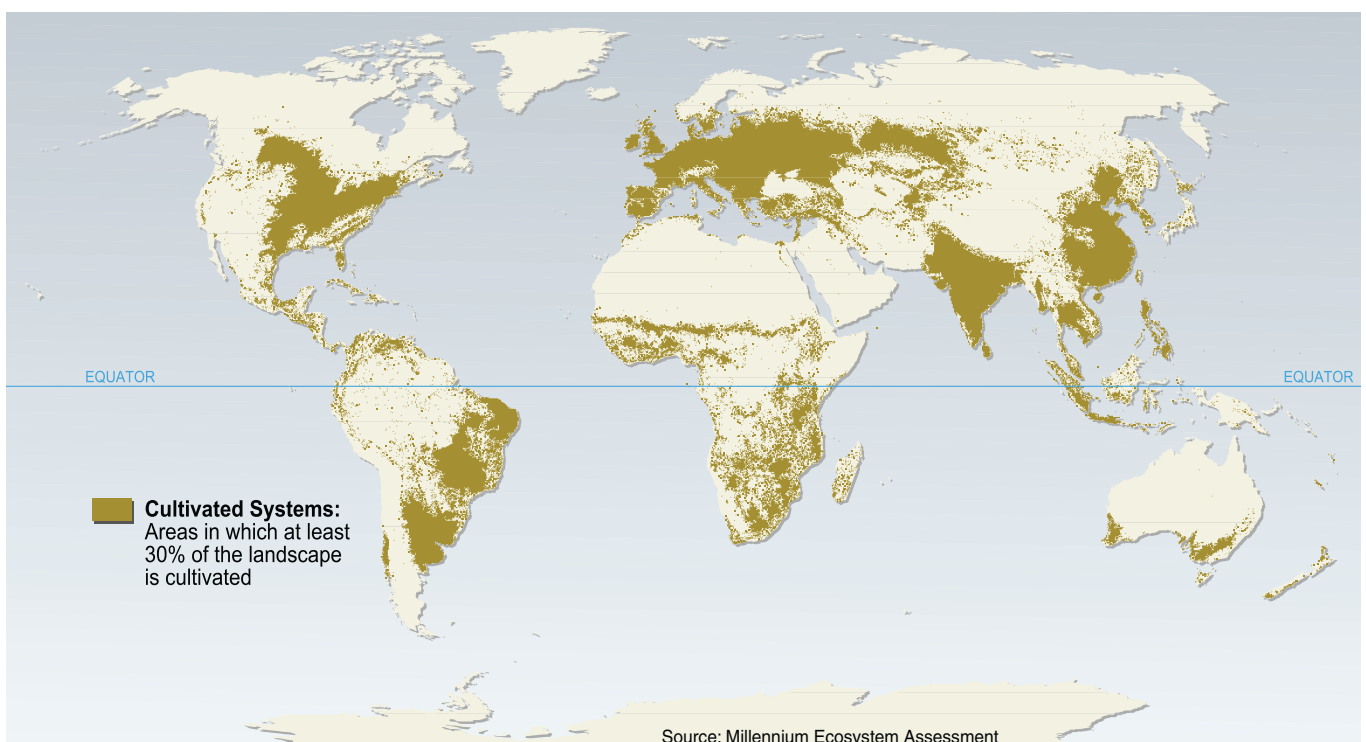


Modelling provisioning services and their relationship with socio-ecological factors in Japan

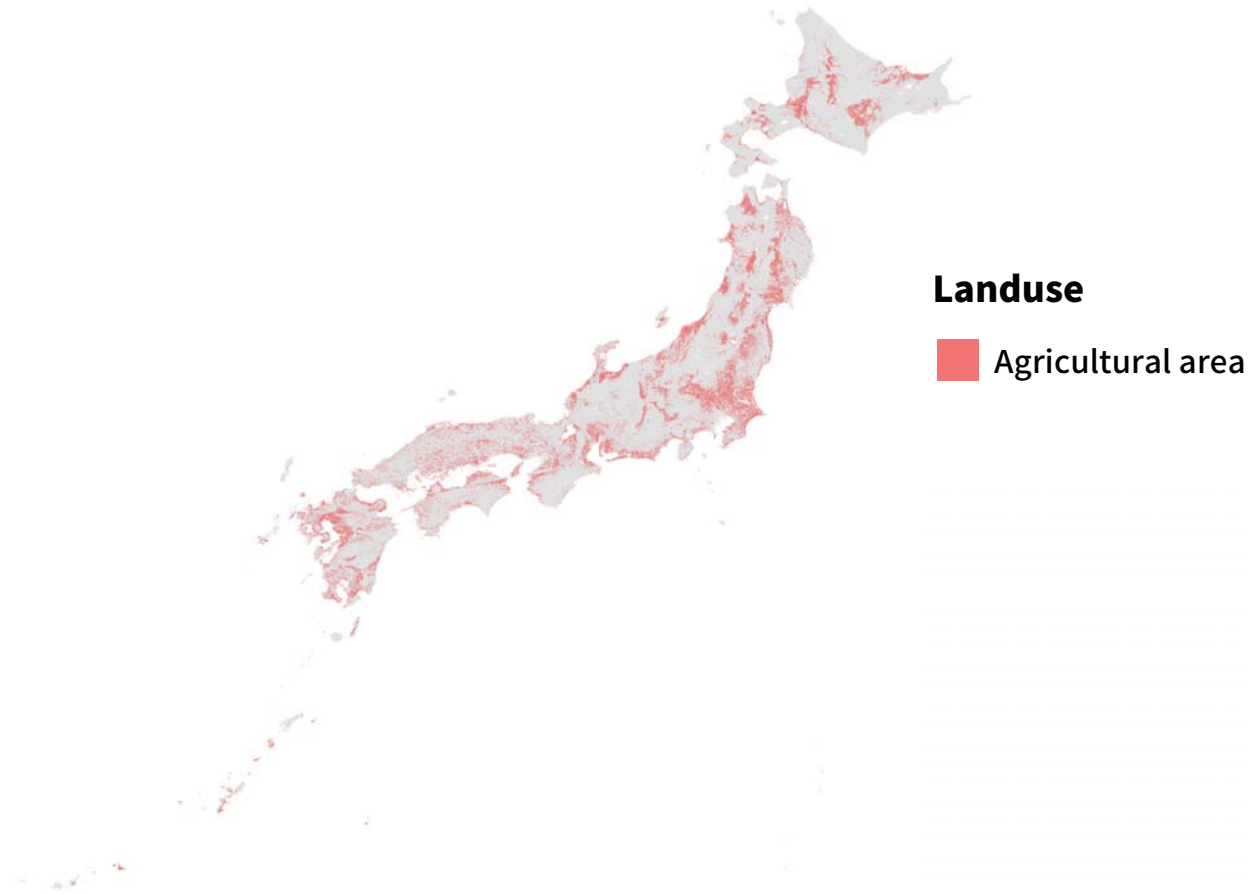
Michio Oguro (小黒 芳生), Hisatomo Taki, Takuya Furukawa, Hiroko Kurokawa, Takashi Masaki

