THE STRUCTURE AND THE ESSENTIAL FUNCTIONS OF A SOFTWARE MODULE ON BEEF PERFORMANCE RECORDING

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Abstract

This study aimed to present the logical structure and core functions of a software module for recording, processing and reporting information relating to performance control in beef cattle. The research comprised a literature review on several control systems used in other countries, international guidelines and recommendation in the field and a syntheses of key issues that led to the successful implementation of an information module that takes into account these requirements, described in this article. The results of scientific investigations illustrate that the process of collecting and inputting data has a important role in the process of performance recording in its early stage and although the performance indexes for each animal can be already useful in practice, the software needs a period of 3-5 years of continuously recording the data in order to become fully mature.

Key words: performance recording, beef cattle, software

INTRODUCTION

Despite the lack of a tradition in the field, the breeding of beef cattle has experienced a significant development in Romania after 1989. Out of ANARZ statics, in 2008 there were around 9,300 pure breed and beef cattle crossbreeds in Romania, especially from Angus, Charolais and Limousin breeds. In 2011 were registered about 25,000 pure breed and crossbred animals from beef breeds. This data does not include animals raised in households. [11]

The growth occurred as a result of importing pure breed animals from EU countries and as consequence of numerous artificial inseminations made with semen from beef bulls. According to the same institution, in 2009 about 26% of artificial inseminations were made with semen from specialized beef bulls and the percentage rose to 52% in 2011. No data about number of natural matings were available.

Comparing with the EU, where approximately 35% of the adult female cattle population belonged to a beef breed, in Romania this figure was only 1.7% in 2010. [4]

The market demands coupled with favourable geographical and climatic conditions to breed beef animals in Romania and the highly regulated conditions of hygiene and food safety imposed in dairy industry, lead to the hypothesize of the rapidly increase of specialized beef animals in the coming years, at least in a proportion equal to the EU. [11]

This phenomenon generated also concerns for developing strategies in order to increase the economic performance of farms with this profile, but also for increasing the genetic value of livestock exploited in Romania.

The research revealed that there isn't currently any computerised system used for the beef cattle performance recording in Romania. In this context we conducted this scientific investigation that focused on the implementation and description of a software structure and functions, created for recording, processing and reporting information used in performance control in beef cattle.

MATERIAL AND METHOD

The research was conducted in six stages:

a) a comprehensive review of literature was made in the first step in order to identify the state of art methods and systems used in practice along with international recommendations and standards

b) designing the database structure and the graphical user interface was done with a team of eight people including specialists in genetics, programming, livestock keeping and project management

c) implementation of the model was done by two programmers paid under a service contract using PHP, Java and an SQL database.

d) software module testing included two stages, the first one performed with virtual data and the second one with data from three farms included in the pilot project

The methods used to conduct the research were mainly: review of scientific literature, analysis, synthesis, data collection, data modelling, computer programming, software testing and observation.

The research was completed within a period of approximately 14 months from which the last two stages lasted around six months.

RESULTS AND DISCUSSIONS

In the field of beef performance recording and genetic evaluation, there are more systems used in practice over the world, different from country to country and even from breed to breed, in the same country. The explanation is historical, or dictated by the selection objectives, which vary from country to country, according to its own natural conditions or social demands. [5]

However there is a strong worldwide concern for harmonization and standardization of the control methods and for making comparable the results of genetic evaluation at a global level. The focal points of these efforts are done through ICAR and INTEBEEF. [10]

Due to the computational demands, linguistic differences and particularities of each country, the genetic evaluation remains a task of breeders' associations and is done through different software at national level.

The traits included in the official evaluation vary also considerably from country to country as the approach in expressing the results. [10]

The system described below is based on the ICAR guidelines and recommendation concerning beef recording and combines structural elements form BRREDPLAN and the system used in France, which are the most widespread and complex systems used in the world.

