Conceptualization and development of an informatics system for planning the pastoral beekeeping in Romania

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Abstract. The paper presents the basic ideas that leaded to the conceptualization and development of an informatics system for planning the pastoral beekeeping in Romania. This informatics system integrates administrative and geographic information database, average multiannual climatic data, melliferous potential calculation, and beekeepers and beehives database. This informatics system is thought to be used by decision makers at national and regional level for planning the pastoral activity of the beekeepers in Romania, but also to be used by beekeepers for obtaining useful information about the repartition and places of the melliferous forests and crops, and about their melliferous potential according to the climatic conditions of the year.

Keywords: informatics system, pastoral beekeeping, acacia, lime, sunflower, rapeseed.

1 Introduction

According to the national legislation, the beekeepers in Romania are allowed to benefit free of charge of the state forestry and agricultural melliferous resources. Thus, the beekeepers can move in pastoral all over the country with their beehives to the melliferous forests and crops. Unfortunately, the pastoral activity is not organised and planned at national or regional level. As a consequence, it often happens to have too much beehives for a forest or some melliferous crops in a certain zone, which leads to a reduced efficiency of the melliferous pastoral activity and an increased risk of sanitary problems for the bees. Also, it very often happens that some melliferous forests and crops to be less or even not at all valorised. These are the circumstances that lead to the necessity to have an informatics system to be used by decision makers at national and regional level for planning the pastoral activity of the beekeepers and to provide through it useful information for beekeepers about the melliferous potential of different forests and crops according to the climatic conditions of the year.

2 Material and Method

The informatics system for planning the pastoral beekeeping in Romania is thought as an useful tool for providing information about: locations of acacia and lime forests all over Romania; main zones for growing sunflower and rapeseed in Romania; melliferous potential of acacia (*Robinia pseudocacia* L.), lime (*Tilia tomentosa* Moench.*; Tilia cordata* Mill.*; Tilia platyphyllos* Scop.), sunflower (*Helianthus annuus* L.) and rapeseed (*Brassica napus* L. *ssp. oleifera* Metzg.) according to the climatic conditions of the year, respectively the forecasting of beginning and duration of the flowering process and the potential honey production function of potential nectar secretion and its sugar concentration, and potential number of flowers. The species taken into account represent the most important melliferous resources in Romania, more than three quarters of Romanian honey marketed production coming from these species.

The informatics system is thought to be developed gradually at regional and national level, in different stages, respectively:

1. In the first stage, a database is to be developed containing administrative and geographic information concerning acacia and lime forests in each county, as well as containing information about sunflower and rapeseed crops; each county will be presented as digital maps with the repartition of the forests and crops.
2. It the second stage, the average multiannual climatic data for each acacia and lime forest, as well as for each homogenous zone with melliferous crops (sunflower and rapeseed) has to be gathered.
3. In the third stage, for each acacia and lime forest, as well as for each homogenous zone with sunflower and rapeseed crops the melliferous potential has to be calculated and the maximum load of beehives has to be established.
4. In the fourth stage, a database containing the number of beekeepers and beehives in each county and each place has to be built.
5. In the fifth stage, all the data and information has to be compiled into an informatics system running on the web that will enable the use by decision makers at national and regional level (county level), as well as by researches in the field of beekeeping and even by beekeepers themselves.

3 Results and Discussion

Administrative and Geographic Information Database. For each county of Romania, the database has been created containing administrative and geographic information about the acacia and lime forests (figure 1 and figure 2), as well as containing information about sunflower and rapeseed crops. These databases were realised starting from the 42 county maps of Romania with the aim of giving the possibility of a rapid identification for each forest and agricultural homogenous area, based on administrative limits, hydrography, roads and other elements represented on these maps (figure 3). For each forest, there is associated information related to the

following aspects: surface, acacia and lime species presence and their abundance, and average age of plants (trees). For each agricultural homogenous area, there is associated information related to the surface as average value cultivated with sunflower and rapeseed in the last years, and the most cultivated varieties.

