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The economic value of bees in the UK

NORMAN CARRECK AND INGRID WILLIAMS

In the UK, as elsewhere in Europe, bees are valued not only for the honey and wax that they produce, but also for the pollination service that they provide to the majority of our crops and wild flowers. However, no estimate of their value in economic terms has been made in recent years.

Introduction

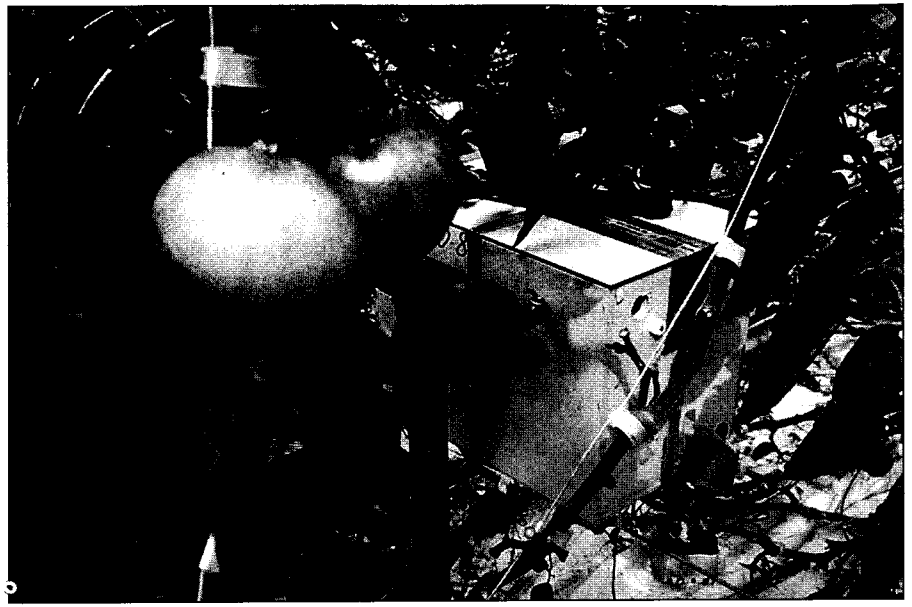
At least 39 crops grown in the UK for their fruit or seed are insect pollinated, and a further 32 need insects for propagative seed production[33,35]. Honey bees and bumble bees generally outnumber all other visitors to these crops although the relative proportions of each vary with the crop, its location, season, time of day and pollination management practice[11].

The honey bee (*Apis mellifera*) plays a dominant role[33], being the only managed pollinator available for field and outdoor fruit crops. Surveys of beekeepers[6,35] in the UK have shown that many move their colonies to a variety (up to 30) of different crops requiring pollination, at the request of growers and for a pollination fee, to supplement locally available pollinators. However, beekeeping has declined in recent years[36] and losses of honey bee colonies to the parasitic mite *Varroa jacobsoni*[18] have meant that beekeepers are increasingly unable to meet the demand for colonies (Bee Farmers Association, personal communication).

Although the distributions of many species of bumble bee have contracted over recent decades[37,38], particularly in areas of intensive agriculture, the use of bumble bees for the pollination of protected crops has increased greatly during the 1990s. Now, commercially reared *Bombus terrestris* are used for the managed pollination of almost all tomato (total area approximately 350 ha), pepper and aubergine crops grown in glasshouses and polythene tunnels in the UK.

The value of bees to wild plant pollination is without doubt substantial, but impossible to evaluate in economic terms because the pollination requirements of most of the nearly 1800 species of wild plant in the British Isles are unknown[7]. However, the majority (57%) of the 104 plant species identified by UK beekeepers as important sources of nectar for their honey bees[6,35] are indigenous and a large proportion of endangered (Red Data Book) plant species[27] probably depend on bees for their survival. Of the 321 species included, 27% are from families considered to be 'bee pollinated' by Corbet *et al.*[7].