Software structure

The software has been built to accomplish 5 essentials functions:

1. to manage the users and their hierarchical structure relating to the beef control system

2. to keep records and to manage the information for the herd book of any beef breeds

3. to keep records and to manage the data collected from beef control

4. to calculate indexes for productive and reproductive traits

5. to estimate breeding values for beef cattle

1. *Managing users and their hierarchical structure relating to the beef control system*
The software uses a web based technology being accessed through any computer connected to Internet by visitors or registered users at the address (www.pedigriu.ro).
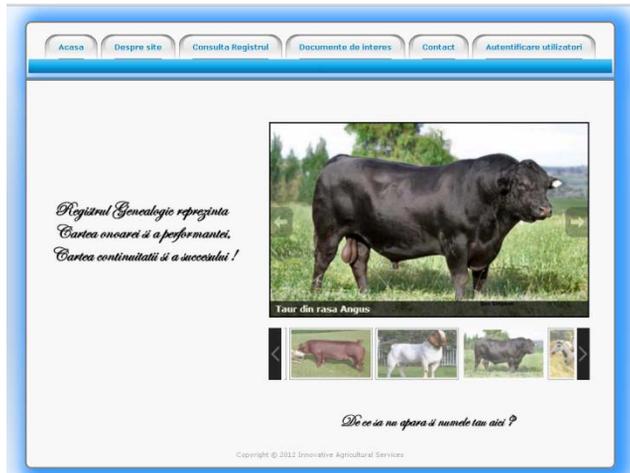
Fig. 1 – Print screen of the main page

The visitors can access general information about animals on the database, about associations of breeders, regulations, application forms and other documents.

The registered users are divided into 4 categories, each of them having tailored access to the application:

a) National Agency for Amelioration and Reproduction in Animal Breeding "Prof. Dr .G.K. Constantinescu" (ANARZ) has the right to access data concerning all users and synthesis reports concerning the activity at national level. This comprises the list of all the associations, breeders, animals, all the herd books, data collecting from the performance recording etc. However, ANARZ cannot modify these data.

ANARZ, according to the law, can grant the permission to any breeders' association to keep the herd book for a breed or to implement measures of official control, or latter to withdraw the official recognition if it does no longer fulfil the established conditions. [3] From an operational point of view, this activity can be done using the software, denying or allowing the access to specific modules.

b) The associations of breeders have access (through representatives) to all data concerning their members. They can allow members to join to the organisation or to expel them, according to their statute by law, using the software. The associations can save, access and modify the data about animals owned by the members and can also access the reports regarding their activity.

c) The rights of members (farmers) to use the software are set up by associations. Some of them can be allowed to submit data regarding their farm other don't, but all of them have the possibility to access all the information about their cattle and to send short comments about noticed errors. However, the data submitted by farmers must be confirmed by technicians employed by association in order to become official.

In order to facilitate the communications between all the parties involved in the process, we created a module with which any user can send officially requests to the others, attaching relevant documents, pictures and receive the response to his request.

The most complex type of user is the administrator one, who has the right to make settings for all the users, about the performance recording systems, settings related to every breed, performance indicators for the breed and to delete or modify data related to any user. Nevertheless, these settings and interventions are done only at the associations' requests, according to their statutes and rules.

Table 1 – Users' rights

User	User rights
ANARZ	*Accessing data from all other users* *Synthesis reports about activity on each breed and at national level*
Associations of breeders	*Saving, accessing, modifying and deleting data from all their member* *Managing the herd book* *Synthesis reports about the activity at the association level*
Farmers	*Saving, accessing, modifying and deleting some data regarding their animals (according to the rights given by association)* *Synthesis reports about the activity at the farm level*
Software administrator	*Set all the variables for all the breeds and systems, creating, modifying and deleting user accounts*

2. *Keeping records and managing the herd book of any cattle breeds*

At the national level, more associations can perform performance control activities, but only one is officially empowered by ANARZ to keep the herd book of a breed, and is responsible with publishing the results of genetic evaluation for that breed.

The keeper of the herd book organises it in advance (helped by software administrators) in more sections and classes. In the same time there are established minimal conditions for animals in order to be included in each section and class, taking into consideration the European legislation. [1]

Then, the responsible association can add any animal found on the database into the herd book, regardless of who belongs. From a functional point of view, adding an animal to the herd book implies selecting it, checking the information available and clicking on the *Add* button. The software assigns a registration number and saves it with the date of inclusion.

