# Relieving agricultural GHG stress: the transition of staple food strategy in China

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# Outline

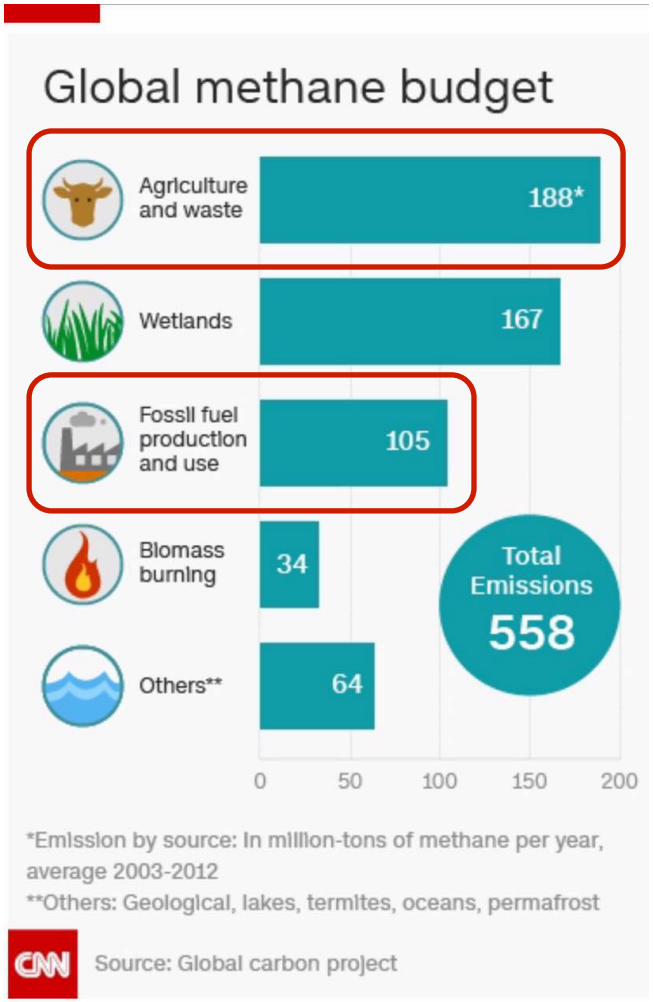
1 Introduction

2 Methodology

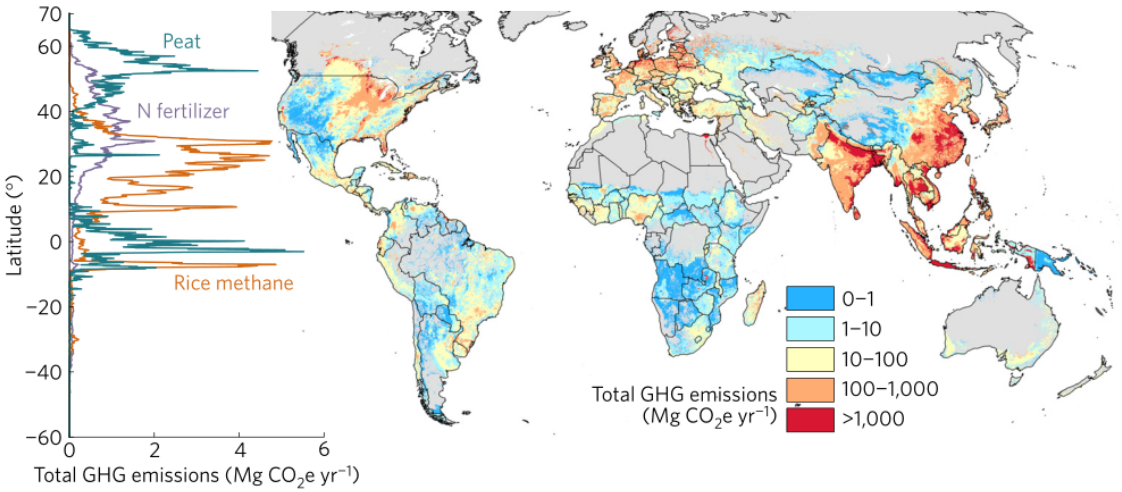
3 Results and discussion

4 Conclusion

# Challenges of GHGs emission of Agriculture and Waste




Crop and livestock production is responsible for up to **1/3** total anthropogenic GHG emissions. (Vermeulen S. J., et al, 2013)




China accounts for 17% of global agricultural emissions. (Kimberly M. C., et al, 2017)

Currently agriculture GHGs are not well studied on regional and national level.

- ✓ Difference on energy and material input
- ✓ Geographical difference
- ✓ Crop management
- ✓ Crop structure

