

INNOVATIVE POTENTIAL OF BEEKEEPING PRODUCTION IN AP VOJVODINA

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ABSTRACT: The research was carried out in the area of the AP Vojvodina with the aim of obtaining data on the degree of application of innovations in the beekeeping industry, as well as the potential and readiness of beekeepers to introduce new technologies such as smart hives, permanent satellites, and organic production systems. Total of 112 beekeepers was selected, randomly selected, where the sample was to be as representative as possible, that is, the spatial coverage was considered. The average age of beekeepers was 46 years with an average experience of 11.5 years. Three types of hives were identified (a hive with frames, a modern hive, and a smart hive). More than 60% of the respondents harvest honey annually, while about 30% of the respondents picked up between two to three times a year. Moreover, on average 21 and 24 kg of honey is collected from modern and smart hives, respectively. Classic hives provide a yield of honey on average 21.5 kg. There were differences in the yield of honey depending on the type of hive and the length of the beekeeping period, where more experienced beekeepers achieved somewhat better results. More than 90% of respondents prefer classic hives. Factors that affect the lack of use of modern hives are the lack of equipment (36.5%), followed by the quality and availability of wax (34%). In order to adopt and maintain modern technology of hives, the focus should be on education, equipment for honey production, as well as on the quality of wax and its availability.

Key words: *bee-keeping, innovation, plastic honeycomb, Bee Smart technologies*

INTRODUCTION

Beekeeping is a sustainable form of agriculture and one of the ways to generate and increase revenues in the rural areas of AP Vojvodina. The most valuable results of bee production are honey, wax, and pollination, which is in the function of increasing the yield of many agricultural and horticultural crops. Beekeeping is an opportunity for earning income in rural areas or the possibility of supplementing agricultural income. AP Vojvodina has huge potential for beekeeping production, considering the diversity of flora and climate. However, this huge potential is used to a small extent, mostly because conventional agriculture disables the development of bee communities due to the use of insecticides, especially in fruit and vegetable production (Bošković et al., 2016). The data of the Statistical Office of the Republic of Serbia show that there are 165,000 hives in AP Vojvodina. A large number of beekeepers deal with this activity with an amateur or as a hobby, which affects relatively lower productivity and economic effects.

According to some estimates, the current volume of beekeeping production represents only about 30% of the production potential of AP Vojvodina, and it is therefore of great interest to define a policy that will raise this production to a much higher level. Beekeeping is dominated by classical production technologies, which point to the need for modernization. In Vojvodina, agricultural activity has been developed, and most cereals, feed and industrial plants, while in recent times there is a trend of raising fruit trees, which is the main source of the feed for bees. AP Vojvodina disposes mainly of arable land and pastures, and there are also higher altitude areas, such as Fruska Gora. Adequate availability of bee pasha in combination with favorable and varied agro-climatic conditions of AP Vojvodina creates conditions that favor the development of bee colonies. Biodiversity, or various and unique flower plants, make the area of AP Vojvodina very suitable for maintaining a large number of beekeeping colonies and considering the long-standing practice of beekeeping. The area is covered with natural vegetation, one-year and perennial cultivated crops. Water resources are mostly represented, while at the same time some surface waters are contaminated and as such are a limitation for the development of beekeeping, especially organic beekeeping. The production of honey and other bee products is relatively low, which leads to low consumption of these products and relatively low sales revenues. Thus, the contribution of beekeeping in the AP Vojvodina is limited and certainly below the possibilities, which provide agro-climatic conditions and natural resources. Despite the high potential for beekeeping and extensive practice, deep research, or scanning of the situation in beekeeping production, has not been carried out so far. Apicultural resources and the accompanying restrictions for the beekeeping sector are not precisely defined, so the intention is to try to assess the potential for dynamizing beekeeping production with existing reusers and in the perspective of using innovative technologies. Since no systematic study has been carried out in relation to the production potentials in AP Vojvodina beekeeping, management and constraints associated with this sector, we have come up with the idea to evaluate the production potentials, the perceptions of the community on the management of beekeeping and the restrictions associated with the beekeeping sector. The research was carried out to assess the current practices of beekeeping, production potentials, potentials for introducing innovations and production constraints. Most (99%) beekeepers in AP Vojvodina have classic hives. The lack of information technologies, the unorganized market, the lack of trained consultants and pests in beekeeping are the main problems that the manufacturing sector faces. The most important restrictions on beekeeping are insecticides and bee diseases, as well as the lack of education. Vojvodić and Bubalo (2017) point out that increasingly complex and technologically demanding beekeeping requires continuous improvement of beekeepers and their readiness to improve their knowledge and skills by attending education programs. One of the many advantages of modern beekeeping is the use of mobile frames. Moving frames allow regular control of the conditions of the nuts and bees of the crankshaft. Their low weight allows easy handling by women and children (Yap and Devlin, 2015). High yields, honey quality, ease of inspection, low disease rate, lack of market problems, lack of thieving problems are the main advantages of the modern hive and, at the same time, the reasons for adoption in most of those who introduced modern hives into production. On the other hand, the high costs, the need for high skills, pests, and predators, the lack of wax are the main disadvantages of using a modern hive (Jebesa, 2017). There are three basic types of beehives in beekeeping practice, which are classic hive frames, modern hives, and smart hives, which are