Agricultural land covers ca. 24% of the world.



Millenium Ecosystem Assessment 2005

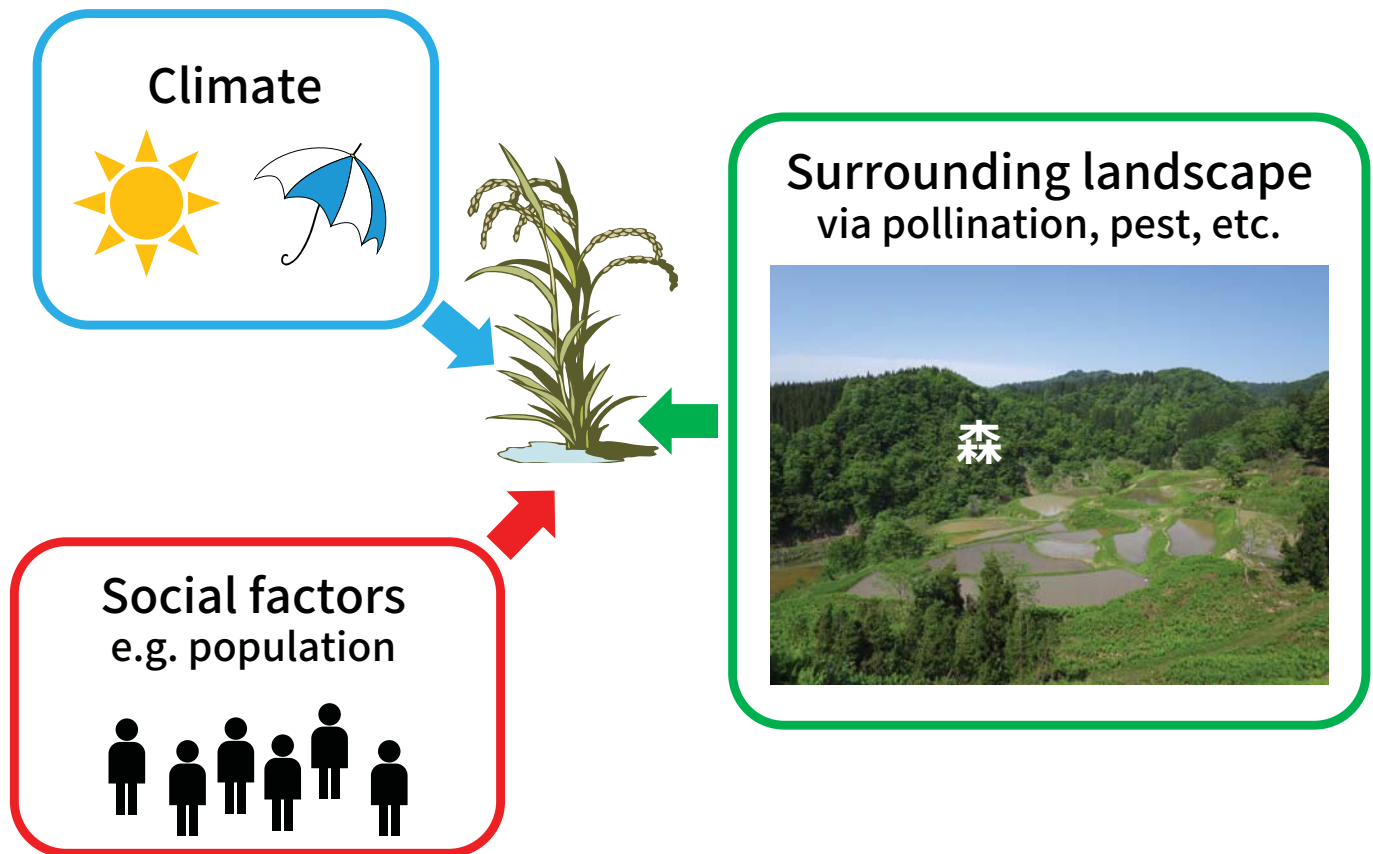
In Japan, it covers 11.8% of the nation.