# Transition of Staple Food strategy in China

## Structure of staple food in China(2006-2015)

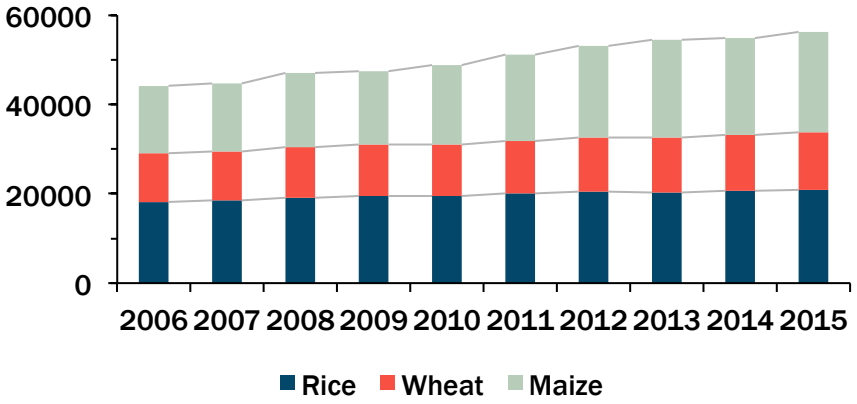



Fig1. Yields (10 thousand tons yr-1) for 3 staple crops

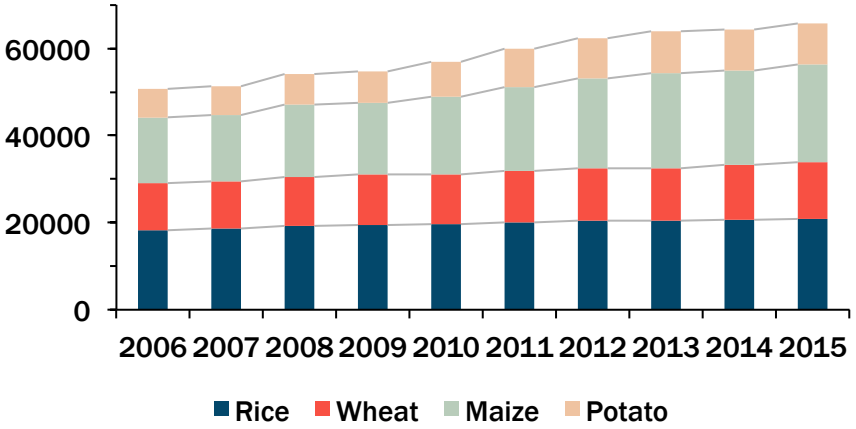



Fig2. Yields (10 thousand tons yr-1) for 4 staple crops

Ratio of potato : 12.7%(2006)→14.5%(2015)
Potato yield Increases: 47.1%(2006-2015)

## Potato staple food strategy in China

农业部关于推进马铃薯产业开发的指导意见

**Potato industry development instructions**
**2016.04**

北京、河北、内蒙古、黑龙江、上海、浙江、江西、湖北、广东、四川、贵州、陕西、甘肃、宁夏等省、自治区、直辖市农业（农牧）厅（委、局）：

为贯彻落实中央1号文件精神和新形势下国家粮食安全战略部署，推进农业供给侧结构性改革，转变农业发展方式，加快农业转型升级，把马铃薯作为主粮产品进行产业化开发，树立健康理念，科学引导消费，促进稳粮增收、提质增效和农业可持续发展。现就推进马铃薯产业开发提出如下意见。

Benefit of potato staple food

- **more food for the population**
- more healthy for consumers
- more income for farmers

Agriculture faces great challenges to ensure food security by increasing yields while reducing environmental costs.

# Research Question

- **Will the transition of staple food strategy in China contribute to GHG reductions? What about in global level?**

✓ Difference on energy and material input
✓ Yield difference
✓ Crop management
✓ Crop structure
✓ GHG leakage

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# GHGs emission of planting systems

Life Cycle Analysis

Uncertainty (McKone T. E., et al, 2011)

System boundary (Suh, S., et al, 2004; Suh, S., et al, 2005)

Emission factors (Chen H., et al, 2013; Hu N., et al, 2016; Xu S.P., et al, 2007)

Crop management practices (Tilman D., et al, 2006; Chen X., et al, 2014)

**Main Data source**

| Crops | Region | Data | Sources |
|---|---|---|---|
| Rice<br>Wheat<br>Maize<br>Potato | 31 provinces (mostly in city level) in China mainland | Area harvested<br>Production | China Rural Statistical Yearbook |
| | | Input of fertilizer and plastic film | Compilation of the National Agricultural Costs and Returns |

# GHGs emission of planting systems

## Life Cycle Analysis

### System boundary & emission components

1. $CH_4$ emission during crop planting
2. $N_2O$ emission during fertilizer application
3. GHG emissions during the production and transportation of agricultural inputs

### Uncertainty identification

- $CH_4$ and $N_2O$ emission factor
- Crop management practices

### Function unit

- Production intensity (Mg $CO_2$e M $kcal^{-1}$)

