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EXTERNALITY EFFECTS OF HONEY PRODUCTION

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Abstract: Bee-keeping and honey production has a long history in Hungary. Honey is an important and healthy food of people and it can be consumed without any human processing.

The honey production has important role, too. Some researchers say that if honey bee will extinct the humanity in the world would also extinct. It is true since plant pollination by honey bees is very important. It is confirmed by researchers' studies that plant pollination by honey bees has significant positive external impacts on potential yields in orchards.

Although the contribution of honey production to the GDP in Hungary is only a few per cent, other benefits play more important role. One of them is the positive external effect – mentioned above – and the other is the contribution to the biodiversity of the nature.

This paper focuses on secondary research methods, gathering and evaluating data regarding the positive external impacts of plant pollination by honey bees as well as finding possible solution for the problem that bee-keepers have a lot of costs in connection with carrying honey bees to orchards, while farmers "only" benefit from the positive externality of plant pollination of their fields. To evaluate its economic effects a numerical HEEM-model was developed and applied for the Hungarian situation.

Keywords: Honey production, bee-keeping, positive external impacts, HEEM model

Introduction

Honey is one of the most important foods of our modern world taking into account the current trend in food consumption. In addition to it, honey has an important role in the so-called "healthy lifestyle", since it can be consumed without any further processing. While honey has been used for thousands of years to treat wounds and ailments, scientists have only recently begun to explain the precise effects of the natural sweetener's antiseptic and antibacterial qualities on human health (*Heller,* 2008).

Worldwide production of honey amounts to around 1.4 million tonnes. The EU is an important producer of honey, in terms of production volume. In 2006, EU production of honey amounted to almost 200 thousand tonnes, accounting for approximately 14% of the global production. Other leading producers according to their production shares are China (22%), the USA (6%), Argentina (6%) and Turkey (5%) (*Faostat*, 2010).

Nowadays bee-keeping – as one of the activities can provide alternative income for small businesses in rural areas – has become more and more important topic in Hungary and in several part of the world. It takes important role in the preservation of rural landscape, traditions and their regional values. Rural development has become more and more important issue in Hungary since rural areas also contribute to the efficiency of the national economy. Development of rural areas also very important issue in the European Union, which could contribute to the improvement of profitability of small family businesses, higher employment rate in rural areas as well as slow down the migration of people from rural into urban areas. Nowadays bee-keeping sector provides income roughly 15 thousands families in Hungary. Hungary is one of the largest EU producers of natural honey, with production amounting to 19.7 thousand tonnes in 2006.

The contribution of honey production to the GDP in Hungary is only 1 per cent and to the animal husbandry is approximately 3 per cent. Bee-keeping has incontestable role in plant pollination too, hereby gives positive externality to plant production sector. In addition to it, contributes to the biodiversity of the nature directly. Classic micro economical example of positive externality is the contact between the apiary and the neighbouring orchard (*Kopányi,* 1993).

Research method

The main objective of this paper to show the relevant literature that contributes to the benefits and effects of pollination by insects with special regard to honey bees.

Secondary research methods were used for data gathering and evaluation, as the most internationally accepted one. Within the framework of the secondary research the restructuring and evaluation of the available data have been carried out.

For estimating the positive external impact in EUR, a model (HEEM – Honey-bee Economic Evaluation Model) has been created for evaluating different development scenarios. For creation of the numerical model the method suggested by ZIMÁNYI (2006) was taken into account.

Evaluation of the most important literature regarding to the benefits of the pollination by honey-bees

The agronomic and economic value of honey-bee effected pollination has been an internationally contentious issue since at least the turn of the century (*Gill,* 1991). Unfortunately the recognition of the value of honeybees as pollinating agents has not always been unanimous. While the technical literature pertaining to the pollination of cultivated plants is relatively big and well-founded, that pertaining to the economic or social valuation of the pollination benefit is not.

Ecosystem services, defined as the benefits to human welfare provided by organisms interacting in ecosystems, are considered to be at risk (*Daily,* 1997; *Palmer et al,* 2004). Pollination by wild animals and honeybees is a key ecosystem service. Insect pollination is an ecosystem service with high economic value that is mainly provided by bees.