As wild bee species have declined in many areas, managed honey bees could play an increasingly important role in maintaining the populations of wild plant species. Wild plants provide food sources for wild animals through their vegetation, fruit and nuts, so adequate pollination is indirectly essential for the survival of many herbivorous species of birds, mammals and other animals, and the predators which feed on them.



Bumble bee hive for pollination of glasshouse tomatoes.

In this article we evaluate, in economic terms, the role of bees as pollinators of selected crops and as producers of honey and wax. This updates the last evaluation of 'the position of the honey bee in the national economy of the UK'[5] made more than 50 years ago, and extends the evaluation to include the contribution made by bumble bees.

Value as pollinators and honey and wax producers

Despite the inherent difficulties, attempts have been made to ascribe an economic value to the pollination service provided by bees. In the case of the honey bee and the crops that it pollinates, this has been done in Canada[14,39], the European Union[3,4], Hungary[2], New Zealand[19], the USA[15,16,20,28,29,31,32] and the former USSR[30]. The economic value of bumble bee pollination of glasshouse crops in Europe has been estimated[10]. Such estimates have shown that, in economic terms, the value of the honey bee as a crop pollinator greatly exceeds its value as a producer of honey, wax and other hive products[5,15,28,29].

Assessments of the value of bees to crop pollination have used a variety of methods. Some authors have considered the market value of all[19], or some[26] of the insect pollinated crops grown; others only that portion of production attributable to honey bees[4]. Some have included the value of crops grown from seed derived from bee-pollinated plants[17], the legume crops and livestock products dependent on them, or even those legumes that fix nitrogen and thereby reduce nitrate fertilizer requirements[15,16]. Southwick and Southwick[31,32] evaluated the gains to consumers through lower prices for crops benefitted by honey bees, based on

Blackcurrants have a high dependency on bees for pollination.

estimation of economic demand functions for bee-pollinated crops and the proportional increase in crop production due to honey bees, assuming either no replacement or some replacement by other pollinators should honey bees be depleted. Unfortunately, there is at present insufficient information on the pollination requirements of crops, the benefits to be derived from bee pollination, and the proportion of those bees that are honey bees, to allow any estimates to be made with great accuracy.

For our evaluation, we have focused on those arable, tree, soft fruit and seed crops to which beekeepers are known to move honey bee colonies for pollination[6,35] (table 1) or those crops on which commercially reared bumble bee colonies are placed for pollination (table 2) and for which production areas and crop value statistics are available. The market values used are average 1996 farm-gate prices, i.e. the average price received by the grower, excluding subsidies[23,24,25]. Each crop has been categorized as having high, medium or low dependency on insects for pollination, based on published insect pollination dependency levels[33]. Each dependency level has then been weighted (following O'Grady, cited in Robinson *et al.*[28]) as follows: high 0.9; medium 0.5; low 0.1. This weighting factor has then been used to multiply the crop value to estimate the proportion attributable to insects.

Agricultural statistics for production of many of the minor seed and glasshouse crops grown which benefit from bee pollination are lacking, and these have had to be excluded from the table. These are, however, frequently high value crops. For example, 200 ha of white mustard, and 200 ha of brown mustard, with a combined value of £311 500 were grown on contract for a condiment manufacturer in Eastern England in 1996 (Costello, personal communication). Similarly, in 1996, 2.6 t of white clover seed and 3.2 t of red clover seed was produced in the UK, with a market value of approximately £33 000 (Marshall, personal communication).

The total value of insect pollination, mainly that by bees, calculated on this basis can be estimated to be £172.2 million for outdoor crops (table 1) and £29.8 million for glasshouse crops (table 2). There are few data from which to estimate proportions of pollination attributable to different bees in the UK. However, if we attribute 80% of the insect pollination of outside crops to honey bees following accepted evaluations in other countries[1,28,29], the estimated value of honey bee pollination of these selected crops amounts to £137.8 million. Glasshouse crops (especially tomatoes) are now mostly pollinated by commercially reared bumble bees, although beekeepers also supply

TABLE 1. Estimated value of insect pollination to selected crops in the UK in 1996 and 1943.