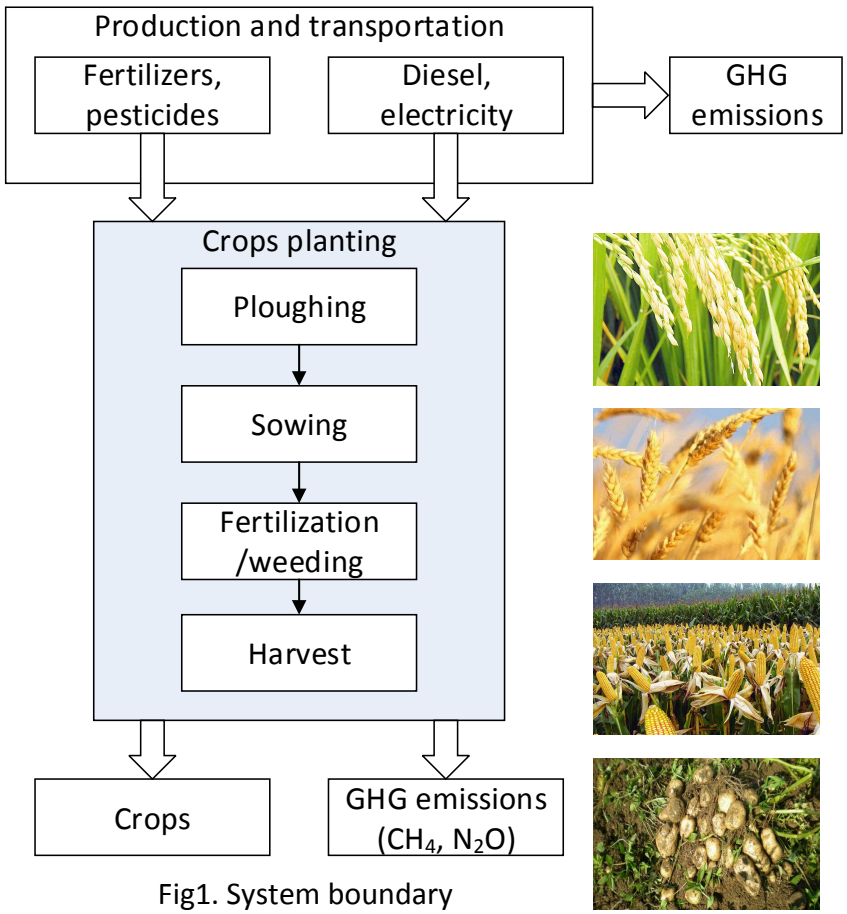



Fig1. System boundary

# Transition of staple food structure

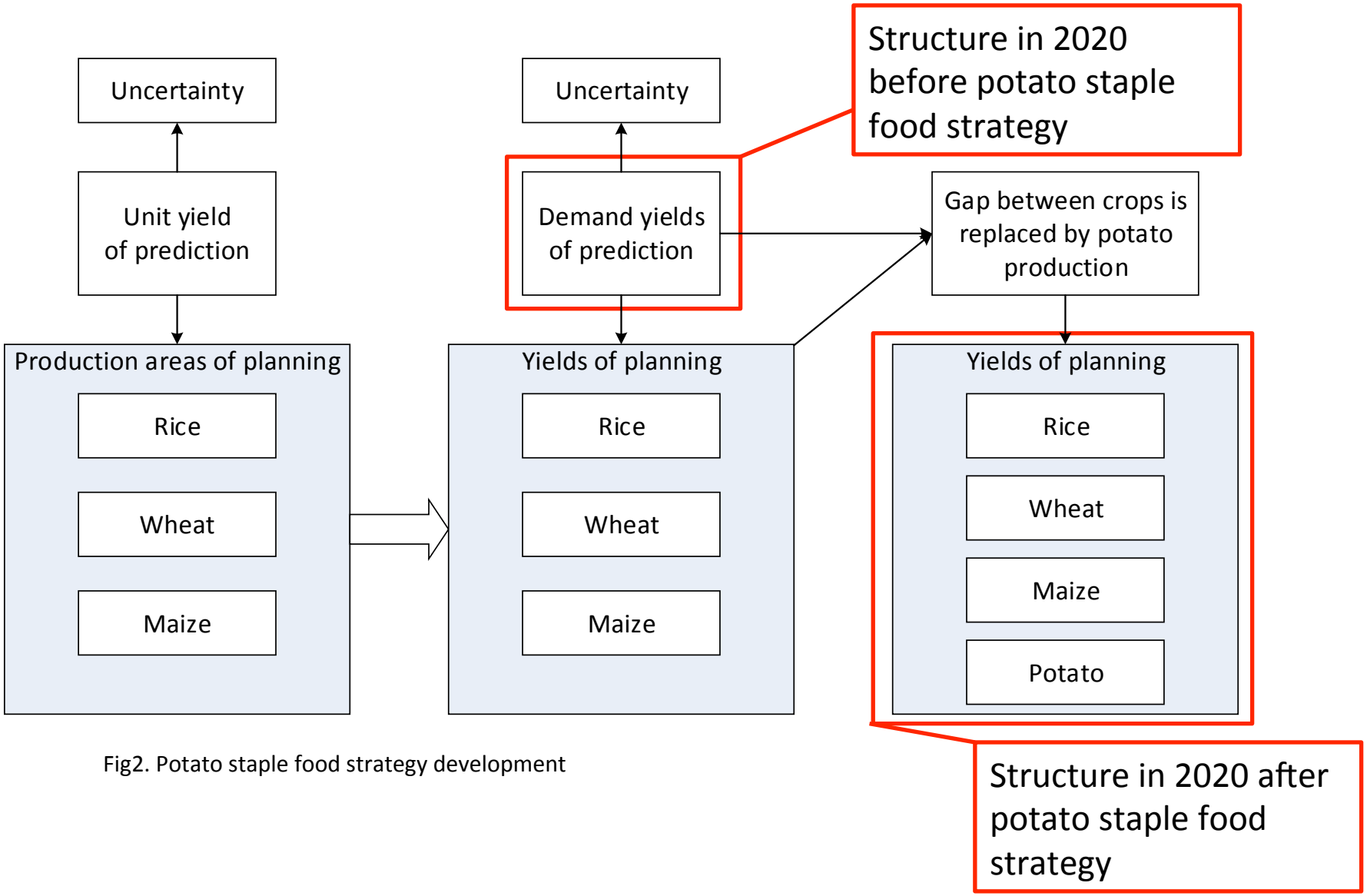
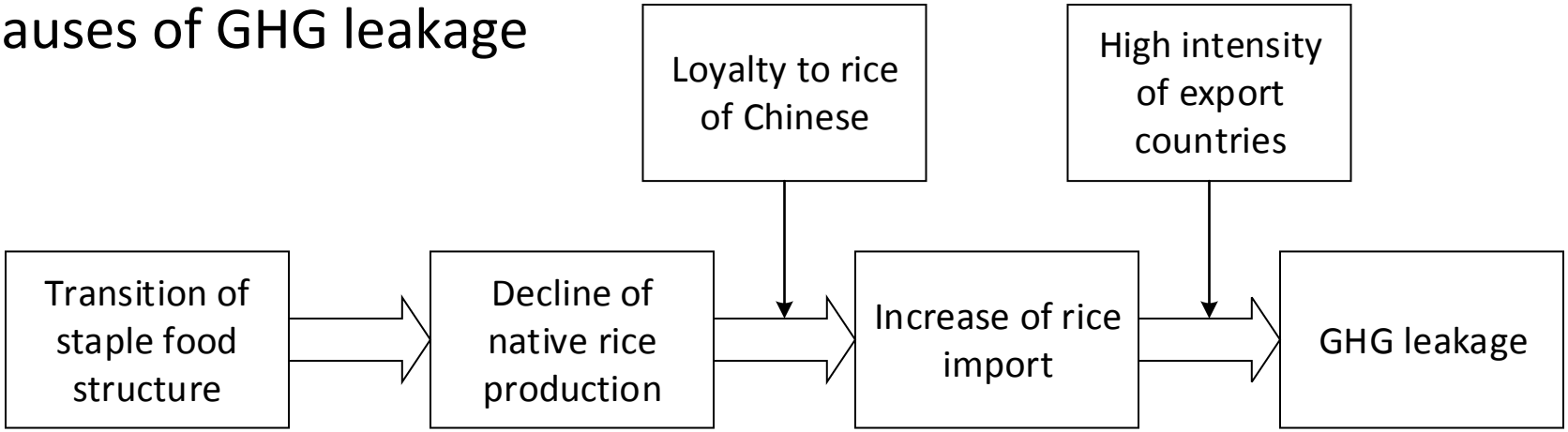