Honeybees, mainly Apis mellifera, remain the most economically valuable pollinators of crop monocultures worldwide (McGregor, 1976), and yields of some fruit, seed and nut crops decrease by more than 90 % without these pollinators (*Southwick* and *Southwick,* 1992). When wild bees do not visit agricultural fields, managed honeybee hives are often the solution farmers to ensure crop pollination.

An economic evaluation of the contribution of bee pollination to the production of 30 insect-pollinated crops was published more than two decade ago (*Borneck* and *Bricout* 1989). These authors attributed to each crop a value, ‘the coefficient of incidence’, based on its dependence on insect pollination and attributed 85% of insect pollination to honey bees. They calculated that the crops had a combined annual market value of 65,000 million ecus, that insect pollination contributed 5000 million ecus and that pollination by honey bees contributed 4250 million ecus (1 ecu = *ca.* 1$). There is a need to update this evaluation and include more than 30 of the 177 crops grown in the EU that benefit from bee pollination. More recently, the value of honey bees and bumble bees as pollinators of major selected UK crops for which market statistics are available, has been estimated to be £172 million for outdoor crops (rape, beans, tree and soft fruit) and £30 million for glasshouse crops (tomatoes and sweet peppers) (*Carreck* and *Williams* 1998).

Kevan et al. (1990) stated that underestimation of the pivotal role played by managed and native insect pollinators is a key constraint to the sustainability of contemporary agricultural practices. The economic value of such insects to pollination, seed set, and fruit formation greatly outweighs that suggested by more conventional indices, such as the value of honey and wax produced by honey bees.

Allsopp et al (2008) presented in their study replacement costs as a more accurate value estimate of insect pollination as an ecosystem service. In their opinion the importance of insect pollination to agriculture is unequivocal. Insect pollination is not only a critical ecosystem function, but also an essential input in the production of a host of agricultural crops grown world-wide. Of the approximately 300 commercial crops (*Richards,* 1993) about 84% are insect pollinated (*Williams,* 1996). Modern commercial crop production is increasingly dependent on managed pollinators (e.g. the introduction of honeybee colonies into orchards or fields to improve crop production), and less on wild insects living on the periphery of crop fields (Richards, 2001).

The “value” of managed honeybee pollination has been used to justify honey price support schemes (ROBINSON et al, 1989); funding for honeybee research and extension programmes (*Richards,* 1993; *Cook* et al, 2007); invasive weeds as necessary bee forage (*Gill et al,* 1985; *Allsopp et al,* 2004); and for the preservation of indigenous vegetation (*Turpie et al,* 2003). In turn the “value” of the wild pollination services (pollination ecosystem service) forms part of a case for the conservation of natural biodiversity.

We take a different approach to valuation by estimating industry-wide replacement costs for wild and managed insect pollination services (Table 1). We adopt an approach where the value of wild and managed insect pollination services are equivalent to the amount of income lost if these components were to be replaced by alternative (non-insect) means of pollination *(Table 1).* Consequently the replacement cost is proposed as an estimate of the relative value of these services.

French scientists from INRA and the CNRS, in collaboration with a German scientist, found that the worldwide economic value of the pollination service provided by insect pollinators, mainly bees, was €153 billion in 2005 for the main crops that feed the world. In terms of weight, 35% of the world food production comes from crops which depend on insect pollination, 60% come from crops which do not (such as cereals) and 5% come from crops on which the impact of insect pollination is still unknown. The total

Table 1. Current approach to calculate pollination service value

Approach	Formula to calculate “Pollination service value”	Reference
Total production value	Annual production value	n/a.
Proportion of total production value attributed to insect pollination	Annual production x insect dependence factor	MORSE et al., 2000; LOSEY et al., 2006.
Replacement value	(Annual production attributed to insect pollination) – (Annual production value using pollinator replacement)	ALLSOPP, 2008

Source: ALLSOPP, 2008.

economic value of pollination worldwide amounted to €153 billion in 2005, which represented 9.5% of the value of the world agricultural production used for human food that year.