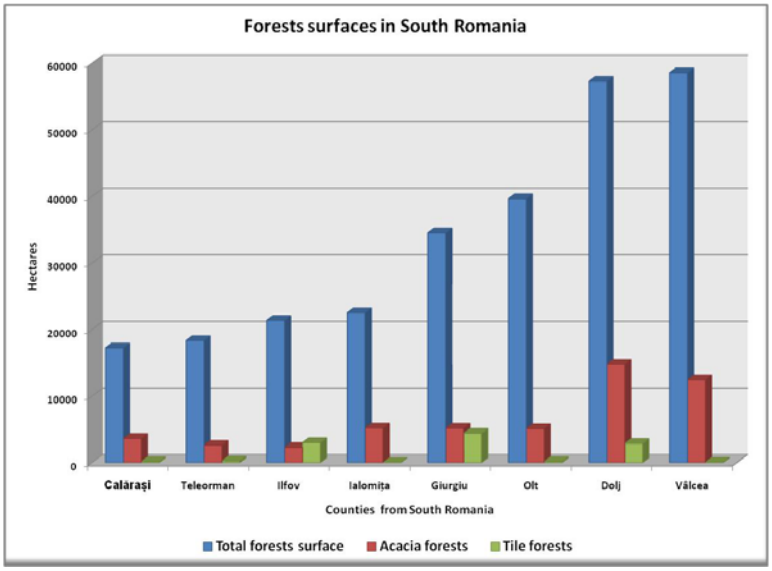

Fig. 1. Forests surfaces in different counties from South Romania as total surface, acacia surface and lime surface.

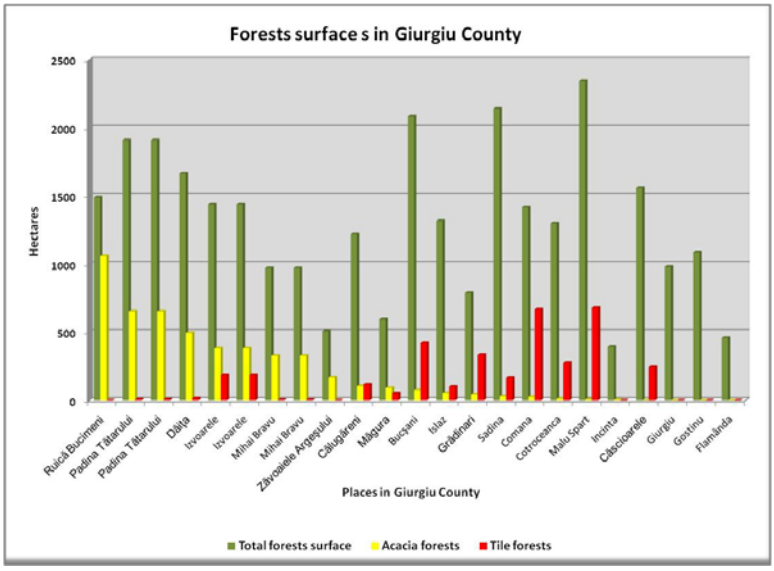

Fig. 2. Forests surfaces in different places from Giurgiu county (South Romania) as total surface, acacia surface and lime surface.

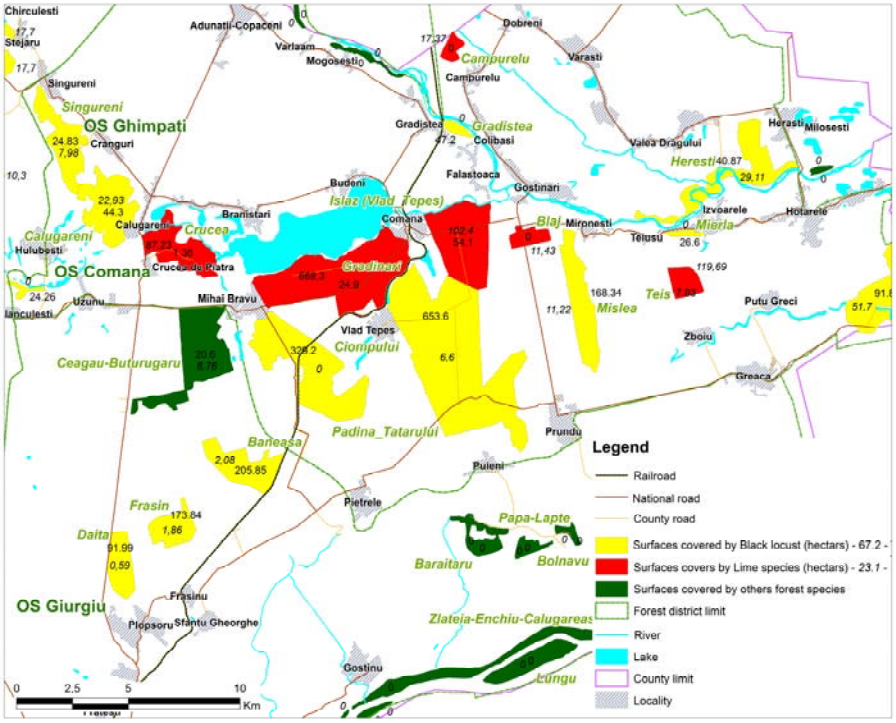

Fig. 3. Detailed part of the Giurgiu county map (South Romania). Elements of the figure present the location of the acacia (yellow) and lime (red) forests in the county and their position reported to villages, roads, and rivers.

