THE VALUE OF HONEYBEE POLLINATION TO SOCIETY

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Introduction

The agronomic and economic value of honeybee effected pollination has been an internationally contentious issue since at least the turn of the century. As early as 1913 horticultural scientists were urging cherry growers in Oregon State of the USA to employ bees for pollination:

"…There is little question… that many cherry orchards would be rendered much more productive if their owners would give proper recognition to the known facts regarding the importance of bees in the orchard." (Oregon Agricultural College Experiment Station 1913).

The recognition of the value of honeybees as pollinating agents has not always been unanimous. The US State of Utah passed legislation in 1929 to effectively prohibit the movement of honeybees into that State. This legislation was designed to protect alfalfa from the presumed ravages of honeybees which" … made alfalfa wilt and fail to set seed." (WHITCOMBE, (1955). Californian alfalfa growers were more progressive in their thinking. Early trials at about the same time in the latter State indicated increases in alfalfa yields of up to 500 percent as a result of managed honeybee pollination (WHITCOMBE, ibid.). By 1950, Californian growers were generally prepared to pay a pollination contract fee of $5,00 per hive to beekeepers. Some beekeepers were successful in negotiating share contracts with growers whereby a proportion of the extra yield attributable to beneficial effects of honeybees was paid to the beekeepers (WHITCOMBE, ibid).

Today, most beekeepers in the Pacific North West region of the USA generate at least 40 percent of their annual income from pollination contract fees (BURGETT, D.M. and MAYER, D.F., personal communications). The US pollination services market is most active in California where around 70 percent of all US managed pollination contracts are negotiated (ROBINSON et al., 1989). This market is largely dominated by almond pollination. The latter market's requirements for bees is so large that the demand for hives cannot be satisfied by Californian beekeepers alone. Beekeepers from Washington State and even from Florida participate in this market (ROBINSON, F., personal communication). At least two pollination brokerage operations exist largely to place hives with almond growers in California.

The pollination services market is not as active anywhere in Australia as it is in California and the Pacific North West or in New Zealand (where an active market exists to pollinate kiwi fruit among other crops). Nevertheless, the issue of the value of pollination services to the agricultural economy is topical in this country. The Australian Honey Research Council has nominated this issue as one of its priority research areas. This paper is one component of a larger project funded by that organization to investigate this and related issues.

The technical literature pertaining to the agronomic benefits of managed honeybee pollination is large. This and the proceeding five International Pollination Symposia have served as a major forum for the discussion of such studies. A recent review of the technical literature by this author revealed over 300 articles pertaining to the results of field pollination trials since 1970. Australian researchers are also active in this field. A detailed publication by the United States Department of Agriculture (McGREGOR, 1976) provides a summary of the advantage of managed pollination for commonly cultivated crops. This publication is probably the most widely referenced source of pollination recommendations in the world at present.

While the technical literature pertaining to the pollination of cultivated (and to some extent, non-cultivated) plants is relatively well founded, that pertaining to the economic or social valuation of the pollination benefit is not. This is not to imply that the literature pertaining to the latter is not voluminous. Much has been written on this subject since as long as the agronomic benefits conferred by bees have recognized. Attempts to value the pollination activity have ranged from :guestimates" of no empirical substance, to informed estimated (largely by apiculturists) to a few concerted efforts by economists (which have no necessarily been any more credible than those generated by apiculturists). US researchers have estimated the value of the pollination benefit to US agriculture to be anything from US$ 4.5 billion to US$ 40 billion. A previous estimate for the Australian market was A$ 156 million.

This paper is intended to serve two purposes. First, the literature pertaining to the valuation of the pollination benefit will be reviewed and criticized in general terms. Second and subsequent to this review, an attempt will be made to synthesise, in non-technical terms a reasonable conceptual approach to the valuation of the pollination benefit. This approach will be applied in the generation of a hopefully meaningful valuation for the Australian situation. A priori, it will not be possible to value every facet of the pollination benefit. Many aspects of incidental (or unmanaged) pollination services have not been technically established. It is not possible to value effects which have not been technically established (the benefits and costs associated with the incidental pollination of plants in National parks and even in private gardens are examples of effects which are unlikely to be amenable to economic assessment).

2. Review of the literature pertaining to the valuation of the pollination benefit

2.1. General details regarding the nature of the pollination benefit.

Honeybees effect the cross pollination of receptive plants as they forage for nectar and pollen. The nature and significance of this effect varies between plant species. Some plants are solely dependent on insect pollination for pollen transfer. Other plants may be responsive to wind, bird or other non-insect agent pollination. The commercial pollination services market has evolved to service those crops which are clearly advantaged by honeybee pollination.

