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IMPACT OF CULTIVATION METHOD AND AGRICULTURAL LANDSCAPES ON WILD BEES

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Abstract

The aim of this paper is to present economic impact of cultivation method and optimizing resources. The presence of high quality natural and semi-natural habitats on farms and in agricultural landscapes such as: strips of honey plants interspersed in agricultural crops, wooded areas, living hedges and the edges of grassy fields are essential for the survive al of wild bees. The paper scientifically argues why pollination of agricultural crops should be based primarily on wild bee herds that need to be protected. By integrating beekeeping into aquaponics systems, reducing transhumance is transformed from a compensatory measure of production losses into a measure of increasing productivity and stimulating sustainable economic development with positive effects on environmental resources and thus providing the opportunity to conserve biodiversity.

Key words*: agricultural landscapes, bees, aquaponics systems, cultivation method.*

INTRODUCTION

The bees need access to a semi-natural habitat for survival, to ensure nesting sites and also to provide them with pollen feed and nectar from wild flowers. Thus, natural and semi-natural habitats are needed to support bees.

Agricultural and livestock activities are considered the biggest consumers of fresh water. Estimations reveal that 85% of the global fresh water consumption is for agriculture and nearly one-third of the total water footprint of agriculture in the world is used for livestock products (Hoekstra, 2007) and (Mekonnen & Hoekstra, 2012).

Aquaponics is an integrated and intensive fish-crop farming system under constant recirculation of water through interconnected devices.

Aquaculture development as a whole in the country in combination with production technology, favourable socioeconomic condition and culture environment has already proven successful in terms of increasing productivity, improving profitability and maintaining sustainability (Toufique & Belton, 2014).

The landscapes of intensive industrial agriculture do not support the populations of wild bees and also the pollination services they offer. Organic farming has shown that agriculture without synthetic chemical pesticides and biological pest control is viable: Organic farming does not use synthetic chemical pesticides and measures are being used to increase the biological control of pests. These measures include encouraging natural enemies, such as birds, certain cockroaches, spiders and parasitoids, which are means of biocontrol of pests in agricultural crops. Some scientific studies have shown that natural enemies can suppress harmful insects from crops, thus providing a biological means of controlling natural pests. Scientific research has also shown that the diversity and abundance of natural enemies are improved on organic farms.

Honey production and consumption in Europe

The European Union (EU) is the world's second largest producer of honey and plays an important role in the beekeeping market. European honey production covers only 60% of the annual needs of Europeans. Honey consumption at European level is about 20-25% of world consumption, being 0.70 kilograms per person per year. So the EU is one of the largest importers in the field, with annual honey imports ranging between 120 000 and 150 000 tons. The main suppliers are China, with 63 900 tons (43% of total EU imports), Argentina with 22 300 tons, Mexico with 21 200 tons, and Ukraine with 8 900 tons of honey. Also, the low price of bee products in China leads to lower exports from EU member states. Support for European apiculture in recent years, the EU has implemented support programs and policies for beekeepers. These measures have taken into account the problems faced by European beekeepers, namely the massive loss of bee colonies, honey production costs and fierce competition in the market. The progress of beekeeping will contribute to increasing the competitiveness of this sector and the economic development of rural areas, and by pollination, bee colonies will continue to act as providers of important environmental services, ensuring the sustainable development of these areas.

Scientific research shows that a diversity of untamed bee species is preponderating for guaranteeing property crop production.

Thus, we tend to cannot believe alone on one species - managed honey bees - for impregnation.

A diversity of untamed bee species is additionally essential to confirm food is delivered to our tables each day.

Recent scientific studies have shown that chemical intensive industrial agriculture is involved within the decline of bees and therefore the impregnation services they supply to our crops and wild flowers.

Ever increasing applications of fertilisers, herbicides and insecticides and their synergistic negative impacts on bee health and loss of natural and semi-natural habitat on field, farm and landscape levels are major drivers of bee declines.