Fig2. Potato staple food strategy development

# GHG leakage due to staple food strategy

## Causes of GHG leakage




**Main Data source**

| Crops | Region | Data | Sources |
|---|---|---|---|
| Rice | 8 major import countries | Rice import rate | China customs information website |
| | | Area harvested Production | FAOSTAT |
| | | Applied fertilization rate | IFA |

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# Emissions status quo in 2015

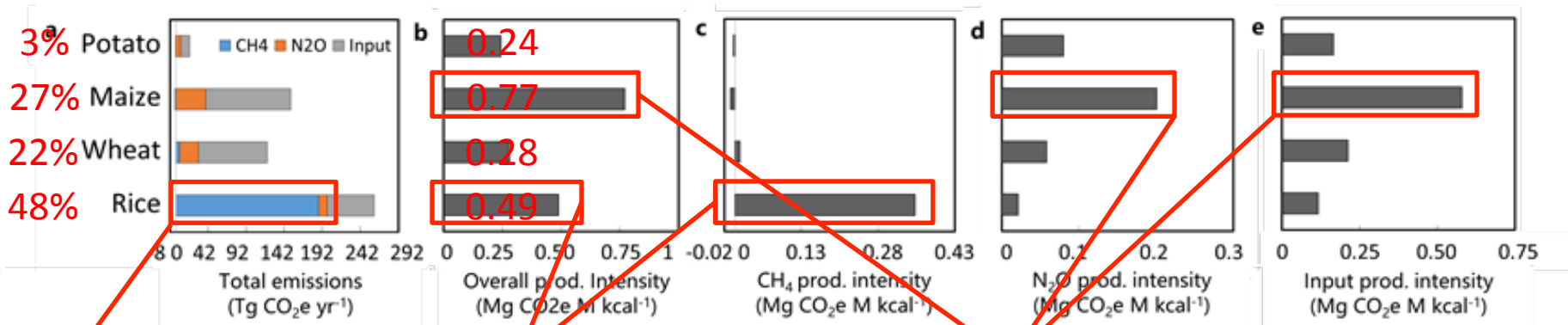



Fig3. Staple food greenhouse gas emissions and intensities of each crops in China

Methane:
72% of rice emission;
34% of all crops.

High intensity of rice:
High Methane emissions due to flooding

High intensity of maize:
High Nitrous Oxide and input emissions from fertilization rate

- Total staple food GHG emissions in China:

  546.90 ± 32.69 Tg $CO_2e$ $yr^{-1}$ (4.4 ± 0.2% of anthropogenic emissions)

- Production intensity of staple food in China:

  0.45 ± 0.13 Mg $CO_2e$ M $kcal^{-1}$

# Emissions status quo in 2015

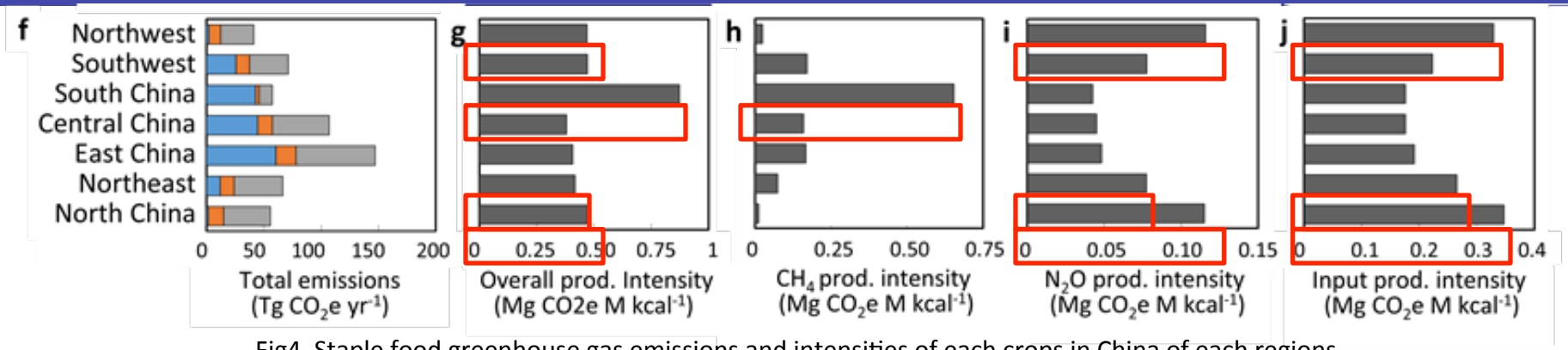
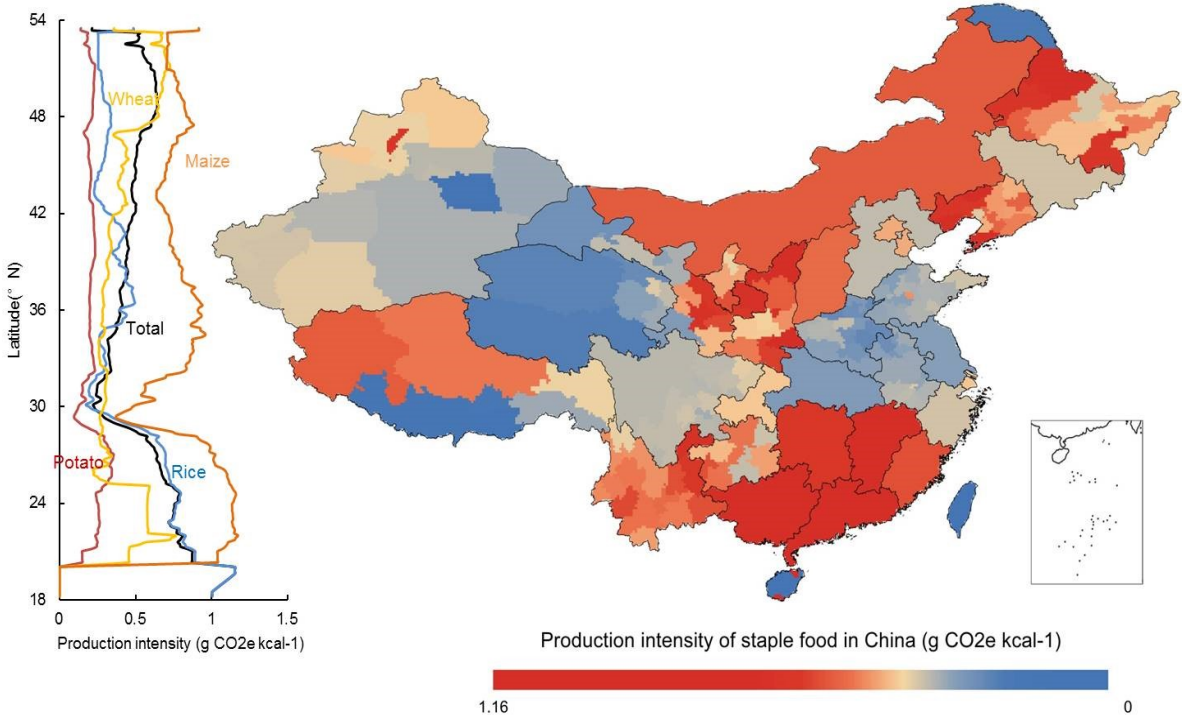