The major conceptual hurdle encountered in any valuation of the pollination benefit is the valuation of unmanaged or incidental pollination. Such pollination services, if provided unwittingly by beekeepers, are unremunerated. Such services may be provided to crops adjoining a contract crop or by bees which are employed specifically for the extraction of nectar for honey or they may be provided by feral or wild bees. Evidence abounds to suggest that many growers depend on incidental or “free” pollination services for their crops. Crop yields may well be at uneconomically low levels in the absence of such services.

Feral and managed honeybees are equally capable of pollinating plants. Where feral bee populations are high, incidental pollination may completely satisfy a specific crop’s pollination requirements. The pollination requirements of other crops (such as almonds), are unlikely to be satisfied by anything other than professionally managed pollination. Where crops are grown in large scale monocultural conditions, such as almonds in California and the Riverina in Australia and pome fruits in the US Pacific North West, commercially managed colonies of bees are usually required. Viable commercial pollination markets also exist where feral bee population are low or nonexistent as a consequence of widespread pesticide usage and/or bee disease/parasite infestations. The active pollination markets in Washington and Oregon in the US may at least partially be attributed to the prevalence of low “feral” honeybee populations in those States (BURGETT, personal communication). Varroa is known to virtually eliminate feral bee populations.

Any social valuation of the pollination benefit must, therefore, include the contribution of managed contractual pollination and incidental pollination provided by managed hives and by feral bees. In addition, bees contribute to social welfare through the pollination of crops which are themselves intermediaries in the production processes of other agricultural commodities. Honeybees contribute to the propagation of livestock pastures through the pollination of clovers and other pasture species. Such pollination services are almost universally incidental and unremunerated. Bees also pollinate plants which are not marketed such as garden vegetables and ornamental flowers. Though these services do not contribute directly to the cash flows of the respective resource owners, the welfare of such individuals is enhanced by the pollinating activities of bees. A complete social accounting of the benefits of honeybee pollination should also include the latter nonmarket effects.

It should now be apparent that a complete social accounting of the benefits provided by the honeybees is infeasible due to problems associated with the identification, measurement and valuation of some of the associated effects. The above discussion, however, should provide a useful context for the following assessment of the various attempts which have been made in this area.

2.2. A review of previous valuations of the pollination benefit.

Valuations of the pollination benefit have been derived through application of a diversity of methodologies. An understanding of the motivations for such valuations can place the choice of valuation methodology in context. Both methodological approach and motivation will be simultaneously considered in the following review.

2.2.1. Valuations based on an infinite elasticity demand assumption.

Typically, analysts have attributed either all or a portion of the output of bee dependent crops to honeybees and multiplied this portion by the current market price of those commodities. If the services of honeybees were removed, the economy would be worse off by the exact amount of the value of lost production, LEVIN (1983) generated a value of $18.9 billion for the US pollination market by application of such a methodology.

There are several major, theoretically irreconcilable problems with LEVINS’s approach. As the output of a crop declines in the absence of bees, the cost of producing that smaller output will also be lower. If crop output declines to zero, production costs will also, naturally, decline to zero. LEVIN’s valuation approach implicitly included such reduced production costs as part of the total monetary loss associated with no bee scenario. Saved costs are not a social loss so should not be included in the calculation.

LEVIN's valuation methodology is conceptualized in Fig. 1. The "supply shock" following the theorized removal of bees is represented by a movement in the supply curve for an individual crop from S2 to S1. Area "C" is the appropriate socially significant loss from the removal of bees. Area "D" is the reduction in production costs attendant with the lower crop output following the theorized exclusion of bees so should not be (though was by LEVIN) included as part of the social loss calculation.