Crop	Need for insect pollination	1996 area grown (ha)	1996 market value (£M)	1996 value of insect pollination (£M)	1943 area grown (ha)	1943 market value (£M)	1943 value of insect pollination (£M)
Oilseed rape	0.1	429 000	419.0	41.9	–	–	–
Field bean	0.1	100 200	49.0	4.9	100 907[1]	0.2	0.02
Broad bean	0.1	2256	3.5	0.4	–	–	–
Runner bean	0.5	3689	16.1	8.1	–	–	–
Apple	0.9	17 896	90.8	81.7	111 901[2]	21.5	19.35
Pear	0.5	2941	14.8	7.4	–	3.5	1.75
Plum	0.5	1644	7.9	2.8	–	5.0	2.5
Cherry	0.9	604	6.2	5.6	–	3.0	2.7
Mixed orchard	0.5	185	1.0	0.5	–	–	–
Raspberry	0.1	2568	30.6	3.1	2745	0.5	0.05
Strawberry	0.1	4622	55.8	5.6	4142	2.6	0.26
Blackcurrant	0.9	2389	10.3	9.3	4547	0.09	0.81
Other soft fruit[3]	0.1	843	11.8	1.2	4260	1.3	0.13
Total			716.8	172.2		38.5	27.57

[1]area includes all beans. Separate figures not available
[2]area includes all orchard fruit. Separate figures not available
[3]includes blackberries, loganberries, gooseberries, red and white currants

TABLE 2. Estimated value of insect pollinated glasshouse crops in 1996.

Crop	Need for insect pollination	Production ($\times 10^3$ t)	Price (£t^{-1})	Market value (£M)	Value of insect pollination (£M)
Tomatoes (heated)	0.5	103.2	529.89	54.68	27.34
Tomatoes (cold)	0.5	10.1	360.71	3.64	1.82
Sweet peppers	0.1	7.3	880.65	6.43	0.64
Total				64.75	29.80

honey bee colonies to many protected crops[6,35].

Honey production by the estimated 200 000 honey bee colonies owned by the estimated 35 000 beekeepers in the UK is about 4000 t per annum[23], valued at approximately £15.7 million. However, actual numbers of beekeepers and colonies are undoubtedly significantly smaller than this estimate because there is no compulsory registration of beekeepers and official estimates probably exaggerate numbers, and because colony losses due to varroa have been considerable since 1995[18]. Beeswax production is also difficult to estimate as most is used directly by beekeepers rather than sold, but using the conservative estimate of Crane[8] that wax production is approximately 1.5% of honey production, UK production may be 60 t per annum, which at £2 per kg (Smith, personal communication) has a market value of £120 000.

Adding the value of honey and beeswax to that of pollination, the total annual value of honey bees can be estimated as £153.6 million. Using the estimate of 200 000 colonies, the annual value to the UK economy of each honey bee colony is therefore currently about £800.

Changes since 1943

In 1943, Butler wrote[5]: *...based on a recent estimate involving nearly 55 600 beekeepers controlling about 429 000 colonies of bees...an average of 40–50 lb* [approx 18–23 kg] *of honey per colony may reasonably be expected at the present level of management. A recent estimate has shown that the annual average cash value of the honey bee to the nation, assuming that it is responsible for pollinating about half the commercial fruit crop (a lower estimate than that usually employed) is at least £5.287 million. Of this £4 million is the wholesale value of the fruit pollinated and £1.287 million the value of the honey produced. From these figures it can be calculated that the annual value of each colony of bees to the nation is about £12.*

Since 1943 there have been considerable changes in the structure of UK agriculture. These include changes in land use and in the insect pollinated crops grown[34], the scale and efficiency of their production, the price support growers receive through the EU Common Agricultural Policy[13], and hence the price of agricultural commodities. These changes, together with those in the beekeeping sector and in the density and diversity of wild bees, have influenced the value of bees to the UK economy relative to 1943.