Further, the fashionable industrial farming model conjointly causes issues of growing resistance of pests and weeds, diminished soil fertility and water retention, contamination of ground waters, high energy input and CO_2 emissions, as well as reduced resilience and increased vulnerability to climate change.

The analysis of these factors allows the measurement of:

• the decline of bee colonies;
• identification of causes and solutions;
• lack of access to the results of applied research;
• insufficient understanding of the economic opportunities offered by the diversification of the production of the integration of more horizontal and vertical activities and of the marketing and other products, other than honey (Figure 1).

As a planning tool and guide in the development of a business, the business plan ensures the knowledge of the current state and prospects of the company in competition with other partners in the case of making an investment of common interest or the realization of an association.

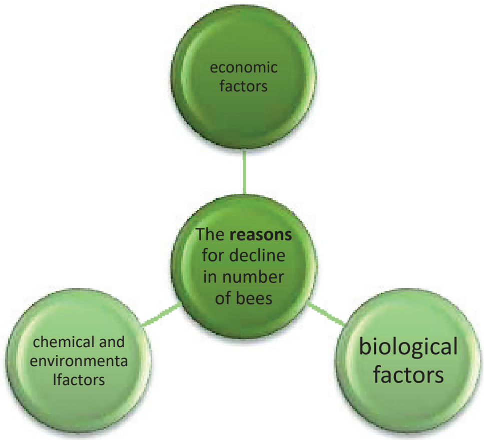

Figure 1. The reasons for decline in number of bees in the near past

MATERIALS AND METHODS

The support granted to support European beekeeping in recent years by the EU's common agricultural policy (CAP) has been represented by a series of policies that have implemented programs and support measures for beekeepers. These measures of the common agricultural policy, considered, a series of problems with which the European beekeepers frequently face, namely, the massive loss registered within the herds of the bee colonies, the increase of the production costs for honey bees and the fierce competition existing on market. The main objectives of all these programs and measures have been permanently improved through actions in the level of production technologies and through actions in the field of marketing of bee products. We can mention the following: the support programs that include technical assistance (training courses), the active measures for combating varicose veins and at the same time the peaceful measures represented by the rationalization of the transhumance and the support granted for analyzing the quality of honey and developing research in the field of intensive beekeeping. In Europe, we find that the number of bee hives has registered a strong long-term decline, while the quantity of honey production has remained quite stable. The number of bee hives decreased by 25% between 1965 and 2016. This decline in the number of bees began in particular around 1985 and has stabilized to a great extent since 1995. The reasons for this decline mentioned both in the literature and in official documents, as well as in interviews and surveys, are:

• economic factors (reduced profitability due to import pressure and increased purchasing power of large middlemen, such as wholesalers and retailers);
• biological factors (pests and diseases);
• chemical factors (insecticides and pesticides);
•environmental factors (anthropogenic degradation).

This is a synthesis paper, which aims to show the impact of cultivation method and agricultural landscapes on wild bees, for sustainable management of vegetal and bees resources, in fact for life on the Earth. In this regard, a series of recent scientific studies were used, in order to emphasize all the main characteristics of, bees and environment stressors. This study employed qualitative technique for examining connections and interactions between varies mechanisms, human and agri-companies activities regarding bees.

Mathematical models within the study of environmental phenomena carry on with the newest ends up in the mathematical domain that might offer solutions for dominant, analysing, predicting and study of risk phenomena.

Water quality models usually consist of a set of mathematical expressions relating one or more water quality parameters.

In any set of environmental measuring, the subjects of accuracy and precision of the measurements are always beneath the surface. Most environmental discharge permits embody ordinarily distributed statistics for environmental events.

