designed as a starting point for further developments, rather than an application based on various elements of which none is fully developed.

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Izvod**SISTEM ZA BALANSIRANJE OBROKA ZA SVINJE NA VEBU**

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Sistem za balansiranje obroka za svinje na vebu je serverski orijentisana aplikacija. Uz ovaku aplikaciju, izrada receptura obroka za svinje je brža i verovatnoća greške manja, u poređenju sa ručnim kalkulacijama ili upotrebom opših računarskih tabelarnih kalkulacija. Uz integraciju sa odgovarajućim računarskim programom ovakva aplikacija može se pokretati i bez povezivanja na internet. Ova aplikacija je slobodna za upotrebu, a kod je otvorenog karaktera, tako da ga potencijalni programeri mogu unapređivati i modifikovati u skladu sa sopstvenim potrebama i zahtevima. Sistem za balansiranje obroka za svinje na vebu je aplikacija razvijena upotrebom programskih jezika HTML i PHP, i zasnovana na MySQL sistemu za upravljanje relacionim bazama podataka. Predstavlja rešenje dizajnirano kao polazna tačka za dalji razvoj, a ne kao aplikacija zasnovana na različitim elementima od kojih nijedan nije u potpunosti razvijen.

Ključne reči: svinje, obrok, balansiranje

Credit authorship contribution statement:

Mihailo A. Radivojević: Conceptualization, Methodology, Software, Formal analysis, Data Curation, Writing - Original Draft, Project administration.

Miletić B. Aleksandar: Validation, Investigation, Writing - Review & Editing.

Jelena K. Milanović: Visualization, Supervision.