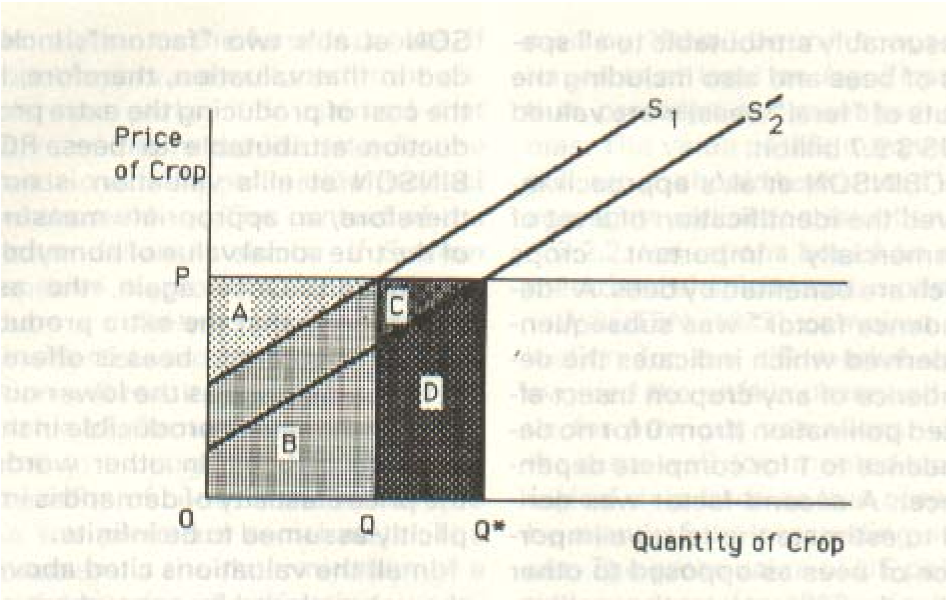

Fig. 1 - Loss in producer surplus following removal of the honeybee pollination benefit assuming an infinite demand elasticity

The assumption of an infinite price elasticity of demand for all affected crops is also fallacious. Consumers are unlikely to be willing to pay the same for an agricultural product when supply is abundant as when scarcity prevails. This latter relationship, however, is implicitly assumed for all crops included in LEVIN's valuation.

The third major fallacy of LEVIN's (1983) approach is the attribution of the entire pollination benefit to honeybees. LEVIN's approach implicitly assumes away the contributions of all other pollinating agents.

MARTIN (1975) applied a similar methodology to LEVIN's to claim that the direct and indirect economic contributions of pollination to US agriculture may approach US$ 40 billion. MARTIN's accounting included the full market value of beef and dairy products which are derived from honeybee pollinated legumes. O'GRADY (1987) revalued LEVIN's estimate down to US $ 4.6 billion by attempting to value the actual yield advantage conferred by bees on selected crops and simultaneously attempting to exclude the contribution of alternative pollinators. This approach still implicitly assumes an infinite demand elasticity, and over-values the pollination service by implicitly including reduced crop production costs (i.e. area "D" in Fig. 1) as a cost of reduced pollination.

ROBINSON, NOWOGRODZKI and MORSE (1989), based their recent analysis of the value of honeybee pollination in the US on the approach adopted by O'GRADY (1987). US pollination services (presumably attributable to all species of bees and also including the inputs of "feral" bees) were valued at US $ 9.7 billion.

ROBINSON et al.'s approach involved the identification of a set of commercially important crops which are benefited by bees. A "dependence factor" was subsequently derived which indicates the dependence of any crop on insect effected pollination (from 0 for no dependence to 1 for complete dependence). A second factor was derived to estimate the relative importance of bees as opposed to other pollinating insects to the pollination of each of these dependent crops. The value of honeybee pollination to each pollination dependent crop was consequently calculated as the product of the estimated money value of each dependent crop, the dependence factor and the "honeybee contribution factor". The aggregate US value of honeybee pollination figure was derived by summing the pollination values for each of the specified crops.

Though ROBINSON et al.'s approach appears to be well supported by agronomic data, the calculated value of pollination services is represented by areas "C" and "D" in figure 1. Area "D" (reduced crop production costs) is as fallaciously included here as it was in LEVIN's (1983) valuation. The magnitude of the shift it the supply function indicated on figure 1 resulting from the removal of honeybees would be described by the product of ROBINSON et al.'s two "factors". Included in that valuation, therefore, is the cost of producing the extra production attributable to bees. ROBINSON et al.'s valuation is not, therefore, an appropriate measure of the true social value of honeybee pollination. Once again, the assumption is that the extra production attributable to bees is offered at the same price as the lower out-put which may be producible in the absence of bees. In other words, the price elasticity of demand is implicitly assumed to be infinite.

In all the valuations cited above, the value placed by consumers on the extra production attributable to honeybee pollination has been ignored (or effectively assumed away by the assumption of an infinite price elasticity of demand). The true social value of the pollination services conferred by honeybees is measured by the sum of appropriate producer and consumer valuations (or "surpluses" in economic terms).

The pollination services market in Australia is not as well defined as those in the USA and New Zealand. Nevertheless, the question of the value of pollination is a topical issue in this country. Two major current policy debates relating to the Australian beekeeping industry include the question of beekeeper access to national parks and the biological control of an important group of honey plants (*Echium* spp.) of value to beekeepers. The social value of honeybee pollination is a central issue to both debates. In relation to the former debate, if beekeepers are excluded from wilderness parks, it is claimed that hive numbers are likely to decline and so will the pollination product of those hives. The context of the latter debate is similar. If *Echium* species are controlled, hive numbers are likely to decline and less incidental and managed pollination will result. In both cases, if the value of affected pollination is proved to be larger than the claimed benefits of control, the status quo is the preferred social state. The problem is the determination of a reliable value of pollination.