currently used in different parts of the earth, but the hives with frames are most represented. Innovative technologies and modern technical facilities in beekeeping improve the efficiency of production (Ignjatijević et al., 2018). On the other hand, if we do not switch to the organic system, the bees will be at risk of dying or there will be no migration beekeeping, which will negatively affect the pollination of agricultural crops, it is possible to foresee a huge loss in crop production, especially those that are dependent on bee pollen (Gaga and Esaulov, 2016). In addition to the introduction of new technologies in beekeeping production, the issue of preservation of bee colonies is even more important, since bees are massively dying around the world due to diseases, pesticides, electromagnetic radiation, climate change, etc. Increased health concerns, as well as the demands for increased quality of food products, have led to the fact that demand for organic food has been formed in recent years (Tasić, 2018). In the European Union, there are restrictions on the development of organic beekeeping and according to the report of the European Commission DG Agriculture and Rural Development (2013), the problem is the presence of lack of production areas that meet the conditions for organic beekeeping (Nedić, 2015). As a rule, organic beekeeping is a complex system for the production of honey and other bee products, and it is possible in non-contaminated areas (contaminated), in cooperation with beekeepers, who are ready to carry out the prescribed biotechnology and the protection of bees in a biological way (Prodanović et al., 2016). Recognizing the importance of organic beekeeping, the Republic of Serbia has incorporated into the Law on Organic Production (Official Gazette RS 30/10) and the Ordinance on Control and Certification in Organic Production and Methods of Organic Production (Official Gazette of RS No. 48/11) basic principles and standards of organic beekeeping. Also, the Regulation on the distribution of incentives in agriculture and rural development in the hive of bees envisions an incentive of 840 RSD / hive in organic beekeeping, slightly more than conventional production, where the stimulus is 720 dinars per hive. Methods of organic production can only be applied to bees of *Apis mellifera carnica* (Carniolan bee) because it is a race that is vital and somewhat more resistant to disease. The Ordinance foresees that organic beekeeping can take place in areas of 3 km from the location of the apiary, that nectar and pollen sources originate from organic production plants, from wild plants and plants from conventional production, which are not treated with pesticides. Given that there are very few such areas in the AP Vojvodina, there is no basic precondition for organic beekeeping. Of course, there is a site where conventional agriculture does not take place and represents natural ecosystems, and they would be suitable for the development of organic beekeeping. Such locations are mainly forest ecosystems, for example, National Park Fruska Gora, Delibatska peščara, Vršачki breg, and only some micro-locations. In conversation with beekeepers, over 90% of them say that AP Vojvodina is not suitable for the establishment of organic beekeeping farms. In this regard, and since it is a general interest, a policy should be created that will encourage sustainable agricultural systems and thus open up the space for the expansion of locations suitable for organic beekeeping. Beekeepers generally point out that the lack of knowledge and skills for organic beekeeping is a limiting factor in the adoption of innovative technologies. 31% of them express that they are willing to switch to the organic system if they receive appropriate support and incentives. Two-thirds of beekeepers (69%) do not show any interest in organic beekeeping because they consider that there are no basic preconditions for this, and the production technology itself is complex.