This is incorrect and rarely accomplished. The Mathematical model of the evolution water quality parameters and the accepted mathematical structures can help establish a more comprehensive map of risk factors. According to the ISO 31000 Risk Management Standard 2009, risk is simply "the effect of uncertainty on the objectives". Based on this definition, the phrase "everyone manages risk" is therefore true. If we accept that all individuals and organizations have goals, that these goals are necessarily set in the future and that the future is uncertain, then each and every organization manages the risk. The risk management system provides tools to build a structured vision of the future and to address the issue of related uncertainty. Implementing risk management in an organization or regulatory body gives management the opportunity to make rational decisions based on available information, no matter how full it is. In order to prove the feasibility of implementing a risk management system, we will return to the fundamental principle of project management, which characterizes the interdependence of the following parameters: the budget, the quality of the finished product and the implementation time. Risk management tools help to make a rational choice among a number of alternatives

In other words, the level of achievement of the desired regulatory objective will depend on the cost of the preventive measures and the abandonment of the expected benefits from one or more areas of economic activity. To identify the risk, the project team should review the scope of the program, cost estimates, program (including critical path evaluation), technical maturity, key performance parameters, performance challenges, stakeholders' expectations of the current plan, external dependencies, and internal challenges, integration, interoperability, sustainability, supply chain vulnerabilities, threat management, cost deviations, test event expectations, safety, security, and more. The analysis of the factors influencing entrepreneurship risk in the beekeeping sector was made using the research method as research method, and the research tool chosen is the questionnaire. The reason for choosing this method is the desire to get the most relevant information about the factors of influence of entrepreneurship risk in the beekeeping sector in the North-West Region and the extent to which beekeepers have succeeded or intend to access European funds. The questionnaire is designed to get as much data as possible on the factors that influence a beekeeper's decision to start a beekeeping business, the level of knowledge and education, the determination of the degree of access to European funds, the collaboration with companies in beekeeping sector, etc. The purpose of applying the questionnaire is to find out the link between the beekeepers' socio-personal characteristics and their strategies and the intention to start a business in the apiculture sector. After the investigation, a centralization of the questionnaires was carried out, followed by data interpretation and analysis.

RESULTS AND DISCUSSIONS

The agricultural policy measures related to technical assistance in beekeeping have decisively contributed to the increase of productivity and quality. The technical assistance was mainly provided through professional training measures, allowing the dissemination of technical information with novelty character among all beekeepers and facilitating the purchase of the latest equipment that offers efficient solutions for honey production and for obtaining other bee products.

Analysing the impact on production determined by the measures that support the fight against the *Varroa* parasite, a virus that is a major threat and which requires high costs, the European Commission considers that the effect of these measures has been very positive. Although positive results have been obtained in some EU Member States, the adoption of measures has been limited. These deficiencies found in the fight against varicose veins were due to the fact that the procedures required to obtain the assistance needed to combat varicose veins were considered difficult by the beekeepers. One of the most effective measures has been shown to support the rationalization of transhumant. This measure has been highly appreciated in the case studies conducted in Greece and Spain. Therefore, we consider that the extension of this measure can be applied in intensive beekeeping systems integrated within an aquaponic system. Thus these super intensive production systems offer the opportunity to increase productivity and reduce the level of transhumance, while also providing support in controlling the spread of the *Varroa* mite. The economic efficiency of this measure is obtained through the integration of several production branches both horizontally and vertically within the same production capacity, without introducing additional production factors. This measure of rationalization of transhumance has been rarely used elsewhere in the EU, because the measure is more suitable for professional beekeepers with a large number of hives. By developing intensive and integrated beekeeping systems, it is thus possible to apply this measure of streamlining of transhumance and for beekeepers with small bee numbers who can achieve a considerable increase in beekeeping income against the background of its location within integrated aquaponics systems.

When the bee hive repopulation measure was applied, those beekeepers who received general support recorded a positive effect on production. The repopulation of agricultural land with wild bees specialized in pollination of crops would also generate positive effects for all other branches of agricultural production. The associations and the individual beekeepers who were consulted in the evaluation of the effects of the policy measures applied within the beekeeping sector at the European level, unanimously expressed their firm conviction regarding the potential importance of the research measure applied to honey production.