The few existing Australian context pollination valuations are subject to the sane criticisms outlined for the preceeding US studies. The current study is designed to contribute a more reliable and supportable valuation for local policy application and to contribute to an appropriate methodology for similar debates in other countries.

One important consideration for any such valuation is to include a value for "feral" and incidental pollination in addition to one for managed pollination if the appropriate context for such a valuation is the well being of society as a whole. Most of the debates to which pollination valuations are directed involve the allocation of public resources, so the social context is usually appropriate. In many parts of at least Australia and the USA incidental or unremunerated pollination performed by managed honeybees and pollination performed by "feral" or unmanaged colonies is at least as significant as that provided by managed colonies. The value of this unmanaged pollination should be included in the aggregate pollination valuation.

2.2.2 Valuations based on parameterized elasticity assumptions

WOOTEN (1987), compiled a valuation for the US market which avoided the pitfalls described above for previous valuations. Using the same well documented technological data base as that accessed by many of the preceeding analyses. The gross value of US pollination services (for 1982 prices and recorded contract numbers) was determined to be between US $ 182 million to a value in excess of US $ 3 billion. This valuation was parameterized for a set of assumptions regarding the responsiveness of crop demand and supply to crop price (price responsiveness is measured by "elasticities"). The resulting estimated range in pollination values is probably too wide to be useful in a policy context. To obtain a single pollination value using this methodology, a vast amount of (probably unavailable) crop production and demand statistics would be required.

The set of crops for which WOOTEN's valuation was undertaken was only a sub-set of all steps which are benefited by bees and included only a small proportion of those considered by ROBINSON et al. (1989). The complete set of pollination benefited crops is being continually redefined by technical research and will no doubt be extended by this Symposium.

WOOTEN (1987) recognized that his valuation did not incorporate any allowance for non-marketed pollination effects. For example, the social contribution of bees in reducing soil erosion by the pollination and consequent propagation of plant species significant in reducing erosion was ignored. The contribution of bees to the propagation of non-agricultural vegetation is also likely to be significant (though may be negative for some species thought to be adversely selected by bees).

3. Results of a social valuation of the pollination benefit in Australia

The characteristics of an appropriate valuation methodology have been described in non-technical terms. The appropriate context for such a valuation intended to contribute to various policy debates regarding the beekeeping industry is one which encompasses the welfare of society as a whole. The author has undertaken such a valuation for the Australian market which includes the contributions of managed and unmanaged pollination. The approach adopted considered only socially relevant effect including the benefits derived by consumers of pollination benefited crops. A relevant sub-set of 25 crops for which adequate statistics were available were considered. A degree of dependence on honeybee pollination index similar to that employed by ROBINSON et al. (1989) was applied in the analysis. The ensuing valuation was a range of A$ 604.8 to A$ 1.2 billion.

Policy implications and discussion

Most of the attempts to value honeybee pollination in the past have been based on theoretically unsupportable premises. The assignation of a pollination value equivalent to the full market value of pollination benefited crops is fallacious, yet such results have been widely promoted in many countries. A recent (ROBINSON et al., 1989) US valuation sponsored jointly by the Economic Research Service of the USDA and the US National Honey Board and criticized in this paper, evidences many unsupportable premises. The author's aims in the current study were to discuss the methodological limitations of proceeding analyses and to indentify and illustrate by application an economically defensible valuation methodology within the context of the Australian market.

The results of the current study are not definitive. Too many data limitations and identification problems preclude the derivation of a single value for honeybee pollination in Australia and probably elsewhere. Nevertheless, these results can and have been employed to useful purpose in the various policy debates pertinent to the Australian beekeeping industry. One hopeful contribution of the study has been some illumination of the nature and significance of the linkages between the beekeeping and other agricultural industries. An understanding of such linkages is an important input into efficient resource allocation decision making in the public arena. Valuations of this kind would have similar application in other countries.

In the USA, value of pollination estimates are employed to justify continued public support of that country's honey price support scheme. In addition, the relatively high value of bees as incidental pollinators is used as an argument for increased public funding of honeybee related research and extension programmes. The construction of reliable valuations can only enhance the efficiency of the policy making process and the standing of beekeepers' as significant contributor to the well-being of society.

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