Crop production

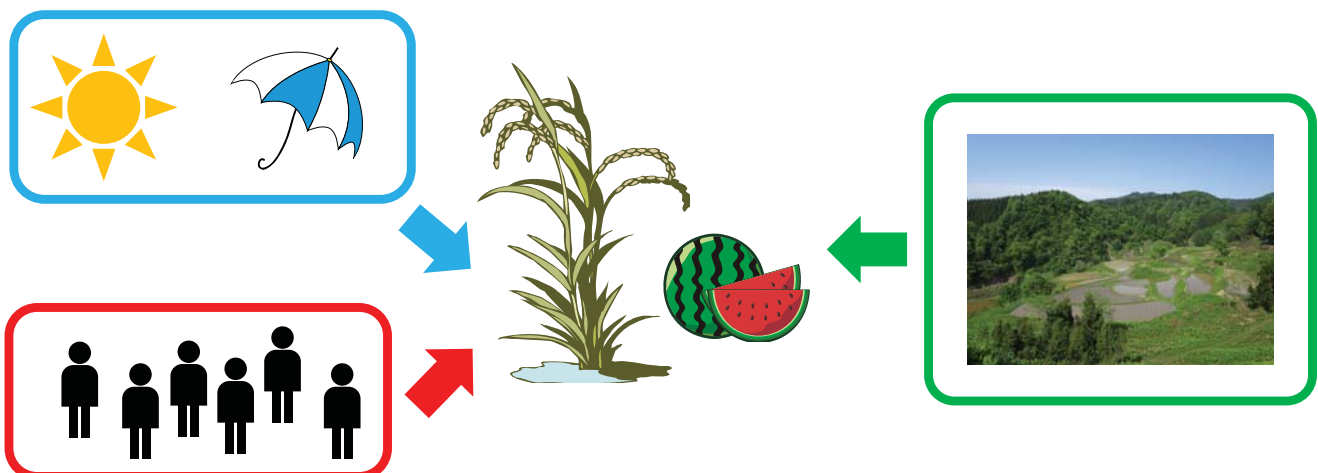
- Important ecosystem service for human society.
- Historically, intensification of agriculture and expansion of cropland have been degraded other ecosystem services (ESs).
- To understand relationship between other ESs and to predict future crop production, understanding factors affecting crop production is important.

Factors affecting crop production

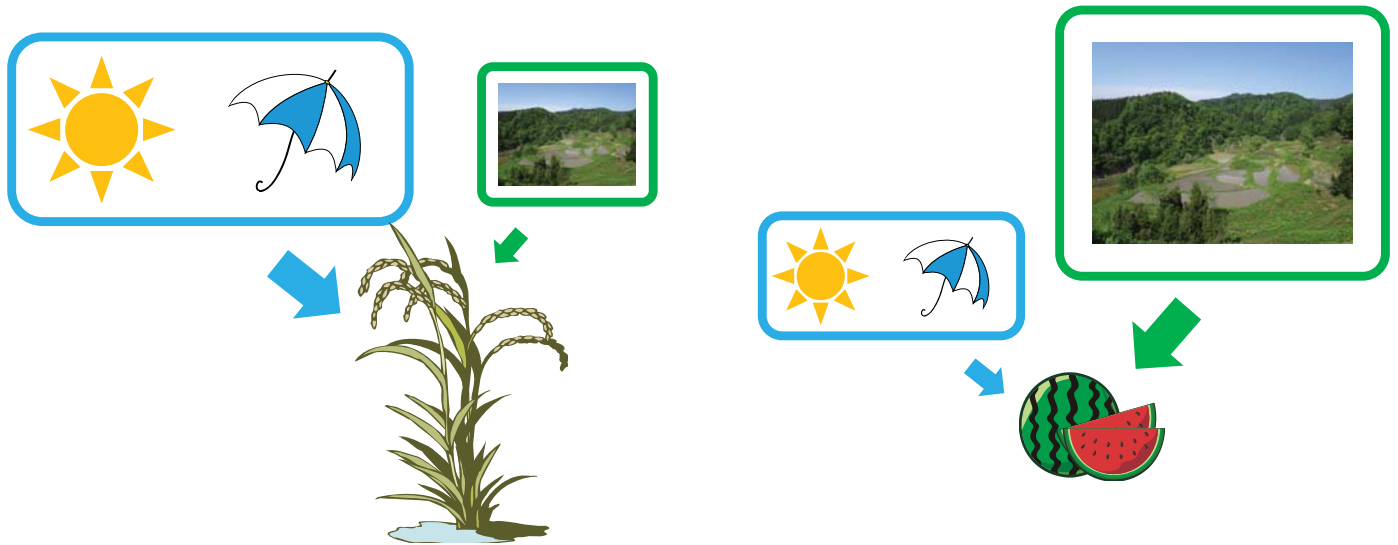


Objective 1

Understanding factors affecting crop production.