An aquaponics system requires frequent attention (Figures 2 and 3). Even on a small scale, aquaponics systems are complex due to their multiple components and requirements. Disease prevention, water level control, and preventing rodents and other problems require

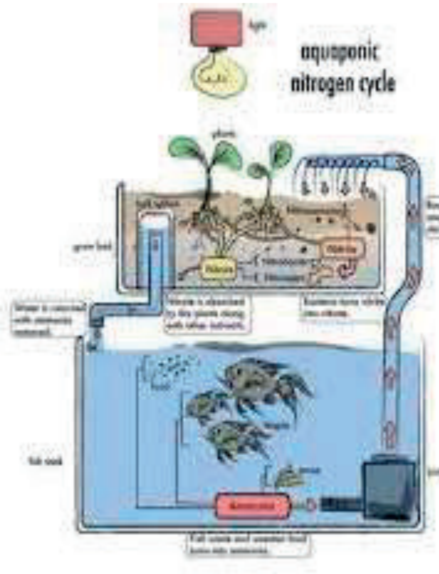

Figure 2. Work principle of aquaponics
Source: Researchgate
Aquaponics Plans (2009). Creating a Sustainable Food Supply Through Aquaponics. Available online at:http://aquaponicsplan.com/creating-a-sustainable-food-supply-through-aquaponics

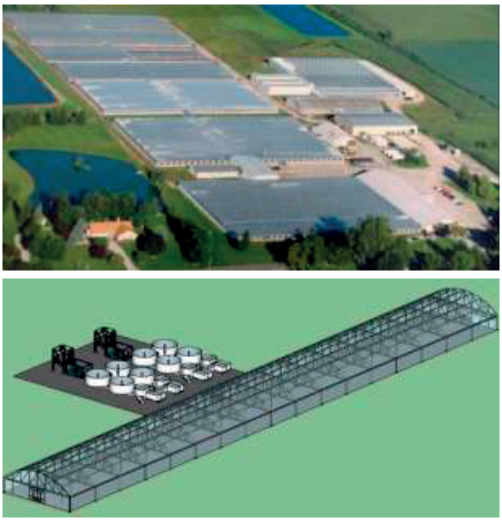

Figure 3. Commercial aquaponics system
Source: Philippines, Bees NEST Consulting Group INC

Harvesting and packing vegetables are also quite labor intensive (Tokunaga et al., 2015) estimated that labor costs were 46% of total operating costs and 40% of total annual costs. This is quite high compared to other forms of aquaculture and prospective aquaponics managers must be certain to have an adequate supply of labor to cover these needs.

Pond water quality is largely defined by temperature, transparency, turbidity, water color, carbon dioxide, pH, alkalinity, hardness, unionized ammonia, nitrite, nitrate, primary productivity, biological oxygen demand and plankton population (Bhatnagar and Devi, 2013).

The accepted level of ammonia should be under the range of 0.05 to 0.10 mg/l (Shoko et al., 2014) and above range it is toxic to the cultured fish.

According to Mizanur et al. (2004), intensive aquaculture ponds sediments has various fertilizing components such as nitrogen, phosphorous, sulphur etc. which are very useful for growth and production of aquaponic plants. Moreover, water spinach is an efficient plant having clustered roots that can absorb nutrients from the water very efficiently according with Kibria & Haque (2012).

It is considered a promising technology, which is highly productive under correct set up and proper management Lal (2013). First, fish feed is eaten by fish and converted into ammonia (NH_3). Some ammonia ionizes in water to ammonium (NH_4^+). Then, bacteria (*Nitrosoma*) convert ammonia into nitrite (NO_2^-) and consequently bacteria (Nitrobacter) oxidize nitrite into nitrate (NO_3^-) (Tyson et al., 2011).

The smaller scale systems had annual net returns that ranged from $4,222 to $30,761. Rates of return on the investment (IRR and MIRR) ranged from 0 percent to 27 percent. Of the studies reported (Tokunaga et al., 2015) is the only one based entirely on a detailed cost analysis of commercial operations. Their analysis showed an MIRR of 7.36 percent, as compared to a cost of capital of 6 percent, demonstrating economic feasibility. The (Tokunaga et al., 2015) profits are lower than those of a number of other studies, but it is not uncommon for analyses with data from commercial farms to show lower levels of profitability than analyses based on hypothetical or experimental data.

