Impact of Culture and Religion on India's Food Phosphorus Footprint

Aurup Ratan Dhar[1,*], Azusa Oita[2], Kazuyo Matsubae[1]
[1]Graduate School of Environmental Studies, Tohoku University, Japan
[2]National Agriculture and Food Research Organization, Japan
*Email: aurup.ratan.dhar.p2@dc.tohoku.ac.jp

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Background

- Phosphorus (P) is widely used in the agriculture sector, mostly as fertilizers
- Only 20% of mined P is actually consumed as food, the remaining is lost in the environment
- Food P footprint is controlled by multiple stimuli including culture and religion

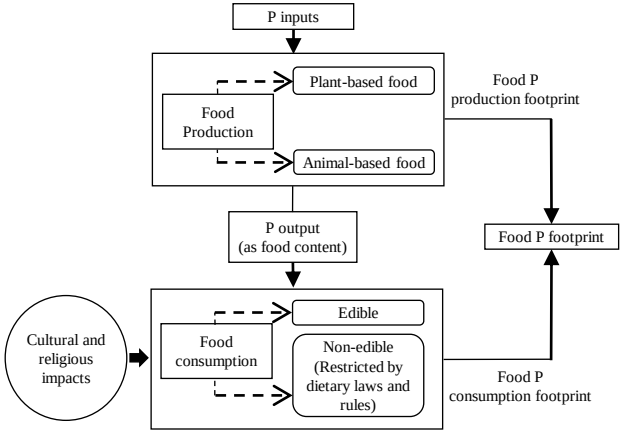

Figure 1: Religious dietary culture affecting food N and P footprint

- This study takes the first step toward estimating India's food P footprint considering diversified religions and food cultures

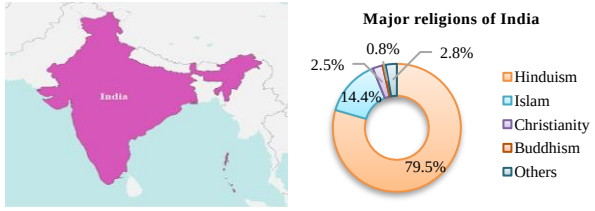

Figure 2: Geographical position and religious variation of India

Materials and Methods

- Major religions considered:

  Hinduism Islam Christianity Buddhism

- Food taboos by religions*:

Lacto-vegetarian	Vegetarian	Non-vegetarian
- Hindus	- Buddhists	- Muslim, Christians and Others (remaining as combined)

*Note: Strict dietary framework adopted from Kittler et al. (2016) and Fieldhouse (2017)

- Data source and time boundary:

  FAO Food Balance Sheet (1961-2013)

- Analytical techniques:

  ➢ P footprint analysis:

  Religious Sensitive N-Calculator

$$PF_{tot} = \sum_{i=1}^{n}\sum_{j=1}^{m} W_j(PF_{prod_{ij}}) + \sum_{i=1}^{n}\sum_{j=1}^{m} W_j(PF_{cons_{ij}}),$$

$$PF_{prod_{ij}} = Fd_{sup_{ij}} \times Fd_{Pcont_i} \times \left(1 - Fd_{wst_i}\right) \times VPF_{trade_i},$$

$$PF_{cons_{ij}} = Fd_{sup_{ij}} \times Fd_{Pcont_i} \times \left(1 - Fd_{wst_i}\right),$$

  ➢ Forecasting analysis:

  Long Short-term Memory Recurrent Neural Network (LSTM-RNN) approach

$$f_t = \sigma(W_f[h_{t-1}, X_t] + b_f),$$
$$i_t = \sigma(W_s[h_{t-1}, X_t] + b_s) \times \tanh(W_n[h_{t-1}, X_t] + b_n),$$
$$C_t = C_{t-1}f_t + i_t,$$
$$o_t = \sigma(W_o[h_{t-1}, X_t] + b_o),$$
$$h_t = o_t\tanh(C_t),$$

Results and Discussion

- ❑ Total food P footprint in 2013: **1852 Gg-P year^{-1}**
- ❑ Individual's mean food P footprint in 2013: **1.48 kg-P capita^{-1} year^{-1}**

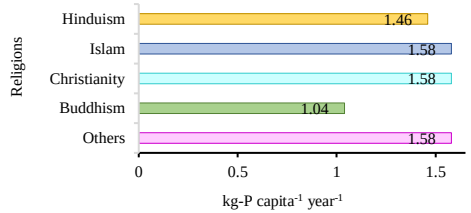

Figure 3: Individual's food P footprint in 2013

- ❑ Lower food P footprints: **Buddhists followed by Hindus**
- ❑ Higher food P footprints: **Muslims, Christians, and others**

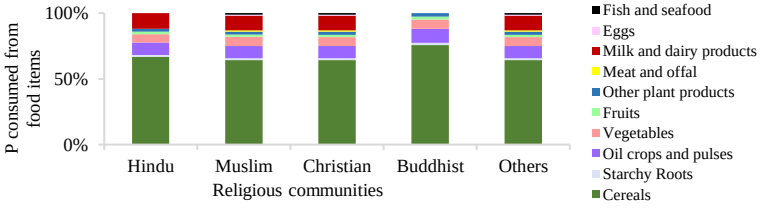

Figure 4: P consumed from food by religion in 2013

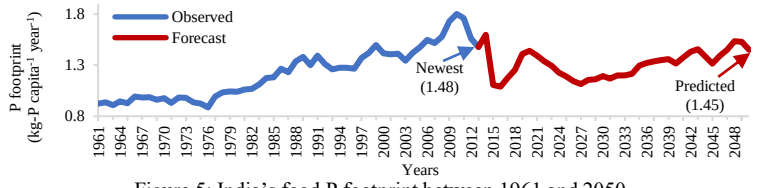

Figure 5: India's food P footprint between 1961 and 2050

Conclusion and Recommendations

- ✓ Religious food cultures are important factors for keeping the P footprint of India in a relatively low level
- ✓ The study recommends promoting public awareness through the following measures:
  - i. Engaging leaders to educate the followers about balanced diet;
  - ii. Recycling waste items in the form of organic fertilizers; and
  - iii. Supporting wastewater treatment keeping divine purity