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# Longan fruit farmers' demand for policies aimed at conserving native pollinating bees in Northern Thailand

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ABSTRACT

Northern Thailand is orienting its agriculture towards intensive production systems at risk of being subjected to the current worldwide pollinator crisis. Bee-friendly pest management, improving native bee habitats within agro-forest ecosystems and fostering the husbandry of native bee species are three widely recognized strategies to conserve the local pollinating fauna. We attempted at eliciting farmers' valuation of these measures and that of their potential effect on local native bees, by conducting a choice experiment with 198 longan (Dimocarpus longan) farmers. The results of a mixed logit model indicate a significant heterogeneity in farmers' preferences, part of which was explained by the respondents' attitude towards native bees, among other idiosyncratic variables such as gender. We also determined a generally positive willingness to pay for the above mentioned conservation measures, which implemented together were valued at approx. €18.1 by the average household, all else equal. Additionally, avoiding a 50% native bee population decline was valued in average at €40.5 per household. These estimates stand in strong contrast with the comparatively high economic losses such a decline could potentially entail in terms of reduced longan production and the relatively low investment costs to implement a conservation strategy aimed at preventing such losses.



## 1. Introduction

The international community is showing increasing concerns regarding the continued decline of both wild and managed pollinator populations worldwide (Dias et al., 1999; Ricketts, 2004; Steffan-Dewenter et al., 2005; Kluser and Peduzzi, 2007; FAO, 2008; Gallai et al., 2009; Potts et al., 2010). Agricultural intensification has been recognized as the main driver for the decline of wild bee populations, especially due to the inappropriate use of pesticides and by reducing natural habitats through land-use change (Kremen et al., 2002; Potts et al., 2010).

Thailand is located in a bee diversity hotspot. With the exception of the European honeybee (*Apis mellifera* L.), all other 8 honeybee species of the world are indigenous to Southeast Asia (Hepburn and Radloff, 2011). There is also a great diversity of stingless bees in this subcontinent, with a large number of species recorded in Thailand, particularly in its northern provinces (Rajitparinya et al., 2001; Klakasikorn et al., 2005; Jongjitvimol et al., 2005). The region has therefore historically been a cluster for traditional beekeeping, which is mainly practiced by smallholders with rather rudimentary technologies that have been developed around the culture of the Asian honeybee (*Apis cerana* F.) and that of stingless bees.

Northern Thailand is also rapidly orienting its agriculture to the production of high-value crops under intensive systems that are often characterized by the overuse of synthetic pesticides (Schreinemachers et al., 2011), which in connection with deforestation (Delang, 2002) risk reproducing the case of other regions in the world, where intensive agriculture has driven pollinator populations to substantial declines (Biesmeijer et al., 2006; National Research Council, 2007; Potts et al., 2010). Thailand has also responded to the continuously growing demand for longan (*Dimocarpus longan* L.), a fruit obtained from a bee-pollination dependent crop (Blanche et al., 2006; Pham, 2012), by dramatically expanding its cultivated area and its yields, i.e. from 12,094 ha (corresponding to 45,756 tons per annum) in 1983 to 168,517 ha (i.e. 976,729 tons per annum) in 2014 (Anupunt and Sukhivibul, 2005; Thai Office of Agricultural Economics, 2014). Currently, ~82% of the longan land is cultivated by 206,328 households in Northern Thailand, ~30% thereof by 69,330 households in Chiang Mai province (Thai Office of Agricultural Economics, 2014), rendering this region the leading exporter of longan worldwide and its economy highly dependent on this crop (Anupunt and Sukhivibul, 2005; Menzel and Waite, 2005).

Although there are yet no official reports on a pollinator crisis in Thailand, in June 2011 we collected anecdotal evidence from the

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eastern Thai province of Chanthaburi that supports the suspicion that a pollinator problem might exist, in at least that region: according to accounts from many local rambutan (*Nephelium lappaceum* L.) farmers, habitat encroachment due to agriculture and pesticide overuse has dramatically reduced the population of wild bees with economically important consequences on their crop yields. In response, a local initiative is correcting such pollination deficiencies by promoting on-farm meliponiculture (i.e. keeping stingless bees).

Against this background, Northern Thailand could benefit from a policy directed at conserving native pollinating bees. Such policy should take into account the perceptions of longan farmers with regards to the benefits of its implementation and the expected yield losses that could arise in the event of an important decline of pollination services. A pollinator conservation policy could consist of following measures: (i) offering farmers bee-friendly alternatives to conventional pesticides (e.g., biological control and integrated pest management), (ii) encouraging the protection and improvement of natural bee habitats within agro-forest ecosystems and (iii) fostering the husbandry of native bee species. Expert interviews and focus group discussions with farmers helped us recognize that, among the recommendations of the Plan of Action of the International Pollinator Initiative (IPI-POA) (Byrne and Fitzpatrick, 2009), these measures potentially have the greatest impact and implementation chances in Thailand's current agricultural and political context.