Fig4. Staple food greenhouse gas emissions and intensities of each crops in China of each regions




Highest production intensity:

- South China

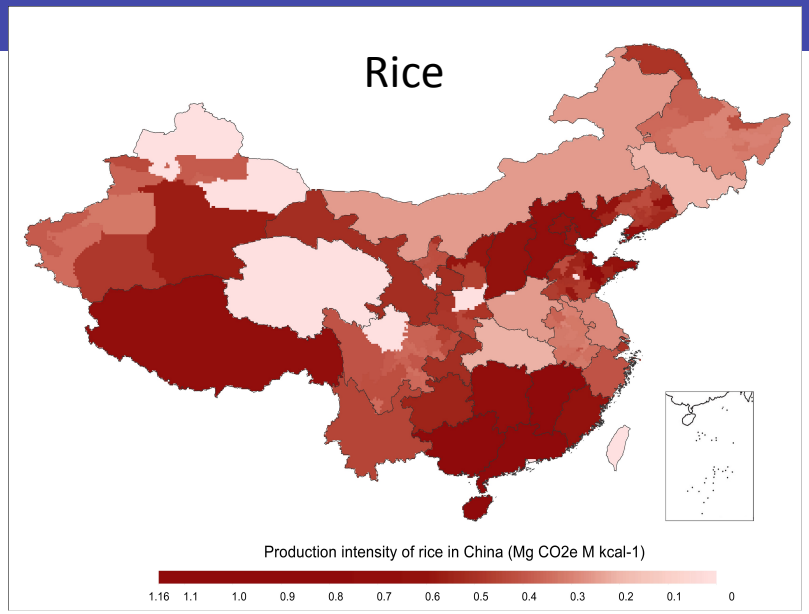
  (rice plantation)

