



OPINION ARTICLE

China invests two times as much as USA on honey bee research [v1; ref status: awaiting peer review, <http://f1000r.es/5hi>]

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Abstract

Honey bees are in no doubt the most beneficial insects to humans due to their widespread use for pollination of our crops. In this paper we compare the recent investment into honey bee research in China and USA. We show that China has invested more heavily into honey bee research than USA since 2007. The recent funding increase promised by the White House Pollinator Task Force, hopefully, will reduce the funding gap between the two countries.

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REVIEW

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Introduction

It is well known that honey bees (*Apis mellifera* in North America and Europe, but also *A. cerana* in Asia) are the most beneficial insects to humans due to the pollination services they provide to our fruits and vegetables (Gallai *et al.*, 2009). The most recent estimated value of honey bees in the US was \$15 billion per year (Morse & Calderone, 2000). This is likely underestimated: in Michigan alone, the value of fruits and vegetables that resulted from honey bee pollination was close to 1 billion per year (<http://bees.msu.edu/2010/bees-worth-a-billion-in-michigan/>), after adjusting for the honey bee dependency factor of each crop. For example, soybean only increases 10% of its yield after honey bee pollination, so only 10% of the total production value was used for this calculation.

Funding in China

In the following discussion, we show that the US lagged behind China in governmental investment in honey bee research. China does not seem to have suffered from the same Colony Collapse Disorder (CCD) that the US has endured since the fall of 2006 (Cox-Foster *et al.*, 2007). The most recent survey conducted by Vander (Vander Zee *et al.*, 2012) found annual colony loss in China was below 10%. Yet, since 2008, China has invested much more than the US in honey bee research. In their Earmarked Fund for Chinese Modern Agro-industry Technology Research System, (shortened as CARS [sic]), a chief scientist, Jie Wu was chosen, who then assembled a team of 19 additional scientists nationwide (Wu, 2009). These scientists were organized into 6 laboratories, though most members in each laboratory were not located at the same institution (Table 1). A total of \$19 million USD has been granted to these scientists since 2008. In addition, 21 honey-bee-specific experimental stations were funded at a slightly lower level with a total of \$10.2 million USD across the two funding periods (Table 2). An independent project for pear pollination in northern China was funded for 15 million RMB (~\$2.5 million USD), also by the Chinese Ministry of Agriculture (personal communication). This was directed by Youquan Shao in Shanxi, who also receives funds from CARS (#5 in Table 2). He was specifically instructed to help farmers use honey bees for pear pollination instead of hand pollination, which was common in some northern provinces of China (Ya *et al.*, 2003).

Notice that these numbers (Table 1 and Table 2) do not include competitive funding from the Ministry of Agriculture (USDA equivalent in China) nor the National Natural Science Foundation of China (NSFC, the NSF equivalent in China) for honey bee research. Unlike the US, in China the NSFC must award 4–6 grants to honey bee research each year, while in US, only the best among animal behavior or physiology (NSF) are funded by NSF, even in USDA grants, honey bee research must be competed in entomology and nematology, so there is no guarantee that honey bee specific proposals will be funded.

It is also quite clear that the funding provided by CARS enabled Chinese scientists to conduct many basic research projects, as evidenced by the acknowledgement of CARS in their papers (Figure 1). The number of publications per year increased significantly ($P=0.03$, one tailed t-test) after CARS funded the three scientists (we assumed a two year delay in publications so we compared before and after 2010). The majority of scientists were to conduct applied research and they published mostly in Chinese trade magazines.

China has a total of 50 such groups within the apicultural system, most of them with larger group sizes than the honey bee group (CARS45). They are planning a third phase of this project (starting in 2016), and per scientist allocation is expected to increase from 700,000 yuan to 1 million (= \$164,000 per year per person).

Funding in the US

In the US, after the initial announcement of CCD in 2006, the USDA gave the four honey bee labs (now only three are left) an “Area Wide” program for honey bee research, totaling \$4 million. Then there was a CAP (Coordinated Agricultural Project) grant specific to honey bees in 2008; entitled the “Sustainable Solutions to Problems Affecting Health of Managed Bees,” this project was managed by Dr. Keith Deplane, University of Georgia and shared by about a dozen honey bee scientists (of which Zachary Y. Huang is a consortium member). Another NIFA-CAP project was funded in 2011, for a total of \$5.0 million (<http://beeinformed.org>), directed by Dennis vanEngelsdorp (University of Maryland). Notice that with the exception of the Area Wide Program, the two CAP grants were also competitive funding and they were funded because they won the competitive over many other, non-honey bee proposals. The original request for proposals for these two grants were not specifically limited for pollinator research. However if we exclude these two grants, then we would not have an even lower figure compared to China. Even with these two grants included, we show that the total investment into honey bee research is about 1:2.5, US:China (Table 3). We did not include other grants won competitively from NIFA, NSF or NIH, because they were not specifically designed for honey bee or pollinator research.