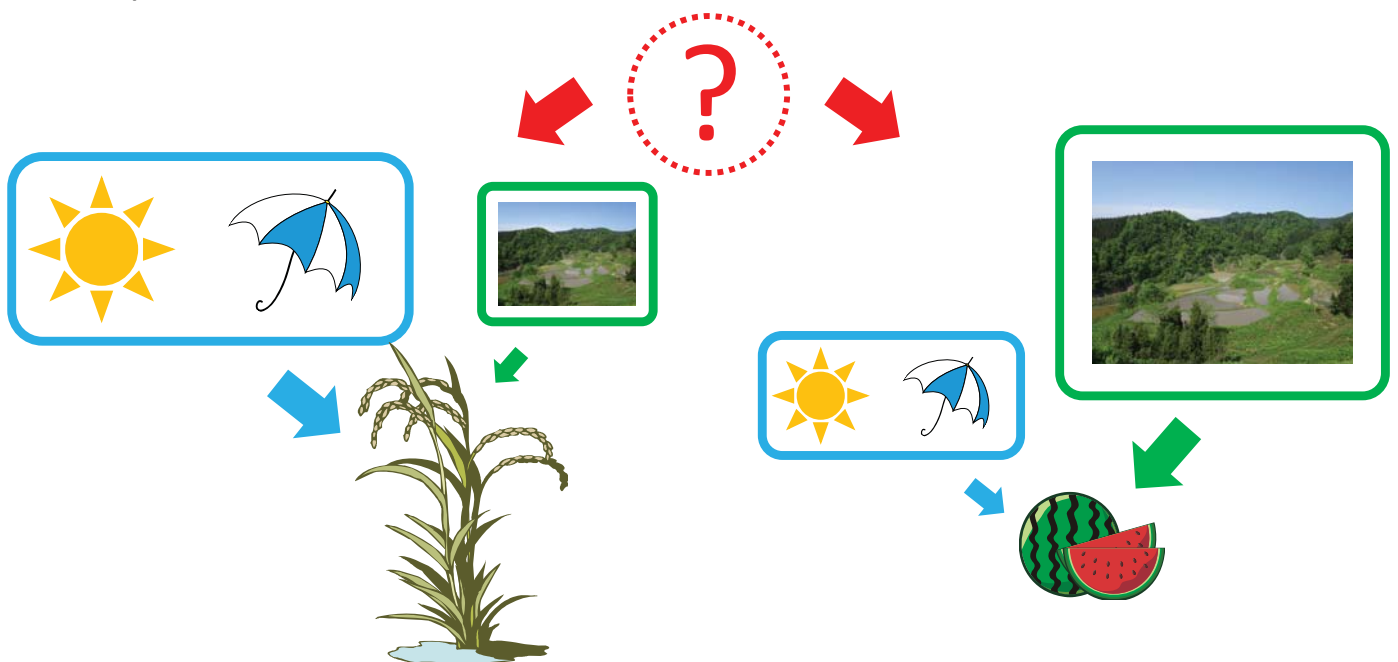


Difference among crops



Relative importance of factors can be different among crop species.

Objective 2



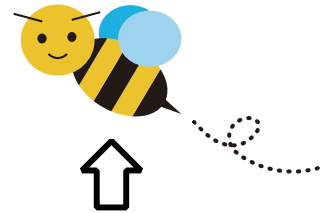
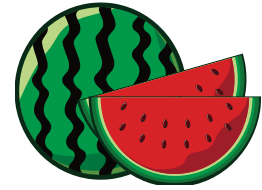
Finding factors explaining difference between crops.

Pollinator dependence

Low



High



Relationship with environmental factors especially landuse patterns and crop production can be different depending on pollinator dependence.

Methods



The crop production data

- Government statistics of crop production for municipalities.
- 1993-2016 (different among crop species).
- 40 fruit or seed crop species including fruits, vegetables and grains.



The crop species

- **Pollinator dependent crops (30)**

Pumpkin, Kiwi fruit, Watermelon, Melon, Ume, Cherry, Chestnut, Prune, Buckwheat, Loquat, Peach, Apple, Pear, Japanese pear, Strawberry, Edamame, Eggplant, Soybean, Iyokan, Common bean, Persimmon, Cucumber, Green bean, Tomato, Natsumikan, Navel orange, Hassaku orange, Unshu mikan, Peanut, Adzuki bean

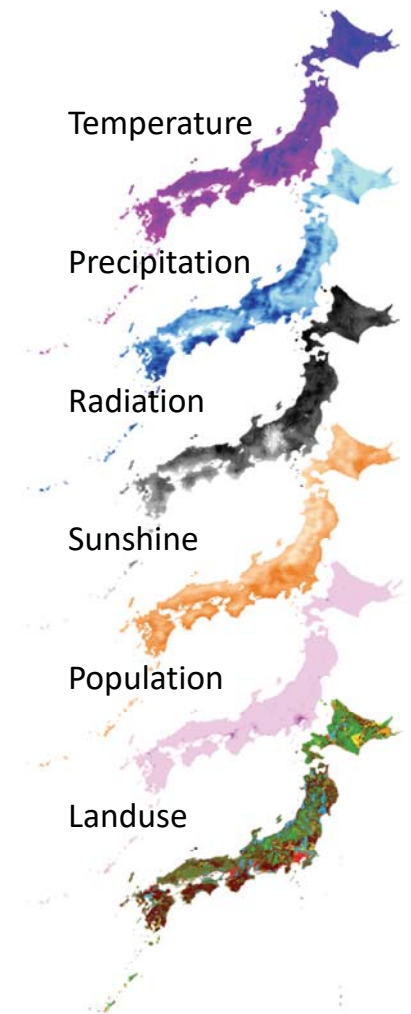
- **Pollinator independent crops (10)**

Podded pea, Corn, Green pepper, Grape, Wheat, Paddy rice, Two-rowed barley, Naked barley, Upland rice, Six-rowed barley

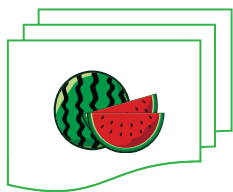


The explanatory variables

- **Climate (1km grid)**
 - Mean annual temperature
 - Annual precipitation
 - Solar radiation
 - Sunshine duration
- **Population (1km grid)**
- **Landuse (1km grid)**



Data processing



1. Converted crop production data into 1km grid.

Precipitation Temperature Radiation Sunshine duration

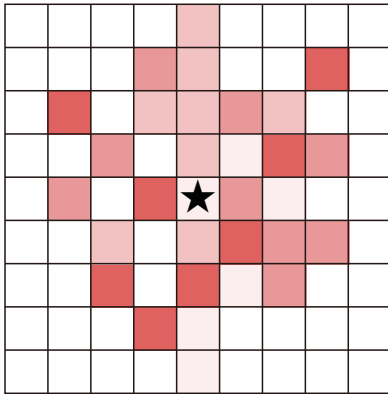


2. Overlaid climate data for crop land pixels.

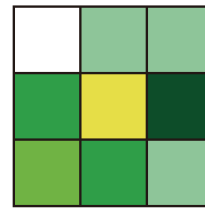
These were done for each year.

Data processing

3. Calculated surrounding population within 9km grid.



4. Calculated landuse adjacent to cropland.



1. Grassland
2. Plantation
3. Secondary forest
4. Old-growth forest

These were done for each pixel.
Same data for all years.