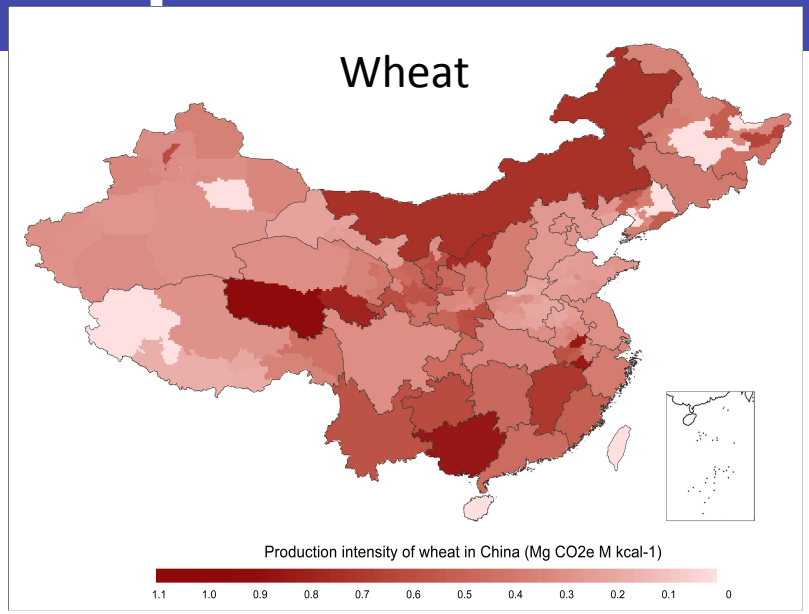
- Northwest, Northeast, and North China

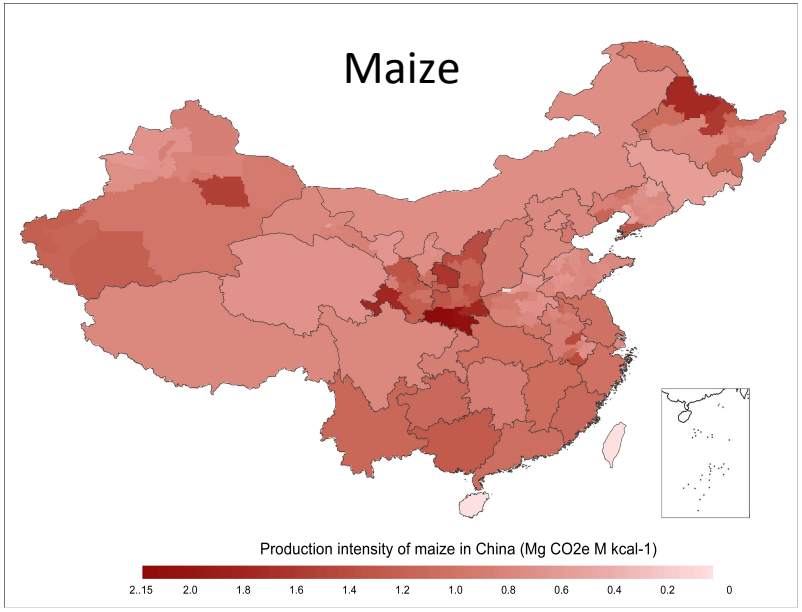
  (high fertilization applied rate)

Fig5. Distribution of production intensity (g $CO_2$-eq $kcal^{-1}$) from staple foods in 2015

# Emissions status quo in 2015



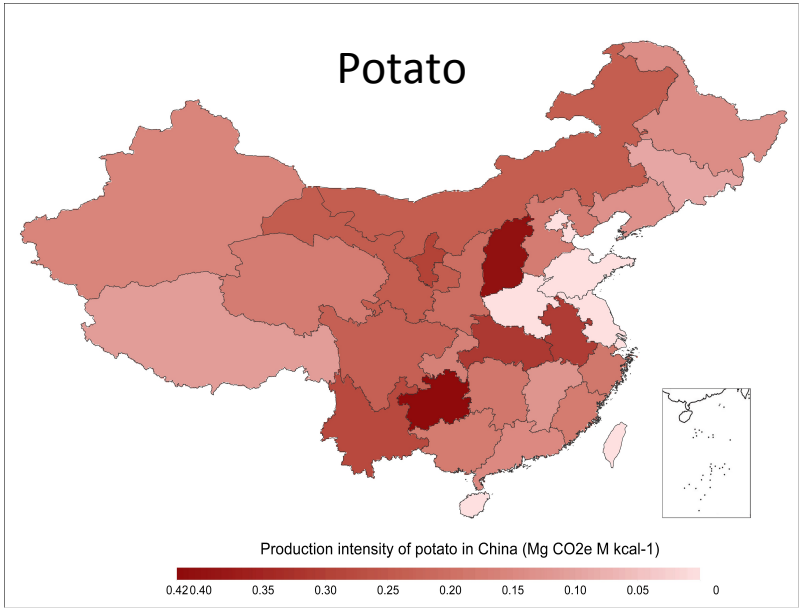




Fig6. Distribution of production intensity (g $CO_2$-eq $kcal^{-1}$) from each staple foods in 2015

# Transition of staple food structure

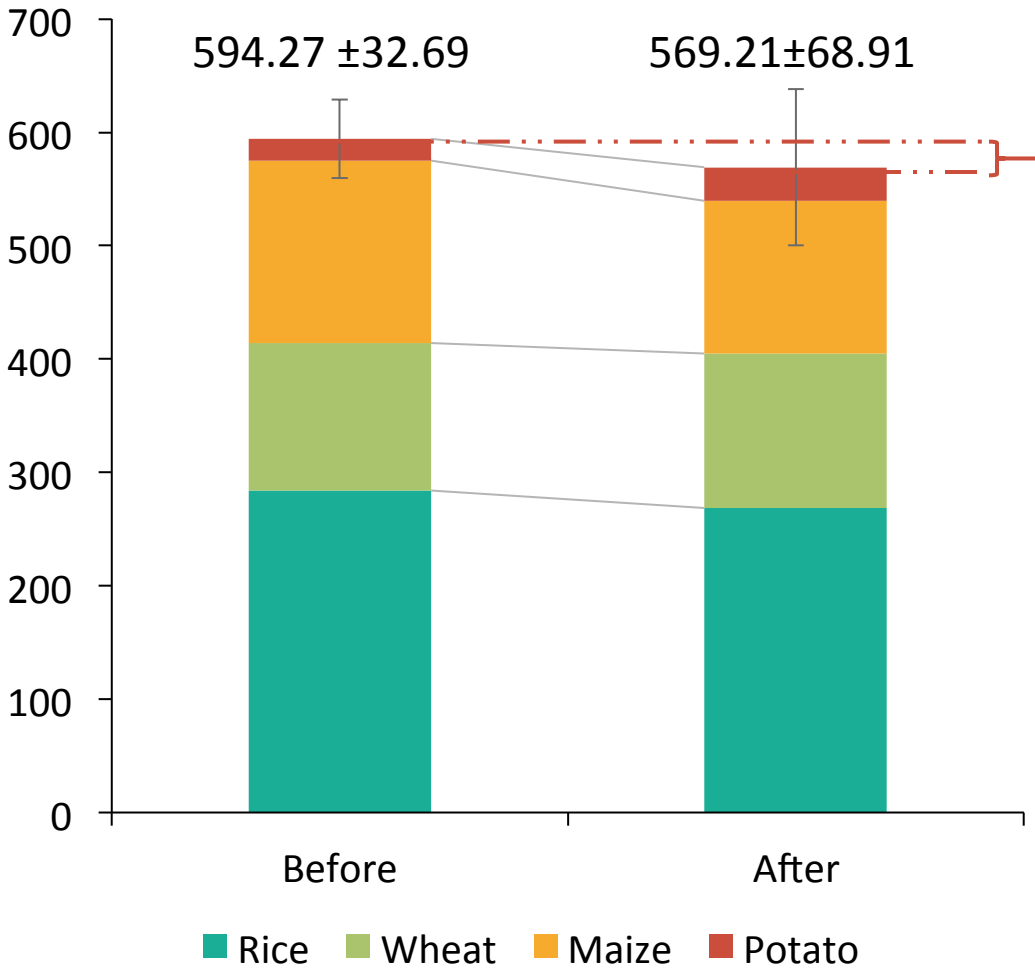



Fig7. GHG emissions (Tg $CO_2$-eq yr-1) in 2020 for before and after transition of staple food structure from 4 crops