Before adding an animal in the herd book, the association's representative can check some data relating to that animal, in order to make a sound decision. The check may cover the identification details, pedigree, performance, ascendants, descendents, ownership history, photo of the animal, prizes won in competitions, pedigrees issued in other countries and attached as documents etc. These data are registered by local associations and the documents or the photo can be attached by the breeder. The Figure 2 illustrates a screen comprising the identification data regarding one animal. More information can be found accessing the icons up on the page.

Fig. 2 – Screen displaying identification data of an animal

In order to avoid the mistakes, the software executes a check for each animal in order to establish if it meets minimal requirements to be registered in the herd book and makes a recommendation to the association' representative.

The inclusion in sections (main section, secondary section, supplementary section, etc) is based on information relating to the numbers of ancestors known as a pure breed and is done automatically by the software. If the amount of information about one animal increases or changes over the time, the section where it belongs is changing accordingly. Logically, the operation is done by comparing the conditions imposed for every section with that met by the animal.

The belonging to a class (class A, B or class I, II, etc) is established also automatically by the software considering the performance of the animal or its genetic merit. One or more indexes can be taken into consideration for including an animal into a class. The class is changing automatic too, if the data about the performance changes over time.

This novelty of the system is that it requires minimum intervention and efforts from users and has the advantage of keeping automatically updated the situation of each animal in real time

The association entitled to keep the herd book can access and print at any time reports concerning animals included in any section and class, classified by gender, age, performance, farm etc.

Based on the information found on the database, the association can issue and print a pedigree for the animal, according to European law. The design and some information from the pedigree can be customized but there is a minimum content required by law which is mandatory. [2]

The software automatically assigns a unique number to the pedigree and save a history of all the pedigrees issued for each animal, comprising the identification number of the animal, the pedigree number and the issue date.

The removal of an animal from the herd book can be done manually. The reason of such decision must be supplied and together with the date of the removal is saved in the database. The software alerts also the users about animals which don't meet anymore the

minimum requirements to be registered in the herd book (due to the changing of the initial identification data or parentage).

3. Keeping records and managing the data collected from beef performance control

The software allows saving and managing the data concerning five major fields of cattle performance: calving ease, growth and conformation, carcase, reproduction and workability (temperament). The same traits are considered by the system proposed by INRA and the University of New England. [9], [12], [13]

The legal responsibility for the correctness and accuracy of data lies on local associations of breeders. However some data can be introduced in the system by farmers and abattoirs and validated by associations' representatives.

a. Calving ease

For the calving ease estimation, the software allows the users to save the birth weight of each animal and the difficulty of calving. The data can be introduced at any time, but it is mainly done through a pop-up window, which appears automatically after the registration of a new born calf. Usually, the data are directly introduced in the system by farmers or by local association in behalf of farmers. Spot checks are carried out to avoid the fraud.

The birth weight is recorded in kilograms and the difficulty of calving by using a five steps scoring system.

b. *Growth and conformation*

The indexes for these productive traits are estimated using weights adjusted at the age of 205 and 365 days and one or more physical evaluation of each animal, completed at certain ages, chosen by the association of breeders. The flexibility is however in line with the ICAR Guidelines [7].

In order to record the weights on the field, the software generates a list of animals that must be weighed at a date chosen by the farmer. It makes also suggestions for grouping the weighing activities according to the age of animals, in order to minimise the number of operations in every farm. After the data is collected on the field, it can be imported into the software through a standard CSV or TEXT file, or the figures can be manually entered into the database.

The software calculates immediately the adjusted weight of each animal and the daily gain in grams, based on its birth date and weight supplied.

Fig. 3 – Screen displaying weighing results

The evaluation of conformation is made by technicians specially trained according to the system used for every breed. The number of traits on the evaluation sheet can be set up for each breed and the traits can be grouped in more functional areas like: muscularity, skeletal, and functional traits, etc. Before going to the farm, the technician can generate and print a list of all the animals that meet the criteria for being evaluated that day. Most of the traits are visually appraised without immobilizing the animal, but some measurements of body can be used as well, for a better accuracy. The software calculates the indexes of performance for every evaluated criterion or group of traits, comparing animal's performance with the average performance of the breed.

c. Carcase

The data about carcase are usually submitted by abattoirs following the signing of an agreement with the associations of breeders. The mandatory data are: live weight of the animal, dead weight and other data about the carcase quality if are collected.