Savidov also discussed food safety concerns expressed by consumers over aquaponics produce (Savidov, 2004).

We proudly found that Romanian beekeeping holds the first place in the EU from the perspective of total honey production. However, the level of production intensification is below the European average, twice lower than the most competitive production systems in Europe, which are found in Finland, Germany and the United Kingdom. This extraordinary economic potential that beekeeping has in Romania contrasts with the lack of competitiveness that manifests itself in the economy as a whole. Through this doctoral thesis I propose an integrated production model that offers advantages related to the intensification of beekeeping production and the increase of competitiveness within the agri-food system. Intensive beekeeping integrated with aquaponic systems is a sustainable and extremely profitable economic activity. With small investments for the acquisition of aquaponic microsystems, significant increases in honey and vegetable production are obtained, thus eliminating the impact of climate change. The investments for the acquisition of an integrated aquaponic microsystem are 250 euros. They shall be recovered from the first year provided that the costs of transhumance are eliminated. Reducing transhumance will lead farmers to adopt biodiversity conservation practices to increase populations of wild pollinators.

CONCLUSIONS

Through this measure of integration of beekeeping in aquaponics systems the measure of transhumance reduction is transformed from a compensatory measure of production losses, to a measure of productivity growth and of stimulating sustainable economic development with positive effects on environmental resources and which thus offers the possibility of biodiversity conservation. The pollination of agricultural crops should be based primarily on the herds of wild bees that should be protected and reintroduced within the agro-ecosystems through specific measures.

For this vision to take effect, it is necessary to start with educational awareness, with the financial support of this vision and with programs to build an adequate human and material infrastructure.

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REFERENCES

Bhatnagar, A., Devi, P. (2013). Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Science*, 3, 6.

Kibria, A.S.M., & Haque, M.M. (2012). *Integrated Multi-Trophic Aquaculture (IMTA) Systems in Freshwater Ponds in Bangladesh: Initial Understanding*. Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Lal, R. (2013). *Beyond Intensification*. In: Paper presentation at the ASA, CSSA, & SSSA international annual meetings, Tampa, Florida, USA.

Mekonnen, M.M., & Hoekstra, A.Y. (2012). A global assessment of the water footprint of farm animal products. *Ecosystems*, 15(3), 401-415.

Mizanur, R., Yakupitiyage, A., & Ranamukhaarachchi, S.L. (2004). Agricultural use of fish pond sediment for environmental amelioration. *Thammasat International Journal of Science and Technology*, 9(4), 1-12.

Savidov, N. (2004). *Evaluation and development of aquaponics production and product market capabilities in Alberta*. Initiatives Fund Final Report, Project #679056201, Crop Diversification Centre South, Brooks, Alberta.

Shoko, A.P., Limbu, S.M., Mrosso, H.D.J., & Mgaya, Y.D. (2014). A comparison of diurnal dynamics of water quality parameters in *Nile tilapia* (*Oreochromis niloticus*, Linnaeus, 1758) monoculture and polyculture with African sharp tooth catfish (*Clarias gariepinus*, Burchell, 1822) in earthen ponds. *Aquaculture Research*, 6, 1-13.

Tokunaga, K., Tamaru, C., Ako, H., & Leung, P.S. (2015). Economics of small-scale commercial aquaponics in Hawaii. *Journal of the World Aquaculture Society*, 46(1), 20-32.

Toufique, K.A., & Belton, B. (2014). Is Aquaculture Pro-Poor? Empirical Evidence of Impacts on Fish Consumption in Bangladesh. *World Development*, 64, 609-620.

Tyson, R.V., Treadwell, D.D., & Simonne, E.H. (2011). Opportunities and challenges to sustainability in aquaponic systems. *Horttechnology*, 21(1), 6-13.