China’s Arable Land Changes and Food Security

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Outline

I. State of arable land resource and food security in China

II. Key issues and study methods

III. Spatio-temporal characters of cropland change

IV. Driving force of cropland transformation

V. Agricultural Productivity

VI. Discussions
I. State of arable land resource and food security in China
The area of arable land (new land reclamation is not included) has shrunk by 13 million mu/year from 1998-2006. Construction took up 1.75 million mu of farmland in 2006, if arable land shrinks at such a pace, the warning level of 1.8 billion mu will be breached in six years. (15 mu = 1 ha)

National arable land area (Data source: Ministry of Land and Resources)
Trends of sown area, grain production and total grain output from 1952 to 2006

- Sown area (10 million ha)
- Total grain output (0.1 billion ton)
- Grain production 100 kg/mu
Key issues to ensure food security

• To defend the 1.8 billion mu red line
• To improve the quality of farmland
• To enhance the capacity of sustained growth of grain production
• To establish a long-term incentive policy system for food producing
II. Core issues and study methods
Core issues

• Dynamic change of arable land in China

• Influence of arable land change on grain production

• The probably initiatives and effects of enhancing national food production capacity
Satellite images database and images update for land use monitoring

Satellite images for 1999 – 2000 land use
Satellite images database and images update for land use monitoring
III. Spatial and temporal change patterns of China’s cropland
Cropland distribution of China in 2000
Reclamation in Heilongjiang province during 1990s
Urban sprawl during 1990s (Wuxi, Jiangsu province)
Arable land change during 1995-2000
Arable land change during 2000-2005
1995-2000

Cropland area increase 17667km$^2$ during 1995-2000

2000-2005

Cropland area decrease 6365km$^2$ during 2000-2005
The provinces that had a significant cropland area decrease during 2000-2005 include: Guangdong, Zhejiang, Shaanxi and Sichuan;

The provinces that had a significant cropland area increase during 2000-2005 include: Xinjiang, Heilongjiang and Jilin.
IV. Direct Driving Force (National Land Use) of cropland transformation
2000-2005: Cropland to Forest
2000-2005: Cropland to Grassland
2000-2005: cropland to built-up land
2000-2005: Grassland to Cropland
2000-2005: Unused land to Cropland
Cropland transformation during 1995-2000 and 2000-2005

![Graph showing cropland transformation](image-url)
V. Simulation and Observation of Agricultural Productivity

1. Impacts of LUCC on Photosynthetic Thermal productivity
2. Impacts of LUCC on actual agricultural productivity estimated from remote sensing model
3. Multiple cropping and its implication on food security assessment
V. Agricultural Productivity

1. Impacts of LUCC on Photosynthetic Thermal productivity
2. Impacts of LUCC on actual agricultural productivity estimated from remote sensing model
3. Multiple cropping and its implication on food security assessment
Cropland distribution along elevation, temperature and precipitation gradient in 1990s
Transformed cropland distribution along temperature gradient in 1990s
Transformed cropland distribution along precipitation gradient in 1990s
Photosynthetic Thermal Productivity in 1980s (based on LUCC of 80s and average climate parameters of 1981~2000 Unit: Kg/hm²)
Photosynthetic Thermal Productivity in 1990s (based on LUCC of 2000 and average climate parameters of 1981～2000 Unit: Kg/hm²)
The interannual variation of photosynthetic thermal productivity gross in China during 1981-2000
Changes of photosynthetic thermal productivity of cultivated land caused by LUCC (based on average climate parameters of 1981~2000 Unit: Kg/hm²)
Provincial changes of photosynthetic thermal productivity of cultivated land caused by LUCC (based on average climate parameters of 1981～2000, Unit: $10^4$ tons)
V. Agricultural Productivity

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Agricultural productivity calculated from a remote sensing-based ecosystem model: GLO-PEM

Biological variables
- NDVI
- Land cover
- LAI

Environmental variables
- Temperature
- VPD
- Rainfall

Other observations
- Prince & Goward, 1995
- Cao et al. 2004
Spatial Pattern of Chinese Agricultural Productivity
(Unit: ton/km$^2$)
Agricultural productivity change from 1980s to 1990s
(Unit: ton/km²)