Competitive or not?

We are not proposing that the funding mechanism is superior in China because competition presumably improves proposal quality. Perhaps a middle road is the best: set aside research money for honey bees specifically, or pollinators in general, both in the USDA and NSF, such that a limited “quota” of proposals are funded each year for honey-bee-specific research. This will ensure both quality (through competition) of studies as well as proper resource partition for honey bee research. Given that honey bees are so important to food production, we argue that honey bees are vitally important for our food security. Undoubtedly, two recently released White House Documents (Pollinator Health Task Force, 2015a; Pollinator Health Task Force, 2015b) might create just such a specific funding mechanism

Table 1. Names and locations of honey bee scientists funded by the Earmarked Fund for Chinese. Modern Agro-industry Technology Research System (CARS45). Each of these scientist receives 700,000 RMB (~120,000 USD), but the chief scientist, Jie Wu receives 1,000,000 RMB (~160,000 USD) per year from 2008 to 2015. Total funding per person during the entire period = 5.6 million RMB (~0.9 million USD). Total funding for all scientists ~19 million USD. Funding amounts were obtained from Wu (2009). Names were obtained from <http://finance.people.com.cn/GB/8215/47807/59262/14712388.html>.

Name (first LAST)	Institute	Upper Administration	City, Province	Responsibility
1. Jie WU	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Chief Scientist, in charge of the entire national program
2. Wei SHI	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Director of the "Breeding and Pollination Lab"
3. Songkun SU	College of Honey Bee Sciences	Fujian Agriculture and Forestry University	Fuzhou, Fujian	Breeding techniques in 2
4. Yunbo XUE	Key Laboratory for Honey Bee Genetics and Queen Breeding	Jilin Provincial Institute of Apicultural Science	Jilin, Jilin Province	Germplasm preservation in 2.
5. Youquan SHAO	Bee Laboratory, Horticulture Research Institute	Academy of Agricultural Sciences of Shanxi Province	Taiyuan, Shanxi	Management of pollinating colonies in 2.
6. Ting ZHOU	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Director of Pest Control and Product-Quality Monitoring Lab
7. Qin LIANG	College of Honey Bee Sciences	Fujian Agriculture and Forestry University	Fuzhou, Fujian	Pest and disease control in 6.
8. Liming WU	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Pesticide residue and its reduction in 6.
9. Linsheng YU	College of Animal Science & technology	Anhui Agricultural University	Hefei, Anhui	Risk assessment in 6.
10. Jing ZHAO	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Bee product quality control in 6.
11. Bingfeng ZHOU	Honey Bee Ecology Laboratory	Fujian Agriculture and Forestry University	Fuzhou, Fujian	Director of Beekeeping Technology and Tools Lab
12. Zhijiang ZENG	Institute of Honey Bee Research	Jiangxi Agricultural University	Nanchang, Jiangxi	Beekeeping for <i>A. mellifera</i> in 11.
13. Jianke LI	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Migratory beekeeping and tools in 11.
14. Shaoyu HE	Institute of Eastern Honey Bee Research	Yunnan Agricultural University	Kunming, Yunnan	Hive bodies and honey combs in 11.
15. Baohua XU	College of Animal Sciences and Veterinary Medicine	Shandong Agricultural University	Taian, Shandong	Nutrition and feed in 11.
16. Fuliang HU	College of Animal Sciences	Zhejiang University	Hangzhou, Zhejiang	Director of Product Processing and Development Lab.
17. Wenjun PENG	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Deep processing in 16.
18. Jie DONG	Institute of Apicultural Research	Chinese Academy of Agricultural Sciences	Beijing	Utilization of bioactive components in 16.
19. Xiaoqing MIAO	College of Honey Bee Sciences	Fujian Agriculture and Forestry University	Fuzhou, Fujian	Product development for human health.
20. Zhijun ZHAO	Institute of Agricultural economics and development	Chinese Academy of Agricultural Sciences	Beijing	Economics of bees and beekeeping.

Table 2. Names and locations of honey bee experimental stations funded by the Earmarked Fund for Chinese.

Modern Agro-industry Technology Research System (**CARS45**). Each of these scientists receives 500,000 RMB (~83,000 USD per year 2011–2015. Eleven of them received 300,000 per year during 2008 to 2010. Total funding for all experimental stations ~10.2 million USD. Funding amounts were obtained from Wu (2009). Names were obtained from <http://finance.people.com.cn/GB/8215/47807/59262/14712388.html>.