25.06 Tg $CO_2$e $yr^{-1}$
4.21±2.11%

Table1. Uncertainty sources of scenario 1

| Uncertainty identified | ranges |
|---|---|
| Potato yields | ±10% |
| Unit yields | ±10% |
| $CH_4$ emission factor of rice | Region specific |
| $CH_4$ emission factor of others | Crops specific |
| $N_2O$ emission factor | Crops specific |

# Transition of staple food structure

## With crop management

ISSM: higher yield with better nitrogen use efficiency

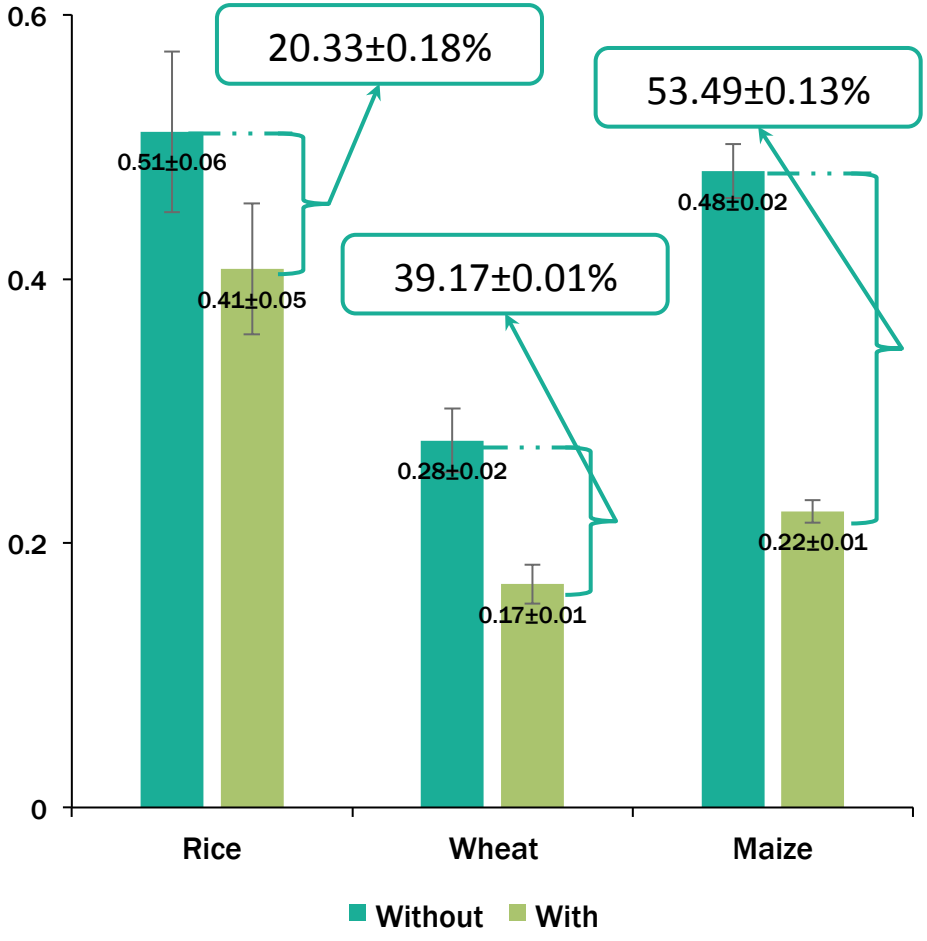



Fig8. GHG emission intensity (g $CO_2$-eq $kcal^{-1}$) for with or not crop management for 3 crops

