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## Guidelines for the economic valuation of pollination services at a national scale

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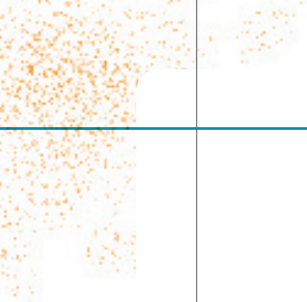
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# GUIDELINES FOR THE ECONOMIC VALUATION OF POLLINATION SERVICES AT A NATIONAL SCALE





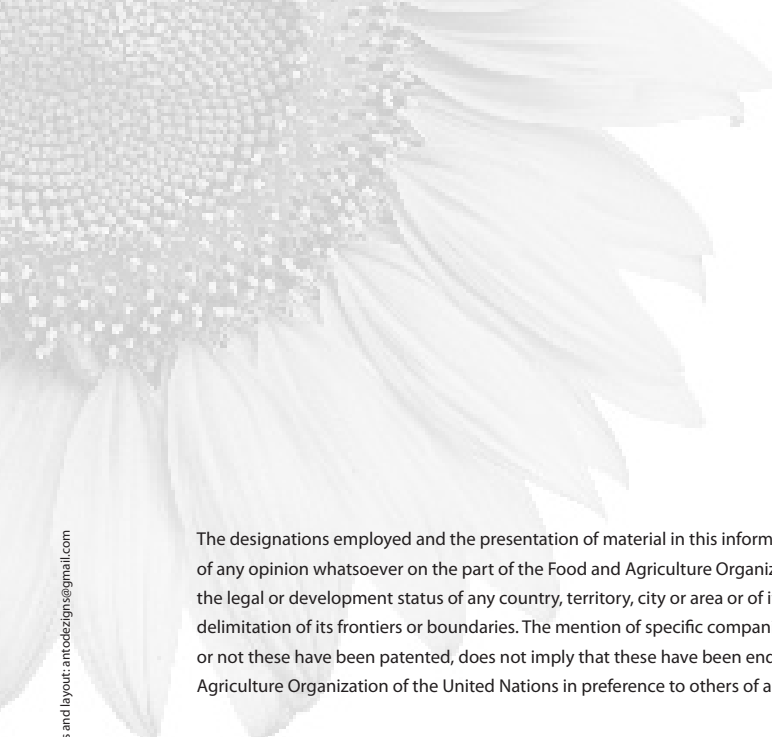


# GUIDELINES FOR THE ECONOMIC VALUATION OF POLLINATION SERVICES AT A NATIONAL SCALE

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GLOBAL ACTION ON POLLINATION SERVICES  
FOR SUSTAINABLE AGRICULTURE



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# PREFACE

Pollinators are an element of crop associated biodiversity, and provide an essential ecosystem service to both natural and agricultural ecosystems. Approximately 80 percent of all flowering plant species are specialized for pollination by animals, mostly insects. The negative impact of the loss of pollinators is strongly felt in agricultural biodiversity. The role of pollinators is, among other things, to ensure reproduction, fruit set development and dispersal in plants, both in agroecosystems and natural ecosystems. In turn, plants need to exist in order for pollinators to be able to feed. Indeed, some plant species rely upon a few types of pollinators to provide pollination services. Some pollinators such as bees also provide food and additional income for rural families, in the form of honey and other by-products - thus, declining pollinator populations impact on the sustainable livelihoods of rural families.

Every continent, except for Antarctica, has reports of pollinator declines in at least one region/country. The losses of pollination services have been well documented in many specific instances. The international community has identified the importance of addressing pollinator declines through the establishment of an International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative-IPI) of the United Nations Convention on Biological Diversity in 2000 (COP decision V/5, section II), facilitated and coordinated by the Food and Agriculture Organization of the United Nations. A Plan of Action for the initiative has been developed and adopted by the Conference of Parties. In the Ninth Conference of Parties Decision IX/1 in 2008 the Parties invited FAO in collaboration with Parties, other Governments and relevant organizations, to continue the implementation of the International Initiative for the Conservation and Sustainable Use of Pollinators (decision VI/5) including (*inter alia*); to assess the agricultural production, ecological, and socio-economic consequences of pollinator declines.