Honey bee colony pollinating sweet peppers in a glasshouse.

The main changes to the range of insect pollinated crops grown have been in oilseeds and fruit. Oilseed rape production began in the late 1960s and now the crop occupies approximately 6% of arable land. Production of fruit has declined. Whilst in 1943 much of that consumed was produced in the UK, in 1996, only 39% of the apple market, 22% of the pear market, and 28% of the plum market was supplied by UK production[25]. Production of seed crops such as clovers has also declined, largely because of yield variability, which almost certainly is partly due to inadequate pollination (Williams & Simpkins, in preparation).

Increases in the scale and efficiency of production have meant that the same yield is now achieved from less land, and at a lower cost. For example, between 1947 and 1992 some 70% of older orchards were, with the aid of government grants, taken out of production, and replanting was with small, densely packed more productive trees. Thus, although the area occupied by apple trees in 1996 was less than half of that occupied in 1943, production of apples was more than 70% of that of 1943.

Whilst food produced under the EU Common Agricultural Policy is generally more expensive than it would be without price support[13], the prices of most agricultural commodities have declined considerably in real terms since 1943, due largely to more efficient production. For example, in 1943, the prices of apples and pears were £49.75 per t and £83.00 per t, respectively[21]. If prices had increased in line with the Retail Price Index, they would have been £1002.40 per t and £1672.34 per t in 1996. Actual prices in 1996 were £429.90 per t and £441.2 per t respectively[24].

Because of these changes, direct comparison of our estimates of the economic value of bees to crop pollination, based on 1996 data (table 1), with that of Butler's 1943 estimate is not very meaningful. To allow more direct comparison, we have recalculated the value of bees to crop pollination in 1943, as far as available data[9,12,21] allow, on the same basis as for 1996 (table1). This estimates the value of insect pollination of crops in 1943 as £27.57 million with £22.06 million (80%) apportioned to the honey bee.

In 1943, UK honey production was 8600 t, and the price was £0.147 per kg. If this had increased in line with the Retail Price Index, the price in 1996 would be £2.97 per kg. Actual honey prices in 1996 were £2.00 per kg for bulk sales (which account for 20% of sales), and £4.40 per kg for retail sales, which make up the remainder[23]. The average price in 1996 was thus £3.92 per kg. Honey has therefore become slightly more expensive in real terms. It should be noted that honey prices in the UK greatly exceed the world market price of £1 per kg or $US 1.67 per kg (Matheson, personal communication). This reflects a high premium for honey produced in the UK, due to consumer demand and the limited supply of UK honey.

White clover (*Trifolium repens*) seed crop production in the UK has declined.

Adding the value of honey to that of crop pollination, the total annual value for honey bees in 1943 can be estimated to have been £23.34 million. Dividing this by the number of colonies, the annual value of each colony can be calculated to be £54 in 1943, equivalent to £1100 at today's prices, compared with £800 in 1996.

Thus, although there has been a reduction in the area of insect pollinated crops, a fall in agricultural commodity prices, and a drop in the value of insect pollinated crops to one third that of 1943, in real terms, because the number of colonies has also fallen by 50%, the value of each colony to the UK economy has only fallen by approximately 25%.

Conclusion

In economic terms, we estimate the value of honey bees and bumble bees as pollinators of major selected commercially grown insect pollinated crops for which crop market statistics are available to exceed £200 million per annum. If the essential pollination services provided by bees are to be maintained, the recent decline in the populations of honey bees and bumble bees must be reversed. National agricultural policies aim to promote sustainable farming and crop diversification and to meet consumer demand for high quality home produced fruit and vegetables whilst enhancing biological diversity of plant and animal life in farmland[22]. If these policies are to be achieved there must be greater appreciation of the role of bees in agriculture and conservation and the development of policies to halt the erosion of resources, particularly nest sites and food plants that bees require for their survival.

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