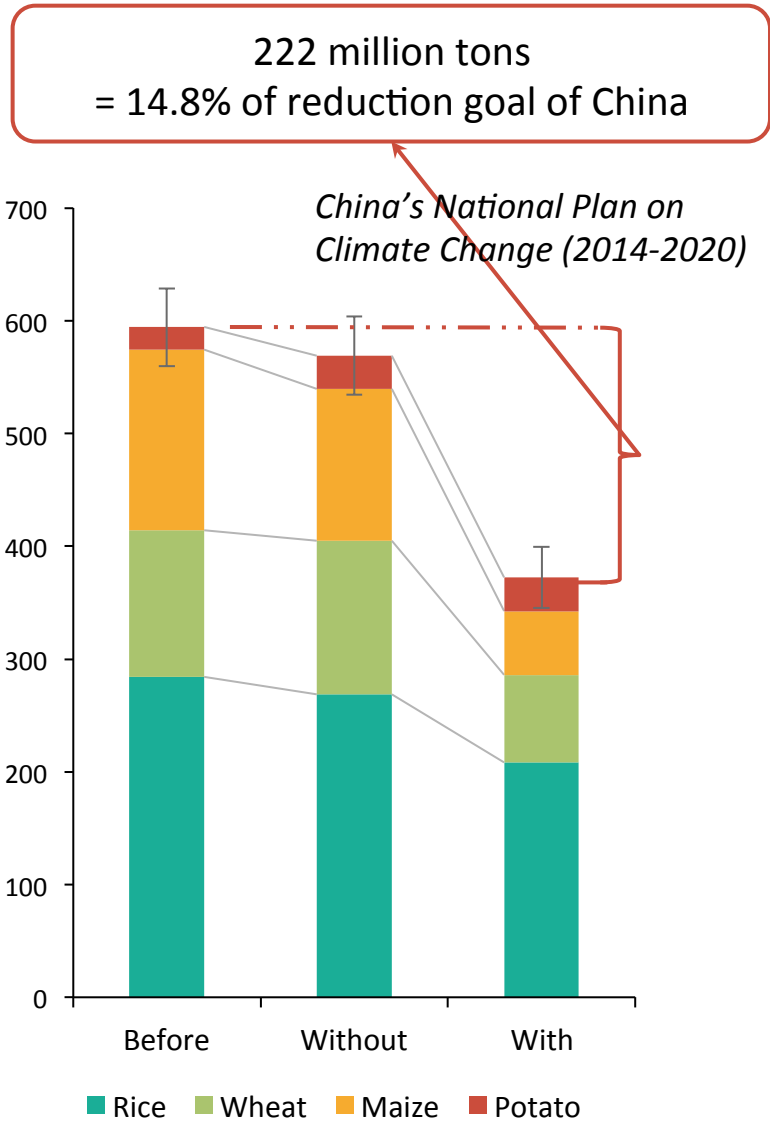



Fig9. GHG emissions (Tg $CO_2$-eq $yr^{-1}$) of each scenario from 4 crops in 2020

# Transition of staple food structure

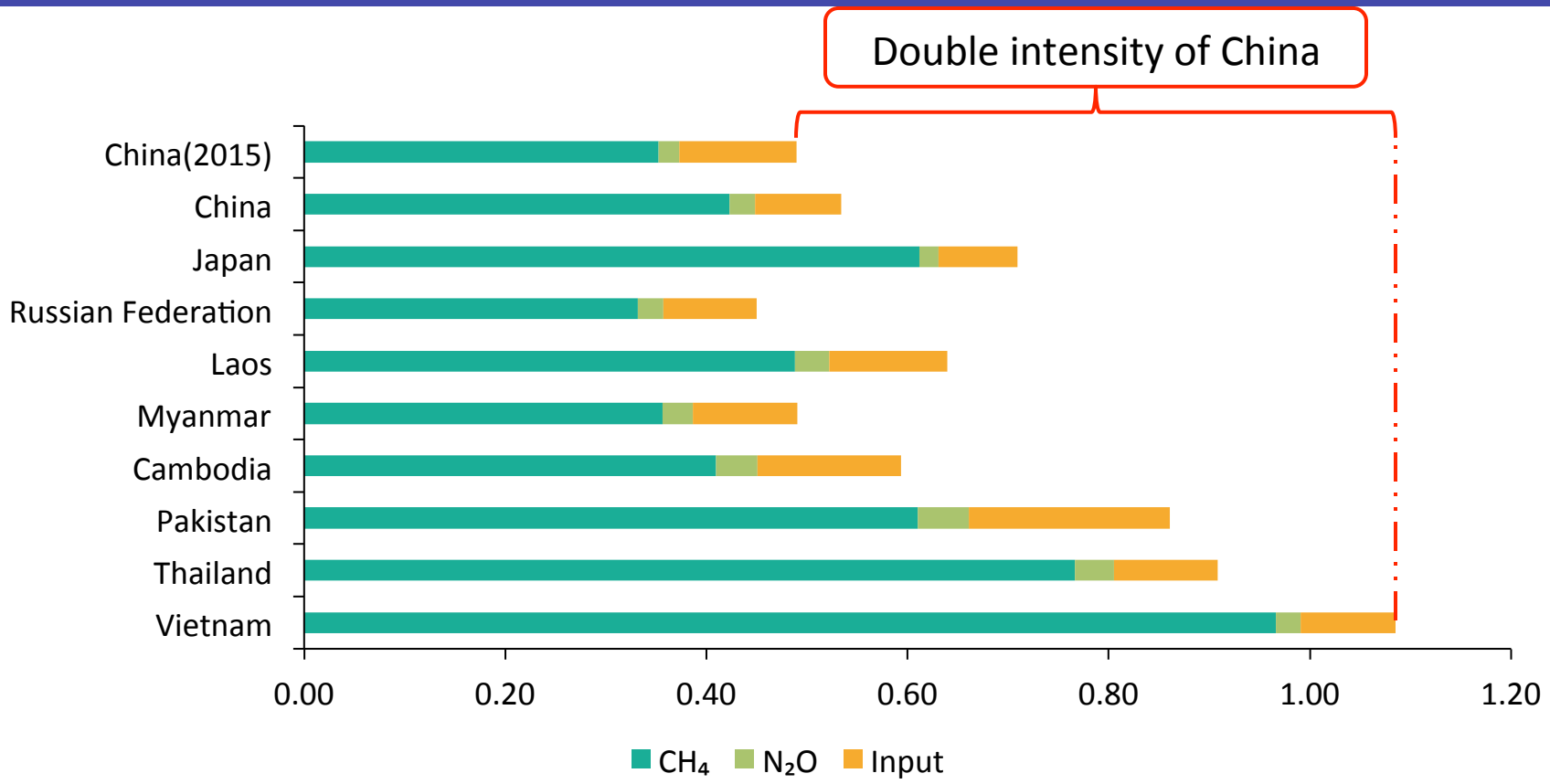



Fig10. GHG emissions intensity (g $CO_2$-eq $kcal^{-1}$) of rice for import countries

- GHG leakage:

  30.10 - 42.12 Tg $CO_2e$ $yr^{-1}$ (exceed emissions reductions in native China)

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# Conclusion

1. In 2015, total staple food GHG emissions in China was 546.90±32.69 Tg $CO_2e$ $yr^{-1}$; production intensity of staple food in China was 0.45±0.13 Mg $CO_2e$ M $kcal^{-1}$.

2. After transition of staple food structure, native GHG emissions of staple food in 2020 might reduce 25.06 Tg $CO_2e$ $yr^{-1}$ (4.21±2.11%); further reduction (33.3-40.4%) could be achieved with crop management improvement.

3. GHG leakage due to potato staple food strategy could achieve 30.10-42.12 Tg $CO_2e$ $yr^{-1}$, which may exceed emissions reductions in native China.

Thank You!

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