As a contribution to this initiative, FAO has collaborated with INRA (L'institut national de recherche agronomique of the French government) to develop a tool for assessing national vulnerabilities to pollinator declines. This document explains the use of the tool. The tool, and background documents, can be found on the website of FAO's Global Action on Pollination Services for Sustainable Agriculture.

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# TOOL FOR ECONOMIC VALUATION OF POLLINATION SERVICES

## BACKGROUND OF THE TOOL

In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops. Pollinators such as bees, birds and bats affect 35 percent of the world's crop production, increasing outputs of 87 of the leading food crops worldwide<sup>1</sup>, plus many plant-derived medicines in the world's pharmacies (see box on page 2)

In the past, pollination has been provided by nature at no explicit cost to human communities. As farm fields have become larger, and the use of agricultural chemicals has increased, mounting evidence points to a potentially serious decline in populations of pollinators under agricultural development. The domesticated honeybee, *Apis mellifera* (and its several Asian relatives) have been utilized to provide managed pollination systems, but for many crops, honeybees are either not effective or are suboptimal pollinators. Managed honeybee populations are also facing increasing threats of pests, disease, and reluctance among younger generations to learn the skills of beekeeping. The process of securing effective pollinators to "service" agricultural fields is proving difficult to engineer, and there is a renewed interest in appreciating the value of wild pollination services and in helping nature provide pollination services through practices that support pollinators.

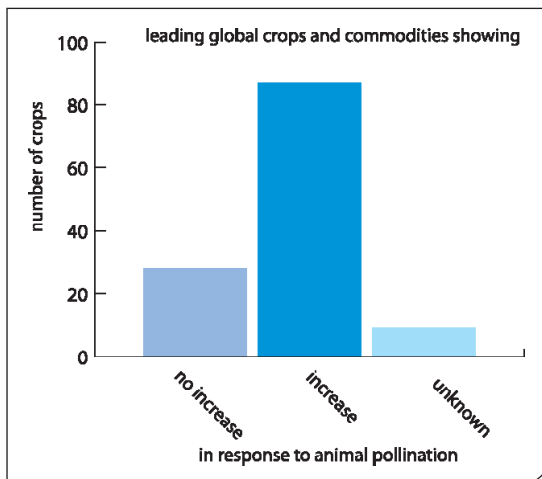


## DEPENDENCE OF WORLD CROPS ON POLLINATORS.

Out of the 115 crops whose pollen vectors were determined in a recent global study, over 75% depend to some degree upon animal pollination. Among the leading crops that benefit from animal pollination, 13 are entirely reliant upon animal pollinators, 30 are greatly dependent and 27 are moderately dependent.

A few crops rely entirely on pollinators for reproduction; without pollinators, a crop could only be produced with human help via hand pollination. These include cocoa, one of the most important cash crops in tropical countries, the vitamin-rich and tasty kiwifruit, passion fruit, annona and sapodilla fruits, as well as vanilla, squashes and pumpkins, cantaloupes and watermelons, and Brazil- and macadamia nuts. Most crops showed a production increase between 5 and 50% as a result of pollination by animals (mainly bees).

The authors of this study readily acknowledge, however, that there are multiple gaps in the knowledge of pollination requirements, which may vary between varieties and geographic locations. The understanding of the pollination needs of many crops has recently been revised, as they are grown under increasingly intensive practices where the underappreciated wild pollination service may be impacted. In addition to gaps in knowledge about pollination requirements, there is also a dynamic aspect about knowledge de-



velopment in this area, as production systems evolve and change. In particular, as production systems intensify, there has been an increase in awareness of the importance (and value) of previously supplied wild pollination services.

*from Klein et al.  
(2007)*

Recognising the importance of pollinators to human livelihoods, the International Pollinators Initiative of the United Nations Convention on Biological Diversity, facilitated and coordinated by the Food and Agriculture Organization, has been requested by the parties to that convention to assess the agricultural production, ecological, and socio-economic consequences of pollinator declines.