The scientists also found that the average value of crops that depend on insect pollinators for their production was on average much higher than that of the crops not pollinated by insects, such as cereals or sugar cane (€760 and €150 per metric ton, respectively). The vulnerability ratio was defined as the ratio of the economic value of insect pollination divided by the total crop production value. This ratio varied considerably among crop categories with a maximum of 39% for stimulants (coffee and cocoa), 31% for nuts and 23% for fruits. There was a positive correlation between the value of a crop category per production unit and its ratio of vulnerability; the higher the dependence on insect pollinators, the higher the price per metric ton (*Klein et. al.,* 2006).

Their results highlighted that the complete loss of insect pollinators, particularly that of honey bees and wild bees which are the main crop pollinators, would not lead to the catastrophic disappearance of agriculture throughout the world, but would nevertheless result in substantial economic losses even though these figures take into consideration only the crops which are directly used for human food.

According to the study of the European Committee on the Status of Pollinators in North America honeybees is the most widely, carefully monitored, and commercially distributed pollinator, are used for the fruit and seed production of more than 100 crops in the United States. Estimates of their economic value in the United States range from $150 milllion (at 2007, the total annual cost of bee-colony rental) to almost $19 billion (the estimated value that farmers would pay if pollinators weren't freely available in nature) (Mazer, 2007).

The European Perspective

Although the European Commission recognises the need for more environmentally-friendly agricultural policies, it does not appear to appreciate the crucial role of pollinator diversity to the functioning of agricultural production systems to ensure continuity of supply of high quality and varied food for Europe or the dangers of over-dependence on the services of a single pollinator, the honey bee.

Crop production in Europe is highly dependent on pollination by insects. At least 264 crop species from 60 plant families are grown in the EU, nothing has been published about the pollination requirements of a third of these species but of the remainder, 84 % depend on, or benefit from, insect pollination (Williams, 1994).

The botanical diversity of morphology, degree of self-compatibility and sexuality of the flowers of crops grown requires a diversity of insect vectors for efficient pollination (*Williams,* 1994). The flowers of most outdoor crops are visited by an assemblage of insects, typically including the honey bee, several species of bumble bee, a few species of solitary bee, and on more open flowers species of flies, beetles, butterflies, or thrips.

The native European honey bee (*Apis mellifera*) is undoubtedly the insect species that contributes most to crop pollination (Williams, 1994). It is abundant and readily available; in the EU there are estimated to be *ca.*7.5 million colonies managed by *ca.*500.000 beekeepers. It is the only pollinator available for supplementary pollination of field crops.

After reviewing the relevant literature, our paper focuses on the model, created by the authors. **HEEM** – Honey-bee Economic Evaluation Model, as a possible solution for evaluating the positive external impact of honey-bee pollination. The main structure of the HEEM (Honey-bee Economic Evaluation Model) is seen below:

Table 2. Basic structure of the HEEM-model

TCCHP=CCCP+CCHK+SSCC+OC		EUR	%
TCCHP	Total Cash Contribution of Honey-bee Pollination	59.724.735	100
CCCP1	Cash Contribution for Crop Producer	14.880.000	24,9
CCCP2	Cash Contribution for Fruit Producer	28.080.000	47,0
CCHK	Cash Contribution for Honey-bee Keepers	288.000	0,5
SSCC	Saved State (social) Cash Contribution	16.476.735	27,6
OC	Other Contribution, such „intangible values" as value of biodiversity, healthy lifestyle, etc.	0*	0*

*not calculated at the present scenario.
Source: own research

The final figure of this calculation can be found in Table 2, that is about 60 million EUR for Hungary per year that is considerable higher than the sales value of the honey produced.

Based on primary and secondary research data the following input figures were taken into account *(Table 1.).*

Conclusions

It can be stated by the most important pertaining literature that benefits of honey pollinating are incontestable in many respects. In this paper we would like to show the relevant literature regarding to this topic and after that we made a model to calculate the economic benefits of the pollination.