The main problem that arises in the market of waxy satin bases is the presence of unwanted ingredients in wax in a large percentage, such as paraffin and tallow. This phenomenon affects beekeepers of great damage, because paraffin and tallow are already melting at 30 - 35 °C, and in conditions of high summer temperatures, honeycomb and endangering bees may be released. One of the solutions is the use of plastic or hybrid clock bases. Such hourly bases contain a hybrid core and a two-sided wax film, and a plug-in attachment to the frame and a jar plug (Milićević, 2017). The technology of durable honeycomb will affect the improvement of bee technology, make it easier and economically more profitable with less risk.



Figure 1. Plastic honeycomb

The construction of honeycombs on permanent hourly bases is faster, compared to classical hourly bases (because bees believe that they only repair honey after honey feeding), it is permanent, it is environmentally acceptable, there is no deformation when feeding (Milićević, 2017). Unlike modern beekeeping and hive frames, they are known and available on the market so-called. Smart beehives or remote control of beehives (Bee Smart technologies). In view of the impossibility of determining the rate of death in classic hives, the so-called. a smart hive in which all the changes can be photographed or recorded by video. This has prompted the idea of smart hives, which can under any circumstances be used to diagnose disease, pests and abnormal conditions (Yap and Devlin, 2015). By reading RFID (Radio-frequency identification) tags or a bar code with a smart hive, you'll get information on the last four reviews on the display and know exactly what was going on in it, what happened and what was done. With this information, a beekeeper can decide whether it is the moment to open a hive or not. He also gives him all the information on what he could expect in, based on his previous visit. In smart hats it is possible to install a camera or digital sensor for remote sensing to monitor through the computer's display virtually all data, starting from information about the parent, quantity of honey, disease, temperature, etc. The "revision" option allows you to check the status of any hive/apiary for all control parameters. Ecological degradation of natural resources is a potential risk in beekeeping production since this production is exclusively tied to the ecosystem (Praca et al., 2017). In spite of the production benefits, beekeeping has only recently recorded an increase in production and a number of beekeepers. Possible risks in beekeeping production are diseases, pests, and predators, droughts, deforestation, and insecticides. Furthermore, lack of knowledge, lack of trained labor and equipment and inadequate research and advisory services prevent further development of beekeeping production. There are tremendous

opportunities to encourage honey production in rural areas. Thus, interventions are needed - introducing modern/smart hives, limiting the use of pesticides in agricultural production, and creating awareness about the importance of beekeeping for humans and the ecosystem. When it comes to the application of new technologies, beekeepers do not show a high level of interest, and as a reason, they cite business problems in current production and often lack the motive for any technological improvements. It is, therefore, necessary to evaluate the production system in beekeeping and to identify the determinants of the benefits of modern hive technology and the main constraints of this potentially important sector, such as bee diseases and conventional agriculture (Kiros and Tsegay, 2017).

The aim of the work is to study modern beekeeping practice, as well as quantification of the introduction of technological innovations in this field, which especially refers to the use of modern hives, permanent honey and the introduction of the principles of organic production in the function of further development of beekeeping production. Possibilities of innovating the production process and introducing new modern equipment, which would accelerate the organization of beekeeping production and provide a higher level of the yield of honey, surely exist, but the question is how many beekeepers are prepared for several reasons. Lack of finance and knowledge are often constraints on introducing innovations, and mistrust is an important reason. Therefore, this research was launched with the aim of assessing the potential for dynamizing beekeeping production and identification of preferences, with regard to new technologies in beekeeping.