Model

Random Forest (Machine learning method)

Response variable:

Unit production (t/ha)

Explanatory variable:

Climate, Population, Landuse

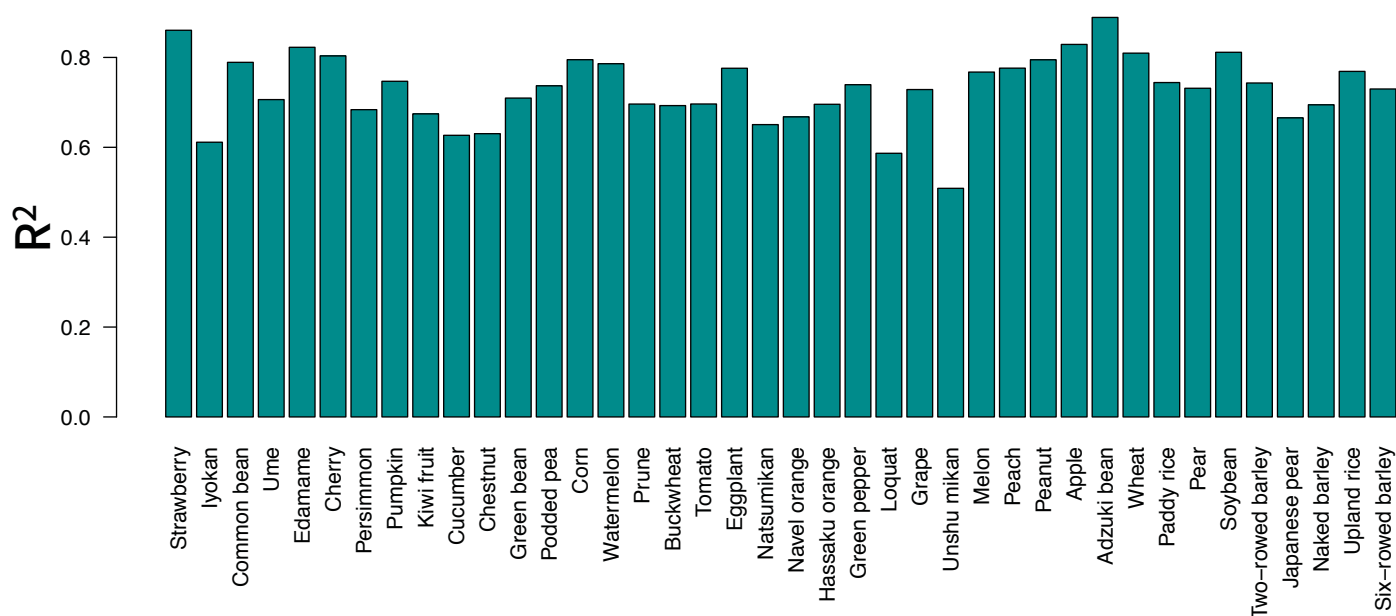
→ Using the models, we calculated model fit, relative importance of the explanatory variables.

Results and Discussions

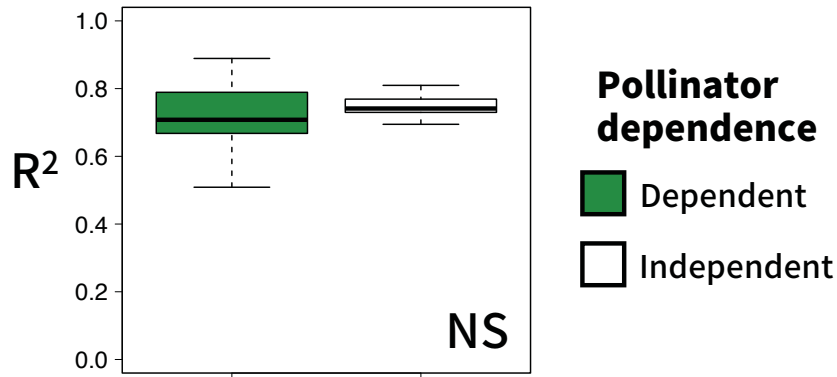


Explanatory power of the models

R^2 differed among the crops.

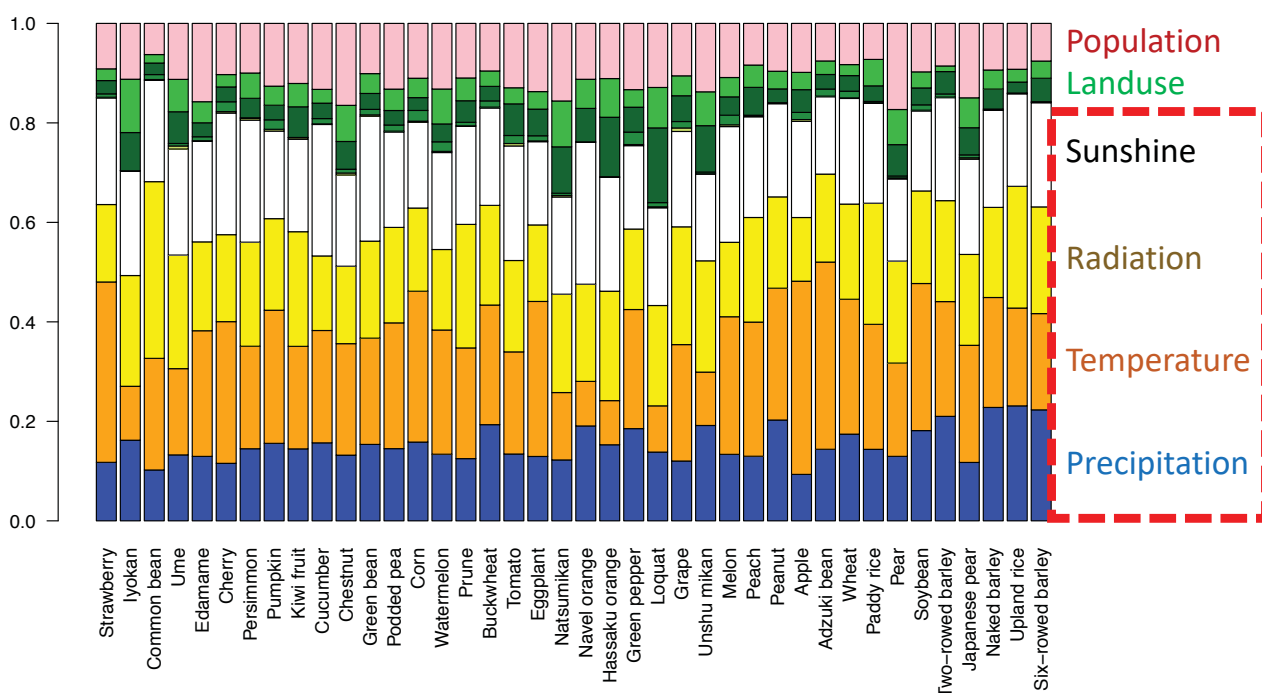


Can pollinator dependence explain the difference in model fit?