As a contribution to this initiative, FAO has collaborated with INRA (L'institut national de recherche agronomique of the French government) to reconfigure the findings of a recent research paper published by scientists affiliated with the institute. The original findings (Gallai et al. 2009) made an economic valuation of the vulnerability of world agriculture to pollinator declines. In the present work, a tool for applying the same analysis on a national level was developed, and is presented in the format of an Excel spreadsheet. The tool, and background documents, can be found on the website of FAO's Global Action on Pollination Services for Sustainable Agriculture.

## HOW DOES IT WORK?

The tool is used to undertake an economic valuation of insect pollinators at a national or larger scale following both a technical economic approach and an economic assessment approach (Gallai et al. 2009). The technical economic approach is a monetary valuation of the contribution of the pollination service to agriculture (Benedek, 1983; Borneck & Bricout, 1984; Borneck & Merle, 1989; Robinson et al., 1989; Southwick & Southwick, 1992; Carreck & Williams, 1998; Morse & Calderone, 2000; Losey & Vaughan, 2006; Gallai et al., 2009) and thereby the vulnerability of agriculture confronted with pollinator declines (Gallai et al., 2009). The economic assessment is an evaluation of the impact of pollinator loss on social welfare (Southwick & Southwick, 1992, Gallai et al., 2009). The definition of these three indicators and the methodology to calculate them are explained in more details in the FAO report "Guidelines for the economic valuation of pollinator services at a national scale: an application to Ghana and Nepal in 2005".

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# DATA FOR THE OPERATION OF THE TOOL

## DATA NEEDS

There are four categories of data that are needed to carry out an analysis of the economic value of pollination. These are:

- Choice of crops to be assessed
- Current knowledge of the impact of animal pollination on yields
- Price of crops to producers
- Production levels of crops

## CHOICE OF CROPS TO BE ASSESSED

In the first worksheet (named "Array" in the the accompanying Excel spreadsheet file, entitled "Pollination Value Array") there are 133 crops given in Table 1. These crops are those used directly for human food, as defined by FAO, and are identified by their common names (column B), species name (column C) and the category to which they belong as defined by the FAO (column D). The scope of the study is limited to the 120 direct crops and 13 commodity crops used directly for human food as reported by FAO. Direct crops are those listed individually with their production by the FAO, while a commodity crop is an aggregation of different crops for which the production figures are pooled together and most are reported as Not Elsewhere Specified. Commodity production figures are based on a questionnaire that countries fill out to include important crops for the world market that are not listed individually by the FAO. Commodity crops are included in the study because they may represent a significant part of the



agricultural output for some countries.

The analytical tool will be applied to each crop of interest. By filling in the information on producer prices and crop production data in columns I and J (under the heading “COLUMNS TO BE FILLED WITH STATISTICS FROM APPROPRIATE YEAR” ) of the selected crops, the value of pollination and vulnerability to pollinator declines will automatically be calculated, and summed into Table 2.

Note that Table 1 can be filled out on a national, or regional scale.

## IMPACT OF ANIMAL POLLINATION

For each crop of the array the authors have associated their qualitative and quantitative dependence on animal pollination (columns E and H) following Klein et al. (2007). Appendices 1 and 2 of Klein et al. (2007) were used to determine the mean level of dependence on insect pollination as follows:

95% = mean value of pollination-driven yield reduction lies between 100% and 90% in experiments comparing commercial yields with and without animal pollinators. Pollination is reported as “essential”.

65% = pollination-driven yield reduction ranges between 40 - <90%. Pollination is reported as “great”.

25% = pollination-driven yield reduction ranges between 10 and <40%. Pollination is reported as “modest”.

5% = pollination-driven yield reduction ranges between >0 and <10% reduction. Pollination is reported as “little”.

For crops not listed with dependency figures in Klein et al. (2007), their dependency value is reported as ‘unknown’ with the symbol ‘-’. For commodities that pool different crops with different levels of dependence to insect pollinators, they are noted as ‘unknown’ as well.