MATERIAL AND METHODS

The research was conducted in the area of AP Vojvodina from March 1 to September 30, 2018. A total of 112 representative beekeepers were randomly selected by the random sample method and interviewed. Beekeepers and scientists have also been involved in providing important information on beekeeping management and research restrictions. The data were collected through formal research, secondary sources, focus group discussions, interviews with key informants and field observations. Relevant information was additionally collected through discussions with representatives of beekeepers' associations. Formal research was conducted using a semi-structured questionnaire with open and closed questions. The questionnaire was structured to collect data such as age and experience of examinees (beekeepers), honeybee preferences, beekeeping practices and/or production management, way of setting up hives, bees, main bee grazing, the yield of honey and restrictions for the adoption of innovations. For discussion in focus groups, those beekeepers that were not included in the farm survey were selected, and they are known for their beekeeping performance.

The collected data were processed using the appropriate statistical packages for social sciences (SPSS software version 20), and the obtained data presented illustratively and severely interpreted.

RESULTS AND DISCUSSION

The study showed that the average age of beekeepers is 46 years. Distribution of the age of beekeeper is mainly active working age. The result shows that beekeepers are older,

or more resources are in the hands of older farmers. The degree of adoption of innovations in correlation is with age, and this may be due to the fact that most of the resources are in the hands of the elderly, while most young farmers do not have enough space for beekeeping and deal with hobbies.

Regarding their experience in beekeeping, respondents had on average 11.5 years of beekeeping experience, with a range of 3-40 years of work with bees. This suggests that beekeepers have a good knowledge of the management of beekeeping production, but do not have enough knowledge about the modern management of beekeeping (72%), although it has been introduced and applied. Of the total number of respondents, 70.5% were not trained to develop their beekeeping management capacities, but they inherited knowledge from the older generations. The most commonly used hives are with frames (96%), while those modern and smart hives are represented to a lesser extent (modern hives almost do not have as much as 2.4%).

Experience is one of the factors that is taken into account when quantifying the degree of innovation, but it has been established that it is negligible, ie there is a small difference between the adoption of innovations depending on the experience in production (Gebiso, 2015).

Generally, out of 112 respondents, only 12% of them have innovated technologies in beekeeping. Of the total number of respondents, almost 27% of them experienced using modern hives, but they mostly did not accept technology because of different reasons, lack of skills and problems with the apiary.

Table 1. Types of beehives and the size of bee colonies

Hive type	Number of respondents	%
Hives with frames	107	96
Modern hives	2	1.6
Smart hives	3	2.4
TOTAL	112	100

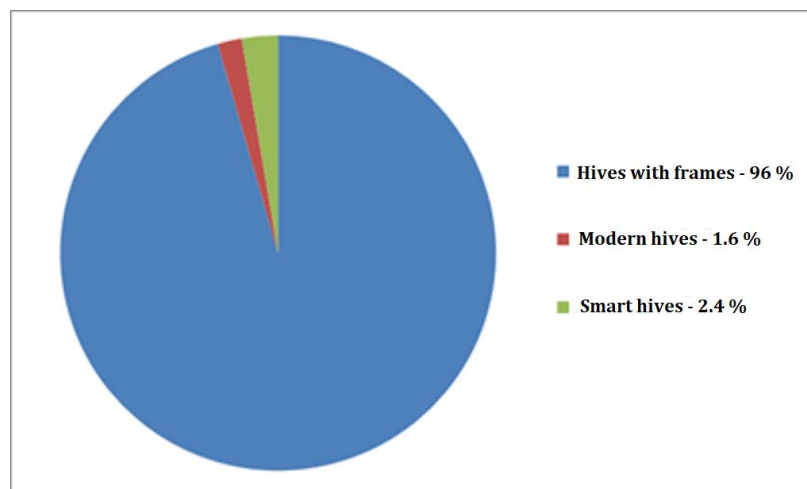


Figure 1. Types of beehives and the size of bee colonies

Table 1 clearly shows that 96% of respondents prefer classic hives. This could be related to the availability of local honeycomb materials and the lack of knowledge of beekeepers for the preference of new technologies, such as smart (hat) hives.