The data are directly saved by abattoirs' employees into the database or sent on the paper format to associations every month, who input them into the software.

c. Reproduction

The reproduction events are saved into the database by associations' representatives or farmers. In the latter case, the data must be validated by associations. Each event must be recorded no later than 60 days from the date of occurrence.

The records are divided in three major categories:
- ➢ calving
- ➢ abortions and calves born dead
- ➢ artificial inseminations, natural mating and embryo transfers

Before saving any events, the software lists the last events of the selected female, helping the users to record inaccurate data.

Based on the recorded events, the software provides a graphic representation of the reproductive history of each female which can be printed.

The software calculates also 5 reproduction performance indexes for females, based on the existed data (calving interval, number of A.I per calving, stillbirths, prolificacy, and number of weaned calves per year).

d. Workability

The temperament of animal is assessed by technicians, with scores from 1 to 5 at the moment of judging animals for conformation and growth traits.

4. Genetic evaluation

The breeding values are estimated using BLUP-method (animal model). The estimation of breeding values is based on:

-    the performance of the animal and of its relatives (considering the degree of relatedness for 3 generations)

- genetic and non genetic correlation between traits
- economic values of traits including into the evaluation model

Assignment of an animal to a specific breed is validated only if 75% of the animal's genes originate from that breed.

The detection of logical inconsistencies and biological improbabilities in the input data are automatically done and inconsistent or biased data are excluded from the genetic evaluations.

For computational reasons, the collected data are transferred in a special module on the local server and processed using a powerful Intel Core i7-3930K of 3.20GHz processor. The results of evaluation are transferred back to the public database where it can be accessed by users.

The breeding values are calculated for all animals simultaneously, all corrections for environmental and genetic effects being included in the model.

The calculation of indexes (I) is done through a system of equations according to the system below:

$$I = b_{A/I} (\grave{}Pg - \grave{}Ppop)$$
$$b_{A/I} = (na'h^2)/(1+(n-1)t)$$
$$t = ah^2 + c^2, \text{ where}$$

I = index of breeding value for a individual trait A

$b_{A/I}$ = regression coefficient

$\grave{}Pg$ = average of n measurements

$\grave{}Ppop$ = the population average performance

The regression coefficient $b_{A/I}$ is determined as: the number of observations (n), times the relationship coefficient, (a), times the heritability, divided by 1 plus (n-1) times the intra class correlation (t).

Based on regression coefficient $b_{A/I}$ is calculated the accuracy of breeding value estimation (r_{IA}), as the square root of the product of the relationship coefficient (a) and the regression coefficient:

$$r_{IA} = (a' \ b_{A/I})$$

The intra class correlation is calculated as the relationship between the individual observations (a), times the heritability (h), plus the common environmental factor (c2). A more detailed explanation of the system used was done by Horia Grosu and Pascal A. Oltenacu [6]

The necessary data for conducting the genetic evaluation can be exported also in the format required by INTERBULL, in order to be used in the international evaluation of bulls. [8]

Publication of the result

The software generates 3 main types of reports:

a) Reports regarding the performance recording activity the activity at farm level, association level or at national level, like:

- *List of all associations and farms registered in the performance control scheme, their data of identification and number of owned animals*

- *List of animals (for each breed) registered in the performance control scheme and their identification data ordered by gender, category, section and class of the Herd book*

- *List of all weightings at farm, association or national level, ordered by date and animals weighted each date*

- *List of all scorings, at farm association or national level, ordered by date and animals scored each date*

b) The reports regarding animal performance comprise rankings of animals, according to each type of performance part of the recording system for the breed. The results are expressed either in the unit of measure used for each particular treat (i.e. kilograms for growth, scores for conformation and centimetres for body size) or using performance indexes. The indexes are calculated comparing the animal performance with the average performance of the breed (for each gender) without excluding the contribution of non-genetically factors.