Considering that the agrarian market is in a special situation in Hungary (*Kozár,* 2010) and based on these information and other calculated figures the value for country of Hungary is close to 60 million EUR in 2010. Since this figure touches about 16000 families the total figure is close to 4000 EUR per family. Other factors is not involved in these figures, like preserving biodiversity and healthy lifestyle, etc. we did not take them into account, so the actual figure can even be higher. Input data of the model will be recalculated based on further research in the near future.

Table 3. Input figures of the recent HEEM-scenario

Symbol	Description	Unit	Value
CCCP1	Cash Contribution of Crop Producer	EUR	14880000
CA1	Cropping Area of the country involved honey-bee pollination	ha	480000
TBF	Total Number of Honey-bee families in the Country	hive	800000
RORHF	Ratio of Relocated Honey-bee families in the Country	%	60
TBFPC	Total Number of Relocated Honey-bee families in the country	hive	480000
BF	Honey-bee families per ha	hive/ha	2
ANAR	Average Number of Annual Relocations	Occasion/year	2
YH1	Average Yield of the crop pollinated by honey-bees	t/ha	3
PRH1	average price of pollinated crop	EUR/t	200
Y01	average yield of the non-pollinated crop	t/ha	2,7
PR01	average price of non-pollinated crop	EUR/t	200
HMC1	harvesting and marketing cost of the crop	EUR/t	30
SCCP1	surplus chemical cost incurred at the crop producer	EUR/ha	15
SCO1	surplus other cost of the crop producer due to the relocation	EUR/ha	5
CCCP2	Cash Contribution of fruit producer	EUR	28080000
CA2	Cropping Area of the country involved honey-bee pollination	ha	24000
TBFPC	Total Number of Honey-bee families in the Country	hive	800000
RORHF	Ratio of Relocated Honey-bee families in the Country	%	3
TBF	Total Number of Relocated Honey-bee families in the country	hive	24000
BF	Honey-bee families per ha	hive/ha	4
ANAR	Average number of annual relocations	occasion	4
YH2	Average yield of the fruit pollinated by honey-bees	t/ha	25
PRH2	average price of pollinated fruit	EUR/t	250
Y02	average yield of the non-pollinated fruit	t/ha	22
PR02	average prie of non-pollinated fruit	EUR/t	220
HMC2	harvesting and marketing cost of the fruit	EUR/t	40
SCCP2	surplus chemical cost incurred at the fruit producer	EUR/t	100
SCO2	surplus other cost of the fruit producer due to the relocation	EUR/ha	20
CCCP	CCCP1+CCCP2	EUR	42960000
CCCHK	Cash Contribution of Honey-Bee Keepers	EUR	288000
HYH	yearly honey yield of the (relocated) honey	kg/hive/year	50
HPRH	average honey price of the (relocated) honey	EUR/kg	3
HY0	yearly honey yield without relocation	kg/hive/year	30
HPR0	average honey price without relocation	EUR/kg	3
ACR	average cost of a one-time relocation	EUR/hive	12
SSCC	Saved state cash contribution	EUR	16476735
ROSPDN	Social contribution recipients	person	3200
SSPPP	Social security payment per person	EUR/person	4000
TSSP	Total saved security payment	EUR	3840000
TBFPC	Total bee families per country	hive	800000
ABFPP	average bee family per person	Hive/person (bee-keeper)	50
SSC	average state social contribution	EUR	1200
ROSPD	Rate of social payment demanders	%	20
CCHK	average actual Cash Cost of Honey-bee keepers, the labour cost is not included in the figure.	EUR	70
LCPH	labour cost/hive/year	EUR	15
MCPH	material cost/hive/year	EUR	55
VAT	VAT	%	25
MCWVAT	Material cost without VAT	EUR	44
VATC	Vat cost	EUR	11
PIVAT	Pay in VAT	EUR	8800000
LCPIRAT	labour cost pay in ratio	%	47
LCREM	Labour cost remained	EUR	10,2
LCPI	Labour cost paid in	EUR	4,8
TLCPI	Total labour cost pain in	EUR	3836734,7
NPPH	Net profit /hive	EUR	4000,0
SSCM1	if NPPH > SSC, then SSCM = 0		0,0

Source: own research

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