Table 2. Honey yield depending on the type of hive

Hive type	Minimum (kg / hive / year)	Maximum (kg / hive / year)
Hives with frames	9	34
Modern hives	11	31
Smart hives	18	30

As shown in Table 2, an average of 21 kg of honey per year is taken out of modern hives and 24 kg of honey from smart hives. Compared to modern/smart hives, the slightly lower yield of honey (21.5 kg) is collected from classic hives. The productivity of modern and smart hives in this study is somewhat higher compared to classic hives, which may be due to better production management, providing waxy baseboards and higher harvesting frequency. In that sense, the innovation of beekeeping production, or the adoption of improved hives, is important. More than 60% of the classic hives examine honey annually, while about 30% of the respondents picked up between two to three times a year. In the study of Gebiso (2015), average productivity in honey production in modern honey was 19.77 kg / HB, while in production with classic hives the yield was lower than the average, only 5.13 kg / HB. In the study of Hippolyte et al. (2015), it is stated that the perceptions about the yield and quality of honey obtained from modern hives significantly increase beekeepers' decisions on their adoption. There are other factors as education (positive correlation), monthly income (negative correlation). In the Desalegni and Amsalu (2012), 25% of the subjects collected from the modern hive three times a year, while only 18% of the respondents did it in a classic hive. It can be said that the type of hive determines the number of honey harvesting. On the other hand, collecting honey three times a year, the indication is that the area is suitable for the development of beekeeping. Regular assessment and rapid detection of bee pests are of the utmost importance to prevent the loss of honey products (Desalegni and Amsalu, 2012). One of the critical factors that slow down the development of beekeeping is the availability of adequate quantities and quality of bee grazing. About 72% of respondents gave additional food during drought, while 28% of sampled beekeepers did not feed. The reason could be a lack of money to buy extra food or lack of knowledge, which coincides with Kiros and Tsegay (2017) research. In contrast to external inspections, 29% of the respondents often had internal controls. Approximately 18% of respondents rarely examine their hives internally. Below 5% of respondents never look at their hive, except when visiting for picking. Factors that affect the lack of use of modern hives are the lack of equipment (36.5%), followed by the quality and availability of wax (34%). Discussants mention that accessibility, availability, and quality of materials, poor wax quality and lack of equipment are the main factors that have limited the introduction and use of modern hives. The adoption of modern technologies is influenced by education, out-of-farm income, credit availability, beekeeping training, and perceived cost of hives. Therefore, adult education and training programs must be promoted and expanded in rural areas as a prerequisite for facilitating the adoption of modern technology. The size of the farm is also one of the determinants, which affects the adoption of new technologies in beekeeping production.

Table 3. Reasons why modern hives are not used

Factors	Number of respondents	%
Lack of awareness	46	29.5
Skill Staff	24	15.4
Lack of equipment	57	36.5
Duration of hives	45	28.8
The problem of quality and availability of wax	53	34.0

Demographic variables such as gender and age, the participation of farmers in the administration of peasant associations, the size of the land, the participation of new technologies and the availability of labor were less important factors in explaining the adoption of modern technology of hives in research Yehuala et al. (2013).