Average Multiannual Climatic Data. For each forest and agricultural homogenous area, the average multiannually maximum and minimum daily temperatures and average multiannually monthly rainfall were gathered from the most closed meteorological station and when this was not possible, these data were obtained through the interpolation calculation of the climatic data existing in the neighbourhood. Climatic data are necessary because they are influencing the melliferous potential but also the period of flowering [2]. For instance, mainly because of temperatures, in South Romania there are three periods of flowering for acacia, respectively: the acacia along the Danube River is flowering first, then acacia in the middle of Romania Plain is flowering and lastly the acacia in the hilly regions nearby Carpathians is flowering. The beekeepers know this different flowering periods of acacia and some of them are moving with their beehives three times in a year only for acacia.

Melliferous Potential Calculation. The melliferous potential expressed through the potential honey yield/ha is calculating using the following formula [1]:

$$M = [(Sn \times Cn \times D \times Nf \times Np)/100{,}000{,}000] \times 1.25 \quad (1)$$

where: M = potential honey yield (kg/ha);
Sn = nectar secretion (mg nectar/flower/day);

Cn = nectar content in sugar (%);
D = flowering duration for a flower (days);
Nf = number of flowers /plant;
Np = number of plants/ha;
1.25 = coefficient of sugar transformation in honey.

All the parameters from the above formula are taken as average values for normal forests and crops in normal climatic years.

The melliferous potential is determined by the biological factor (species and variety) but this is significantly influenced by the climatic conditions, especially by water (rainfall) and temperature. That is why the melliferous potential calculated has to be corrected function of climatic conditions of the year, respectively corrections has to be made in the rainy and cold years and dry and hot years [3].

The calculated melliferous potential is used for the establishment of the maximum load of beehives on the surface unit, but also for the information of the beekeepers which are moving in pastoral with their beehives.

It is also very important to calculate the date of starting and duration of flowering process for the melliferous crop. In this respect, there is already well-known the fact that the crop development is determined by an important number of complex factors and their complex interrelations. This makes the calculation task to be a so-called "poor-structured problem". However, a simple method that can be used to estimate the plant development is based on "thermal time" measured in "growing degree-days" (GDD). This method starts from the fact that each plant requires a specific amount of heat (a specific sum of GDD) to develop from one point to another in their life-cycle and development occurs only if the air temperature exceeds a minimum limit, named "base temperature" (Tb), which has values according to the species (7^oC for sunflower and 0^oC for rapeseed, acacia and lime).

The following model of the GDD calculation is implemented:

$$GDD = [(T_{max} + T_{min})/2] - Tb \quad (2)$$

if: $(T_{max} + T_{min})/2 \leq Tb$ then $GDD = 0$

T_{max} and T_{min} are daily maximum, respectively, minimum air temperatures, which are estimated by averaging the historical meteorological data regarding the requested geographical area.

The sum of GDD is calculated for each crop, e.i. acacia and lime, and regarding the sunflower and rapeseed for each hybrid maturity class.

Beekeepers and Beehives Data. For each Romanian county, the database has been created containing the number of beekeepers, the number of beehives and their repartition over the county. These data are necessary in view to calculate the use rate of melliferous resources in each area and the number of beehives that could be moved in each area in view to have an efficient valorisation of the mellierous resources and to avoid the situations of too much or too less beehives on the surface unit of melliferous crops and forests.

Informatics System Compilation. Once there are all the necessary databases and information, these will be compiled into an informatics system that will run on the web. Into a vey first stage, there will be designed the logical structure of the system

and the web interface (format, graphics, number of pages and so on), which means HTTP programming. Then, the functionality of the web interface will be programmed and connected with the databases, which means PHP programming. Lastly, there will be implemented the digital maps into the web interface and there will be established the format in which the databases will appear on the web.

The informatics system is to be implemented and used at a county level firstly, and after different test and validations, this will be developed at South Romania level, and then at national level. This informatics system will be used by decision makers at national and regional level for planning the pastoral activity of the beekeepers. But, this is providing also useful information for beekeepers about the repartition and places of the melliferous forests and crops, but also about the melliferous potential of different forests and crops according to the climatic conditions of the year.

3 Conclusions

1. At present, in Romania there is a risk of moving beehives at random to the melliferous forests and crops, without knowing their melliferous potential and without knowing the already present beehives in the area.
2. An informatics system that could be used by decision makers at national and regional level for planning the pastoral activity of the beekeepers is a necessity.
3. Also, there is a necessity for an informatics system that could be used by beekeepers in view to get information about the repartition and places of the melliferous forests and crops, as well as about their melliferous potential.
4. Such an informatics system for planning the beekeeping in Romania integrates administrative and geographic information database, average multiannual climatic data, melliferous potential calculation, and beekeepers and beehives database.

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