We conducted a discrete choice experiment (DCE) in Chiang Mai Province in order to understand the preferences of longan farmers with regards to the conservation strategies mentioned above and to hypothetical changes in the local population of native bees. The respondents had to choose between a status quo scenario, associated with an assumed 50% native bee population decline, and a series of alternative hypothetical policy scenarios in which the implementation of different conservation strategy combinations would avoid such declines. The choice decision also involved a single-payment tax hypothetically incurred by the respondents before any conservation policy bundle could be implemented. Our analyses include by this design willingness to pay (WTP) estimates for the individual conservation policy attributes and for the bee population declines assumed in the DCE. Furthermore, we confront the value estimates obtained with the potential costs that would arise if some or all of the ecosystem services provided by local native bees to longan orchards would be lost, as calculated based on the bee-pollination dependence ratios given by Blanche et al. (2006) and Pham (2012) (see Section 2).

## 2. The economic value of pollination services

In several studies, the economic value of the contribution of pollinators to agricultural production has been estimated using a dependence ratio that accounts for the partial production loss of specific crops, attributed to the complete absence of pollinators (Morse and Calderone, 2000; Losey and Vaughan, 2006; Gallai et al., 2009). Gallai et al. (2009) for instance estimated the total economic value of pollination services worldwide at €153 billion. Building upon this approach and having estimated the demand functions of a variety of insect-pollination dependent crops, the potential welfare losses from increases of food prices that would result from the effect of insect pollination shortages on crop yields can be considered (Kevan and Phillips, 2001). Accordingly, Southwick and Southwick Jr. (1992) estimated the annual value of crop pollination by managed honeybees (*A. mellifera*) in the USA to range between USD1.6 and USD5.7 billion.

Pollination experiments along replicated distance gradients have also been used to estimate the economic value of tropical forest patches that, serving as nesting sites for bees, contribute to the pollination of crops, such as coffee (*Coffea arabica* L. and *Coffea robusta* P.) (Ricketts, 2004; Olschewski et al., 2006). Blanche et al. (2006) conducted similar experiments with longan (*Dimocarpus longan*) orchards in North Queensland, Australia, where they assessed the effect of their proximity to rainforests (as beneficial insect reservoirs) on this crop's pollination. No monetary results were offered by this study, yet it concludes that initial fruit set in longan is substantially enhanced by insect pollination (i.e. 62% contribution), prominently from stingless bees. A similar result obtained by Pham (2012) for four different longan cultivars in Quoc Oai, Vietnam attributes 67% of their yields to floral visits by Asian honeybees (*A. cerana*), amounting to €0.34 per kg of fruit in 2011.

Other studies have measured the economic value of pollination services by directly observing the market prices of existing commercial pollination services that are contracted by farmers to substitute their failing ecosystem service counterpart, such as it occurs in the almond groves of California, USA (Rucker et al., 2012). Another approach consists in calculating the cost of potentially having to replace pollination services with labor or capital (e.g., hand pollination, or pollen dusting, respectively), such as to maintain crop production at the same levels that are attained with pollination services from a healthy natural ecosystem (Allsopp et al., 2008).

More recent studies have integrated the estimation of economic values for pollination services with spatial analyses. Ricketts and Lonsdorf (2013), for instance, calculated (discrete) marginal values for unit changes in pollinator habitats by combining the pollen limitation experiment results for coffee fields in Costa Rica from Ricketts (2004) with a model by Lonsdorf et al. (2009) that predicts the supply of pollinators based on the surrounding land cover's suitability to provide nesting sites and floral resources. On the other hand, Barfield et al. (2015) and Lautenbach et al. (2012) applied the pollination dependence ratio and crop vulnerability ratio approaches to plot economic value estimates at local and global scales, respectively; the former using a farm gate dataset for 55 crops in the US state of Georgia, while the latter combined FAO country-specific data for the years 1993 through 2009 with the global crop distribution maps of Monfreda et al. (2008).

## 3. Material and methods

### 3.1. The discrete choice experiment

The studies reported above (Section 2) estimate the so-called use value of pollination services relying upon market price observations of either pollination dependent crops or commercial pollination services. In contrast to such studies, DCEs have been deemed not suitable for the estimation of the economic benefits of pollination services, with the sensible argument that such stated preference methods would require respondents to possess a sound knowledge of the quantitative contribution that pollination delivers to their agricultural production (Mburu et al., 2006), i.e. a lack in ecological knowledge may hinder them from correctly assessing the use value of pollination. We do not dispute such argument, nor do we consider DCEs an alternative to studies that estimate the market value of pollination services. On the contrary, we think both approaches can complement each other: market-based valuation methods are important tools to estimate the use value of pollination, whereas DCEs can be used to assess peoples' current preferences for measures to conserve bees and for avoiding their declines. After all, policy makers should take into account stakeholders' preferences for the implementation and implications