1. Northeast Region
2. Innermongolia and the great wall Region
3. Huanghuaihai Region
4. Loess Plateau Region
5. Middle and lower reach of Yangtze River Region
6. Southwest Region
7. South China Region
8. Ganxin Region
9. Tibet Region
Agricultural productivity change caused by cropland transformation during 1990s
The **loss** of agricultural productivity in **1ha** cropland due to urban expansion = The **gain** in **1.8ha** newly cultivated cropland from grassland
Impacts of different land use change types on total agricultural productivity

+ indicate land use changes make agricultural productivity increase
- indicate land use changes make agricultural productivity decrease
V. Agricultural Productivity

1. Impacts of LUCC on Photosynthetic Thermal productivity
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3. Multiple cropping and its implication on food security assessment
Multiple cropping in China

Multiple cropping, the growing of two or more crops on the same field in one year, is an important component of agriculture throughout half the cropland in China, particularly in south China where intensive cropping practice. By virtue of the direct contributions to crop sown area, multiple cropping is of particularly importance for ensuring China’s food security during the past several decades.

From 1952 to 1995, Multiple Cropping Index (ratio of sown area and cropland area) increased from 131 to 158.
Incorporating multiple cropping into agricultural productivity model is important for food security assessment.

Multiple-cropping has not yet been considered as a land cover type in most land cover classification products or the input datasets of ecosystem productivity models. The significant underestimation of GPP and disadvantage for global biogeochemical cycle and food security studies due to the omission of multiple cropping system has been highlighted in recent research (Zhang et al., 2008).

GPP estimated from the flux measurements, 8-day MOD17 GPP (GPP-MOD1) and 8-day GPP calculated from the MOD17 algorithm using the surface measurement inputs and default parameters (GPP-MOD2) at Yucheng.
Spatial Pattern of Multiple-cropping in China
(AVHRR, 8 km, 10 day)

Based on the NDVI time-series curve, the peak points number of each pixel was identified by combining crop phenological metrics and agricultural practicing calendar (e.g. time of planting and harvest).
Variations of Multiple Cropping in China from 1981 to 2000

1. Northeast Region
2. Innermongolia and the great wall Region
3. Huanghuaihai Region
4. Loess Plateau Region
5. Middle and lower reach of Yangtze River Region
6. Southwest Region
7. South China Region
8. Ganxin Region
9. Tibet Region
Variations of Multiple Cropping in China during 1981-2000 within plain and hilly area

Plain

- 25% MCI increase

- 12% MCI decrease

Hilly Area

- 18% MCI increase

- 28% MCI decrease
Multiple cropping changes in HHH during 1999—2003
(SPOT/VGT, 1km)
Estimating GPP in double-cropping area with VPM model

winter wheat – maize phenology and vegetation index in Yucheng station. In which, W1: Winter wheat emergence; W2: Winter wheat dormancy; W3: winter wheat Reviving; W4: winter wheat tillering; W5: winter wheat jointing; W6: winter wheat heading; W7: winter wheat milking; W8: winter wheat maturity. M1: Maize emergence; M2: Maize seven leaf; M3: Maize jointing; M4: Maize heading; M5: Maize milking; M6: Maize maturity.
Model input:

- EVI
- LSWI
- Temperature
- PAR
- Multiple cropping
- Crop calendar
  (emergence and harvest time)

Crop calendar in HHH plain
Comparison of the seasonal dynamics between the observed gross primary production (GPP) and predicted GPP during 2003-2004 at the eddy flux tower site of Yucheng winter wheat-maize double cropping land, Shandong Province, China. Solid line-GPPpred and open circle-GPPobs.
IV. Discussions

- Measures to ensure 1.8 billion mu of arable land: (1) basic farmland policy system (2) to improve land use efficiency for city construction (3) rural settlements reconstruction (4) development of the necessary reserve of arable land resources

- The possibility and measures of increasing agricultural productivity: (1) to enhance potential productivity (2) to improve agricultural technology (3) to expand irrigated area and improve the basic infrastructure for agriculture, etc. (4) to consolidate newly cultivated arable land (5) to improve the multiple crop index and farmland use efficiency

- Mechanism of regional heterogeneity of arable land resources and agricultural productivity changes: should be fully understood through advanced technology, which is of significance to master the situation of cultivated land resources and food security on national level.
Thanks! Thanks! Thanks! Thanks!