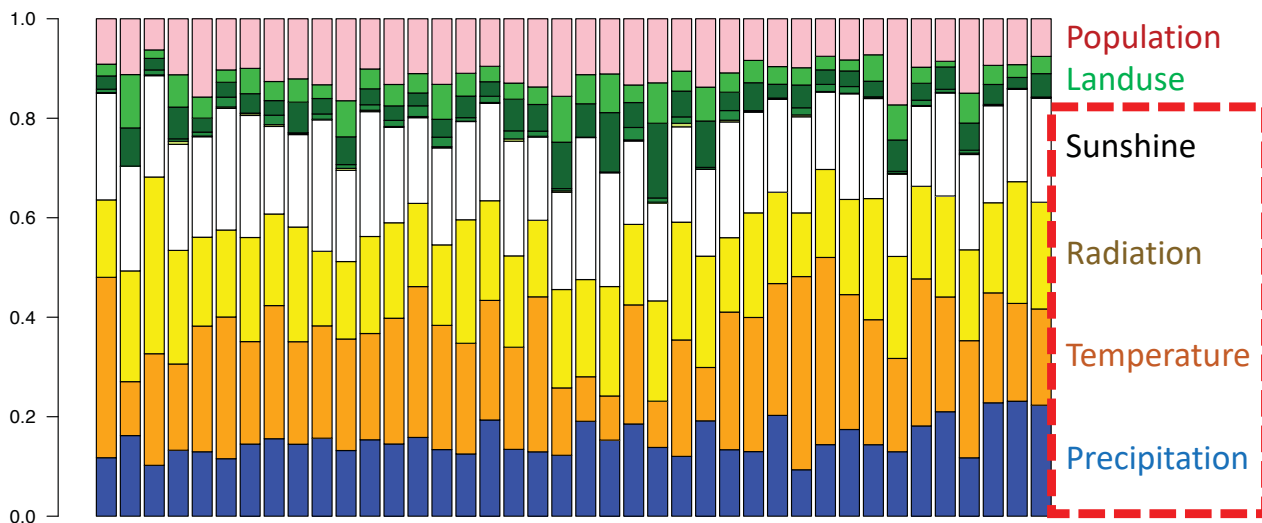
→ No

Relative importance of the variables



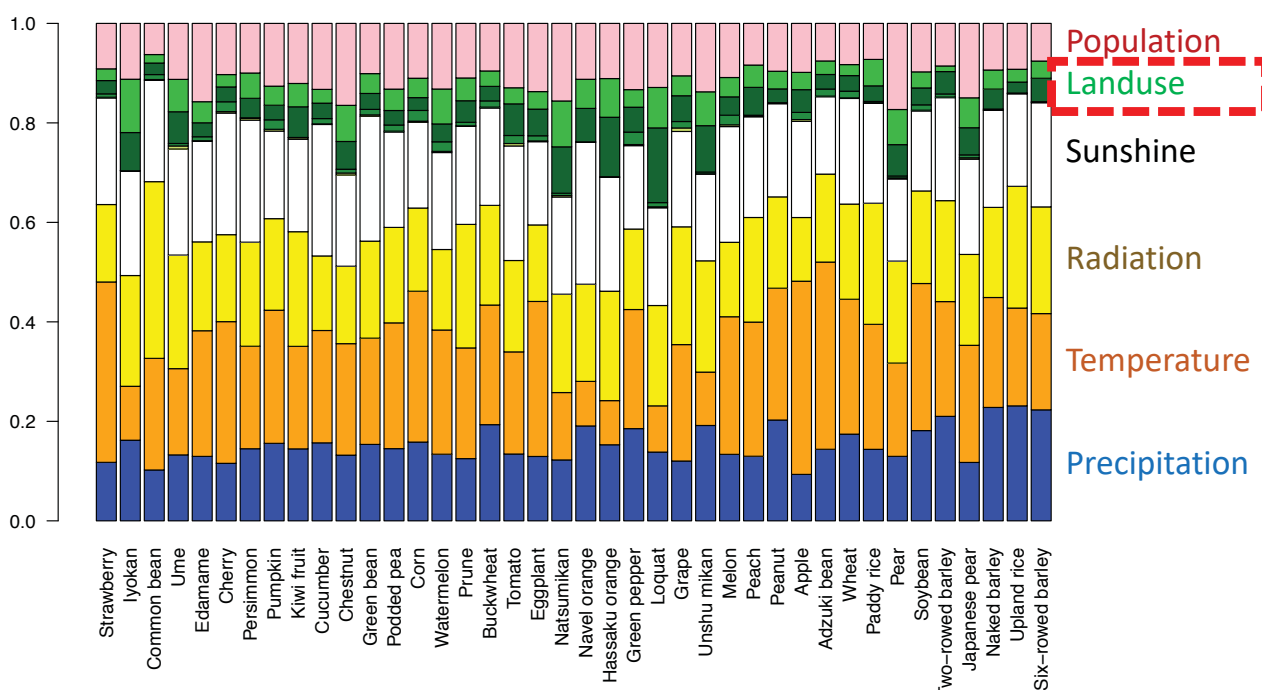
Climatic factors were most important for crop production.