Name (first, LAST)	Station Name	Upper Administration	City, Province
21. Jinzu LIU	Beijing Experimental Station	Beijing Apiculture Company	Beijing
22. Yingsheng ZHANG	Jinzhong Experimental Station	Bee Breeding Apiary	Jinzhong, Shanxi
23. Chunying YUAN	Xingcheng Experiment Station	Safety Supervision Bureau of Animal Production	Shenyang, Liaoning
24. Qingsheng NIU	Jiling Experiment Station	Jilin Provincial Institute of Apicultural Science	Jilin, Jilin province
25. Fuchao GAO	Mudang River Experimental Station	Heilongjiang Academy of Agricultural Sciences	Ha'rbín, Heilongjiang
26. Ting JI	Yangzhou Experimental Station	Yangzhou University	Yangzhou, Jiangsu
27. Qiyun HUA	Jinhua Experimental Station	Academy of Agricultural Sciences of Jinhua	Jinhua, Zhejiang
28. Xiangjin MENG	Hefei Experimental Station	Master Station of Animal Husbandry Technology Promotion	Hefei, Anhui
29. ikun ZHANG	Taian Experimental Station	Bee Breeding Center of Shandong Province	Taian, Shandong
30. Zhongyin ZHANG	Xinxiang Experimental Station	Henan Institute of Science and Technology	Xinxiang, Henan
31. Yanting LI	Wuhan Experimental Station	Baochun Royal Jelly Company	Wuhan, Hubei
32. Yuexiong LUO	Guangzhou Experimental Station	Guangdong Institute of Entomology	Guangzhou, Guangdong
33. Zheng XU	Nanning Experimental Station	Guangxi Zhuang Autonomous Region Beekeeping Advising Center	Nanning, Guangxi
34. Jinglin GAO	Danzhou Experimental Station	Chinese Academy of Tropical Agriculture Environment and Plant Protection Institute	Danzhou, Hainan
35. Rongguo DAI	Chongqing Experimental Station	Chongqing Academy of Animal Husbandry	Chongqing, Sichuan
36. Shunhai WANG	Chengdu Experimental Station	Sichuan Apiculture Technology Exploring Institute	Chengdu, Sichuan
37. Xuewen ZHANG	Honghe Experimental Station	Yunnan Agricultural Academy	Kunming, Yunnan
38. Qinrong YANG	Yan'an Experimental Station	Beekeeping Experimental Station of Yan'an	Yan'an, Shanxi
39. Wenzhong QI	Tianshui Experimental Station	Institute of Beekeeping	Tianshui, Gansu
40. Biao WANG	Guyuan Experimental Station	Beekeeping Experimental Station of Guyuan	Guyuan, Ningxia HuiAutonomous Region
41. Shidong LIU	Wulumuqi Experimental Station	Bee Breeding Farm of Xinjiang Uygur Autonomous Region	Wulumuqi, Xinjiang Uygur Autonomous Region

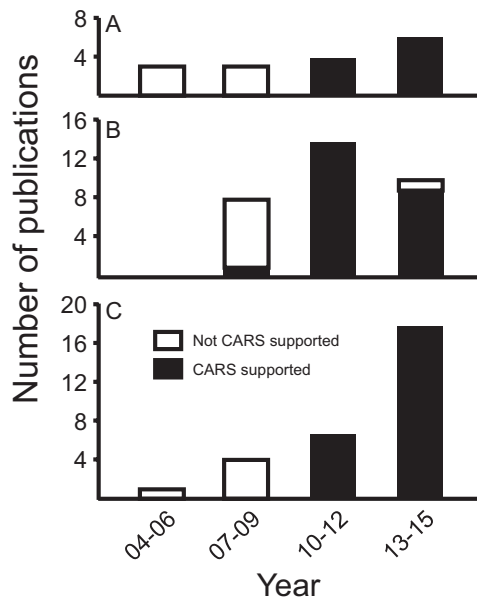


Figure 1. Number of articles published in refereed journals by three scientists in China (Songkun Su, Jianke Li and Zhijiang Zeng, respectively for A, B and C, respectively). Nearly all papers published after 2010 acknowledged CARS funding (dark column).

so that food production by honey bees can be ensured. We therefore welcome this much needed change in the right direction.

Author contributions

ZYH conceived the concept of this paper, SL and XX did data gathering for [Table 1](#) and [Table 2](#). All three wrote the paper.

Competing interests

We declare no competing interests.

Table 3. Comparative investment (millions in USD) into honey bee research in China and USA between 2008 and 2015. Competitive grants are excluded in both countries except the NIFA grants in USA. We used a ratio of 1 USD = 6.1 Chinese Yuan for currency conversion. Data for USA is from [Purcell-Miramontes \(2013\)](#), data for China was obtained from [Wu \(2009\)](#).

China	
1. CARS scientists (Table 1)	19.0
2. CARS stations (Table 2)	10.2
3. Pear Pollination Project	2.5
Total	31.7
USA	
Area-wide program to Honey Bee Labs	5.0
NIFA-CAP (UGA, 20098511805718), competitive (2008)	4.1
NIFA-CAP (BeeInformed, 2011-6700730355), competitive (2011)	5.0
Total	14.1

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I confirm that the funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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