CONCLUSION

This paper examined the degree of adoption of innovations in beekeeping production and determinants, which influence the beekeeper's decision to adopt modern technologies. Although the government of AP Vojvodina pays great attention to agriculture and especially the beekeeping subsector, in order to promote modern beekeeping technology, it has been shown that the rate of adoption and the spread of technology is very low. There are almost no smart hives in production and classical beekeeping technologies are still used, which are of lower performance. According to the results of the research, there is a great potential for increasing the production of honey and improving the way of life of beekeepers in the rural areas of AP Vojvodina. Beekeeping is a good opportunity to improve people's standards in rural areas, whether in production as professionals, amateurs or hobbies. Beekeeping can create an opportunity for a job where all family members can participate. The initial investments are not too high, the hives take up very little space, and this production can be organized in the minimum volume of only a few hives. Although the honey production trend has shown fluctuation in the last decade, the lack of space for colony bees, conventional agriculture that practices chemical methods, lack of capital, knowledge and experience, low subsidies, technology inaccessibility, climate change (drought, high temperatures), illnesses, poor social awareness of beekeeping practice and lack of understanding of the beekeeper's interest in beekeepers and bees, lack of awareness of the advantages of modern hives, are the basic restrictions for the introduction of innovations and the development of beekeeping in AP Vojvodina. The lack of bee fodder plants is the last ranking that is the main cause, especially during the dry season. Sharing experiences among beekeepers would enable the introduction of modern/smart hives and the adoption and implementation of modern production practices. Beekeepers do not have enough awareness about the benefits of new technologies, and they lack the knowledge to use modern/smart hives. Therefore, beekeepers should integrate their efforts in order to modernize beekeeping production, through the training of beekeepers and encouraging the transition from traditional to modern beekeeping. Financial and technological support is needed to fully utilize the great potential for beekeeping in AP Vojvodina and thus to preserve forests and natural ecosystems, while increasing the standards of beekeeping farms. The conventional practice of beekeeping was the most commonly reported practice in this study. The productivity of modern and smart hives is slightly higher than the classic hives. This may be due to better management practices and a higher frequency of harvesting. Honey harvesting takes place once, twice or three

times a year, and on the basis of variations among the hives types, the frequency of honey harvest can be clearly seen. Most respondents prefer a classic hive, although the average amount of honey is somewhat smaller than in a modern hive. The main factors influencing the selection of hives technology are lack of equipment and problems with the quality and availability of wax. By adopting innovations in beekeeping production, such as modern and smart hives, total honey production would increase, provide better competitiveness and encourage further development of this strategically important production. Unless some measures and regulations on the type of pesticides that can be used for agricultural production are adopted, the future of beekeeping is not great. In addition, there is a need for intervention and the introduction of modern hives, which can make households produce more for the international market than for domestic consumption. Farmers should be able to buy biopesticides and apply environmentally friendly ways to protect pests from plants, which will not pose a risk to bees. This research provides valuable insights for the design, implementation, and evaluation of development projects that seek to introduce new ideas, practices, and technologies into beekeeping production with the intention of promoting sustainable practices and quality. Most beekeepers have knowledge of colony-feeding during the dry season, which other beekeepers must adopt to maintain colonies. This suggests that acquiring technical skills and skills on beekeeping will probably contribute positively to the decision to adopt new technologies. In conclusion, in order to adopt and maintain modern technology of hives, the focus should be on the equipment, quality, and availability of hives and wax. Beekeepers should be encouraged far more to adopt new technology and beekeeping technology, to increase their income, health, happiness and better relationships in the family and community. It is not possible to determine the timing of the adoption of innovations in beekeeping production especially, but it is necessary to insist and introduce innovative models. From the perspective of development, the issue of sustainability is undoubtedly the most important. The basic recommendations for encouraging the introduction of innovations in beekeeping are providing adequate and relevant agricultural advisory services (training on modern beekeeping); provision of credit services to beekeepers for the purchase of modern equipment; incentives for the introduction of innovations. Facilitating access to innovation can provide greater productivity, which can back up the introduction of innovation into beekeeping production with the aim of further development.

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