Relative importance of the variables



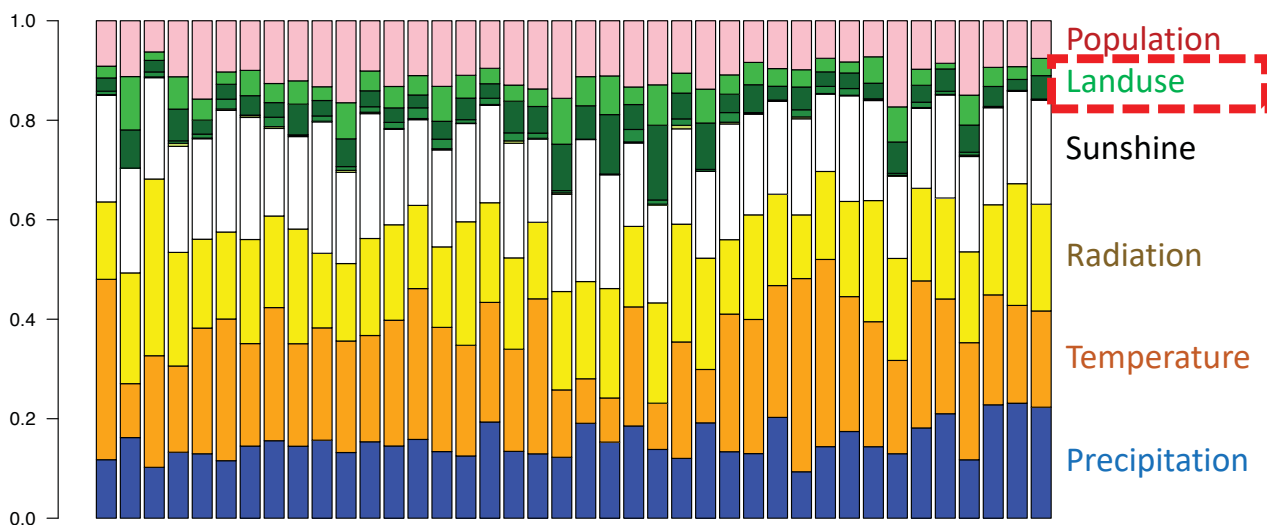
- Apparently climate change will affect production without any mitigation measures.
- For modeling future crop production, incorporating climate change is important.

Relative importance of the variables



Adjacent landuse was not important for most crops.

Relative importance of the variables

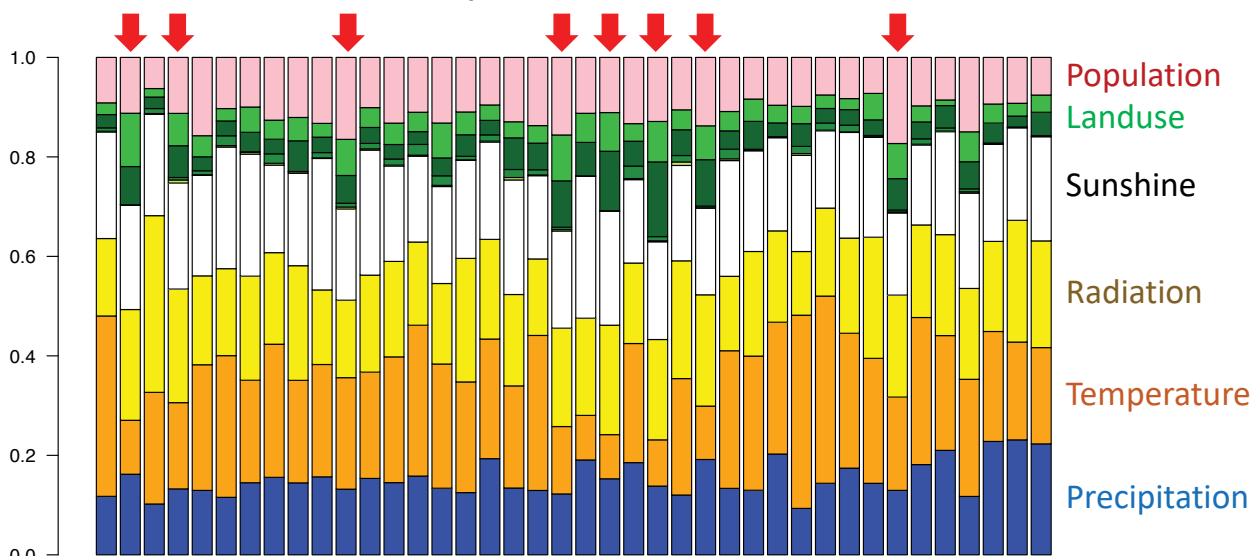


Spatial resolution of landuse data was 1km.

→ Too coarse for evaluating effects of landuse structure for crops.

