Supplemental Information: Coconut oil, conservation and the conscientious consumer

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Oil crop	IUCN Red List species threatened by crop [S1]	Total oil production (2014) (million tons) [S10]	Total area planted (mha)	Threatened species per million tons oil	Threatened species per mha
Oil palm *Elaeis guineensis*	321	84.8	18.9	3.79	17.0
Soybean *Glycine max*	73	57.2	123.9	1.28	0.6
Rapeseed *Brassica napus* and *B. campestris*	1	27.4	35.5	0.04	0.0
Cotton *Gossypium hirsutum*	35	5.3	32.1	6.6	1.1
Groundnuts or peanuts *Arachis hypogaea*	6	5.9	28.2	1.02	0.2
Sunflower *Helianthus annuus*	1	19.9	26.5	0.05	0.0
Coconut *Cocos nucifera*	66	3.6	12.3	18.33	5.3
Olive *Olea europaea*	14	3.4	9.7	4.12	1.4

Table S1. Number of IUCN Red List threatened species for which the threat text mentions different oil crops as a threat, the total oil production in 2014, and the resulting number of threatened species per million tons of oil and millions of hectares of planted area. Related to Figure 1.

Supplemental Experimental Procedures

IUCN Red List of Threatened Species and threats from oil crops

The Red List of Threatened Species [S1] follows a standardized threat classification scheme to identify and quantify threats (https://www.iucnredlist.org/resources/threat-classification-scheme). The scheme is supported by a detailed narrative in the form of free text which is included in each species assessment (threats details field). There are 11 main threat categories subdivided into over 50 subcategories. These threat categories, however, do not record threats from specific crops. To determine whether a species is threatened by a specific crop the threats details text needs to be read in full.

We downloaded the detailed threat texts for all assessed species from The Red List of Threatened Species website in June 2019. The .csv file retrieved included 101,017 species. We developed an R code to i) filter the original table to retain assessments for threatened species only (Critically Endangered, Endangered, and Vulnerable); ii) identify whether and of a list of crops (see below)

appeared in the threat texts for each assessment. In this way, the code extracted a list with only those species for which the selected terms were found in the threats detailed text.

The terms searched were: palm oil, oil palm, palm plantation, maize, corn, coconut, coconuts, peanut, peanuts, groundnut, groundnuts, olive, olives, rapeseed, canola, soy, soybean, soybeans, and cotton. The search was not case sensitive and did not pick up these terms within a word (i.e. Oliveira). For full details of the R code see GitHub repository: https://github.com/DiegoJuBi/R_codes/blob/master/species_threats_oil_crops.

We obtained a list of 650 species for which at least one of the key words was present in the detailed threat texts. We then read all those texts to confirm whether the species was actually threatened by that crop. Our final list included 614 threatened species. Most exclusions were due to common names of species including the terms searched (e.g., New England Cottontail *Sylvilagus transitionalis*, or Autumn Olive *Elaeagnus umbellata*). In other cases, although the selected crops were mentioned in the text, it was not made clear in that text whether or not these posed a major threat to the species. The resulting information was used to create and Figure 1 in the main text. Data S1B show the 66 species for which coconut was identified as a key threat.

Dominant crop analysis

We downloaded the raster layers as GeoTIFF files for the harvested area for the main oil crops, except for olives, as processed products from the SPAM 2010 v1.1 Global Dataset [S2]. Harvested area is the crop-specific data representing number of hectares harvested per land-area of a grid-cell in 2010. In addition to the physical area, harvested area also accounts for multiple harvests of a crop on the same plot. The harvested area is calculated for each production system and the sum of all harvested areas of all production systems in a pixel is the total harvested area of the pixel.

Olive harvested area was not available from the SPAM dataset and was instead downloaded as GeoTIFF files from the EarthStat harvested area dataset [S3]. In EarthStat harvested area is calculated as crop-specific data representing the average number of hectares harvested per land-area of a grid-cell during the 1997-2003 era.

Although the olive data is from a different source, the data sets are comparable. Both data sets rely on a collection of relevant spatially explicit input data, including crop production statistics, cropland data, suitability assessments, population density, as well as any prior knowledge about the spatial distribution of specific crops or crop systems. Some of the data is year specific, while other data is not really tied to a year, such as suitability assessment. It is, however, important to note that olive harvested area distribution is based on an older data set and this may introduce bias to some degree. According to FAOSTAT the area harvested for olives increased from 8.4 million hectares in 2000 (the year represented in EarthStat data) to 9.9 million hectares in 2010 (the year represented in SPAM data). However, most of this growth took place in areas where olive was determined to be the dominant crop such as Morocco and Spain. Therefore, the year mismatch between olive and other crop data will not impact the results for an area's dominant oil crop.

All rasters downloaded had a five-arc-minute by five-arc-minute grid-cell resolution (approximately 10 x 10 km at the equator). We developed an R script to determine which of the

oil crops under consideration has the largest harvested area per raster cell and assigned each cell to that dominant crop. For full details of the R script see GitHub repository: https://github.com/jabrams23/cropcomparison/blob/master/determine_dominant_crop.R

Supplemental Results on Coconut expansion and biodiversity impacts

A brief literature review provided some example of coconut being a major local driver of deforestation: Western Samoa [S4], central Indonesia [S5], Vanuatu [S6] and Bangalore, India [S7].

In 49 out of 95 (52%) countries that produce coconut (Data S1A), the area allocated to coconut had expanded between 2014 and 2017, although it is unclear how much deforestation was involved. Countries that stood out for a high coconut expansion rate and a high number of threatened species included the biggest coconut producers Indonesia and the Philippines, countries like Tuvalu and Kiribati with large percentages of their land cultivated for coconut and relatively high numbers of threatened species, and Vanuatu with significant annual expansion of coconut cultivation (Data S1A).

Supplemental References

S1. IUCN (2019). The IUCN Red List of Threatened Species. Version 2019-2. https://www.iucnredlist.org. (Gland, Switzerland).

S2. International Food Policy Research Institute (2019). Global Spatially-Disaggregated Crop Production Statistics Data for 2010 Version 1.1. https://doi.org/10.7910/DVN/PRFF8V, Harvard Dataverse, V3.

S3. Monfreda, C., Ramankutty, N., and Foley, J.A. (2008). Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles *22*.

S4. Paulson, D.D. (2009). Understanding tropical deforestation: the case of Western Samoa. Environmental Conservation *21*, 326-332.

S5. Chomitz, K.M., and Griffiths, C. (1996). Deforestation, shifting cultivation, and tree crops in Indonesia: Nationwide patterns of smallholder agriculture at the forest frontier. (Washington, DC: World Bank).

S6. Siméoni, P., and Lebot, V. (2012). Spatial representation of land use and population density: Integrated layers of data contribute to environmental planning in Vanuatu. Hum Ecol *40*, 541-555.

S7. Adhikari, S., Fik, T., and Dwivedi, P. (2017). Proximate causes of land-use and land-cover change in Bannerghatta National Park: A spatial statistical model. Forests *8*, 342.

S8. FAOSTAT (2019). Food and agriculture data. http://www.fao.org/faostat/en/#home. (Rome, Italy: Food and Agriculture Organization of the United Nations).

S9. FAO (2016). Global Forest Resources Assessment 2015. How are the world's forests changing? Second edition. (Rome, Italy: Food and Agricultural Organization of the United Nations), p. 44.

S10. USDA (2019). Oil Crops Yearbook - USDA ERS. World Supply and Use of Oilseeds and Oilseed Products.