## PRODUCER PRICE AND CROP PRODUCTION DATA

Users will need to fill in the columns “I” and “J” in the array table 1 which are for producer prices and crop production figures, respectively. These data will depend

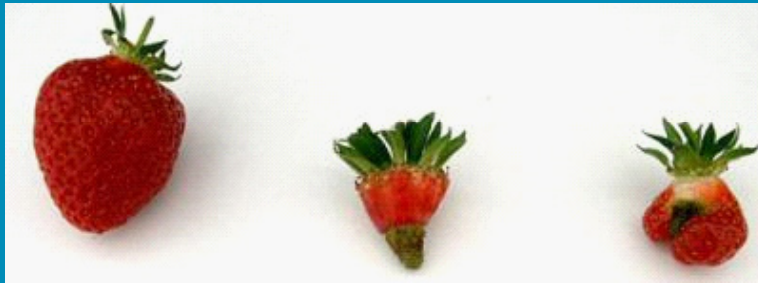
on the scale (country or region) of the intended analysis. They are often available from national agricultural statistics databases. If not, it is possible to use the FAO database (<http://faostat.fao.org>) which is the longest and more complete set of agricultural data in the world. We suggest using it for producer prices and production figures particularly if it is projected to compare agriculture between different countries.

However, FAO data is not always available for both producer price and production figures; production data is generally available for all crops while price may not be. In such cases, it is possible to calculate the weighted mean of the missing data using data of countries in the same region. The production data are available from 1961 to 2007 while producer price data are available from 1991 to 2006.

To calculate the recent economic value of insect pollination (EVIP) and the consumer surplus loss (CSLoss), it is possible to make use of Gallai et al. (2009)'s methodology. It consists in taking into account regional specialization, geographical context, and socio-economic factors. They divided crops into three groups: major world field crops, other world field crops and minor crops. Major world field crops, like most cereals and sugar crops, are produced on a large scale and have a large-enough commercial value to be traded on financial markets. For these crops, one can use the "free on board" (FOB) prices, which are future contracts. These prices are available on the websites of financial market places specialized in commodities such as the Chicago Board of Trade (CBOT ; [http:// www.cbot.com/](http://www.cbot.com/)) and the Intercontinental Exchange Futures US (ICE Futures US ; [https:// www.theice.com/](https://www.theice.com/)). For minor world field crops, prices are not available on the financial market place because of lower interest in their international trading on a large scale. For these crops, one can use the producer prices for each world region that are provided by the European database Eurostat (<http://epp.eurostat.ec.europa.eu>) and by the United States Department of Agriculture (<http://www.fas.usda.gov>). For minor local crops, defined as those for which the producer price are not available in either of these two large databases, as well as for all the commodities, one can use the average producer price listed on the FAOSTAT website for the period 1991-2006 for the most important producing country of each world region.



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Strawberries, after open insect-pollination (left), passive self-pollination (middle) and passive self-pollination and wind-pollination (right).



# RESULTS

## HOW TO USE THE TOOL

The user will need to enter the producer price (column I) and production figures (column J) for each crop listed by common name if it is produced in the area of interest. This operation should be repeated for all crops produced in the study area. Results will automatically be calculated in Table 2, on the right of the array. It is noteworthy that all crop of the world are represented in this table so it would be normal to not fill in all fields of the table. If a crop of interest is not listed in the table, it can be added within the commodity of the correct crop category.

## OUTPUTS

Once columns I and J are filled, the array calculates automatically the total value of the crop (column K), the value of the insect pollination contribution for this crop (column L), and the consumer surplus loss for two value of price elasticity: -0.8 and -1.2 (columns M and N). The aggregated values are calculated automatically on Table 2. This table provides the total value of the crops listed in Table 1 (TVC), the total economic value of insect pollination (EVIP), the vulnerability ratio in regards to insect pollination (VR) and the total consumer loss (CSLoss) for price elasticities ranging from -0.8 and -1.2 per crop category.


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As a contribution to the International Pollinator Initiative, this document provides guidance on the use of analytical tool, in the format of an associated spreadsheet, to assess the economic value of crop pollination and the vulnerability of countries or regions to pollinator declines.



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