The rankings can be generated for all animals born in a chosen time at farm level, association or national level.

c) The reports with the results of genetic evaluation cover the traits included into the evaluation system for the breed. The results are expressed through indexes and accuracy of estimation for each index. The average breeding value of reference population is standardised at 100 points, so better genetic values are expressed as higher numbers and vice versa.

However, due to the small number of animals in the database, insufficient

connectivity between herds and insufficient statistical data about environmental effects verified through the time, the accuracy of estimation the breeding values may suffer, despite the adopted model. The insufficient data for some adult animals is also a barrier for getting comprehensive results.

There were also encountered problems in the first year of using the software, in habituating farmers to constantly record data with a high degree of accuracy and to make them understanding the practical aspects of the recording systems.

It can be estimated according to the current situation, that only after 3-5 years of the data recording, the software can be 100% adapted in order to provide valuable and undisputed results from the genetic evaluation process.

CONCLUSIONS

The breeding of beef cattle has experienced a significant development in Romania in the last 20 years, despite the lack of tradition in this field. However, comparing with EU, where approximately 35% of the adult female cattle population belong to a beef breed, in Romania only 1.7% of population belong to a beef breed.

The increasing interest in breeding specialized beef breeds brings also demands for tools necessary for increasing the economic performance of farms and also for assessing genetic value of livestock.

This article focuses on describing the structure and functions of a software used for recording, processing and reporting information relating to performance control in beef cattle.

The software is based on the ICAR guidelines and recommendation and combines structural elements from BRREDPLAN and the system used in France, which are certainly ones of the most widespread and complex systems used in the world.

The software has been designed to accomplish five major functions, covering the management process of performance recording, herd books' management, animal performance evaluation and estimation of genetic value for animals belonging to a beef breed.

The software uses a web based technology and can be accessed through an username and a password from any computer connected to the Internet, by five types of users: visitors, ANARZ, associations of breeders, farmers and software's administrators.

The module allows users to save and manage data concerning four major fields of cattle performance: calving ease, growth and conformation, carcase, and reproduction. The right to introduce and access data is set up for every type of user, according to the recording system rules of each association.

Through the process of recording or accessing data, the software provide hints or advice to comply with the rules imposed by the recording system and do not allow the registration of data that do not meet logical requirements or are inaccurate.

The data can be manually inputted or imported through a CSV or TEXT file from any mobile dispositive.

Based on recorded events, the software provides graphic representations and printed forms or reports, useful to collect data on the field. The software calculates also performance indexes for animals, comparing their own performance with the average performance of the population, without excluding the environmental effects.

The breeding values are estimated using BLUP-method (animal model) based on the performance of the animal and of its relatives, genetic and non genetic factors and economic values of traits. The necessary data to conduct the genetic evaluation can be exported also in the format required by INTERBULL, in order to be used in the international evaluation of bulls.

The software generates also 3 main types of reports regarding: the process management, animal performance and estimated genetic merit of animals.

However, due to the small number of animals in the database, insufficient connectivity between herds and insufficient statistical data about environmental effects verified through the time, the accuracy of estimation may suffer, despite the adopted model.

The lack of sufficient data for each animal and lack of habit to constantly record

data at farm level are the most encountered problems in the first year of using the software. Although the performance indexes are already useful in practice, the truly valuable and undisputed results for genetic evaluation are expected only after 3-5 years of continuously data recording.

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ACRONYMS:

ANARZ - National Agency for Amelioration and Reproduction in Animal Breeding "Prof. dr. G. K. Constantinescu" (Romania)
BLUP - Best Linear Unbiased Prediction method
BREEDPLAN - genetic evaluation system for beef cattle used in Australia, New Zeeland, Namibia, Thailand, Philippine, United States, Great Britain, Hungary, South Africa and some countries from South America
EU – European Union
ICAR – International Committee for Animal Recording
INTERBULL - International Bull Evaluation Service, permanent sub-committee of the International Committee for Animal Recording

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