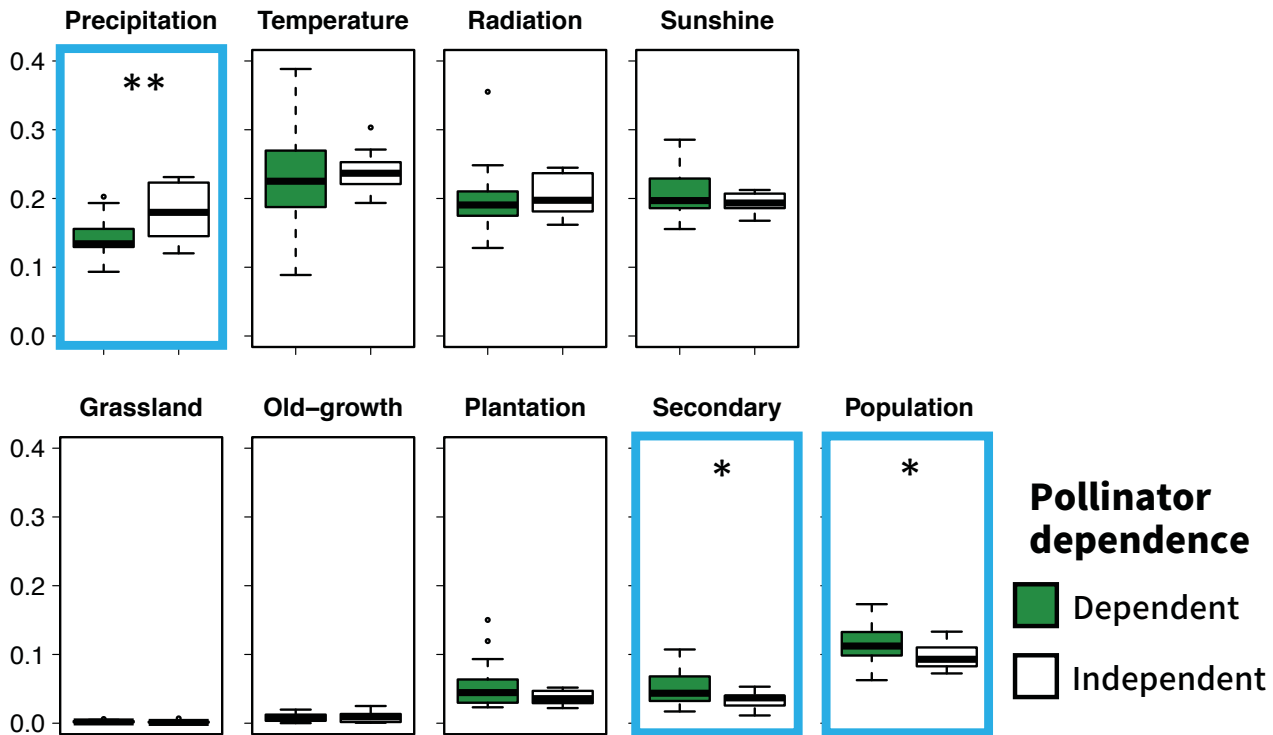
→ Improving data and models are required.

Relative importance of the variables

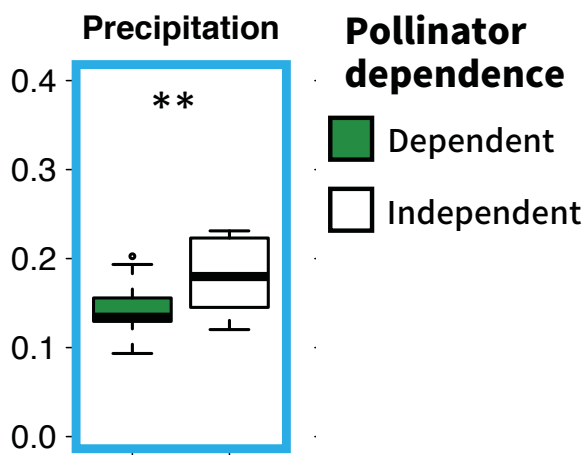


→ So, can pollinator dependence explain these interspecific differences?

Can pollinator dependence explain difference in relative importance?



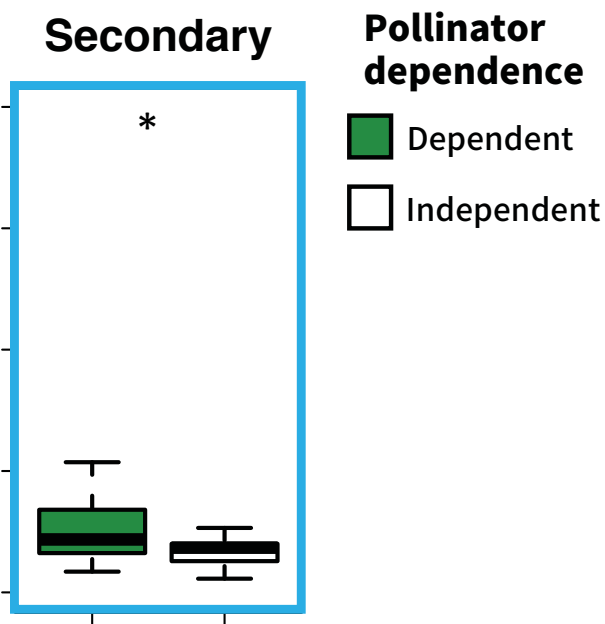
Pollinator dependent crops were less affected by precipitation



Possible hypothesis:

Pollinator dependent crops tend to be grown in green houses so that are not affected by precipitation.

Pollinator dependent crops were more affected by secondary forest

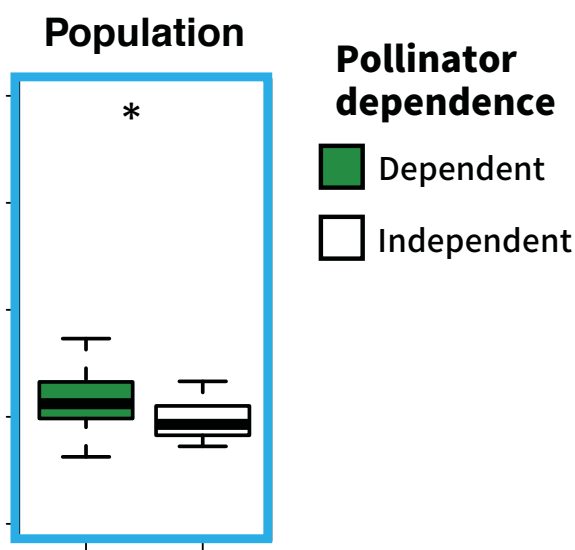


Possible hypothesis:

Secondary forests retain nests/food resources of pollinators (bees).

→ But more investigation is required.

Pollinator dependent crops were more affected by surrounding population



Possible hypothesis:

Some pollinator dependent crops receive hand-pollination in Japan.

→ Population represented intensity of hand-pollination?

→ But it's just a speculation.

Conclusions

- Climatic factors had largest effects on crop production in Japan.
- But landuse pattern is also important for some species.
- Detailed analysis of landuse pattern is required.

Thanks for your
attention!!



Acknowledgement:

- Yasushi Ishigooka for providing climate data
- Ministry of Agriculture, Forestry and Fisheries for providing crop production data.
- Kikuko Shoyama for providing landuse data.
- Takanori Matsui for providing population data.
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