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# Agri-plastic mulch in China-challenges and solution

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# Outline

1. Basic judgement of ag-plastic
2. Pollution and causes
3. Strategies against the pollution
4. Conclusion and discussion

# 1. Basic judgement of PMF issue

- Have to apply plastic mulch film
- Have to against its residual pollution

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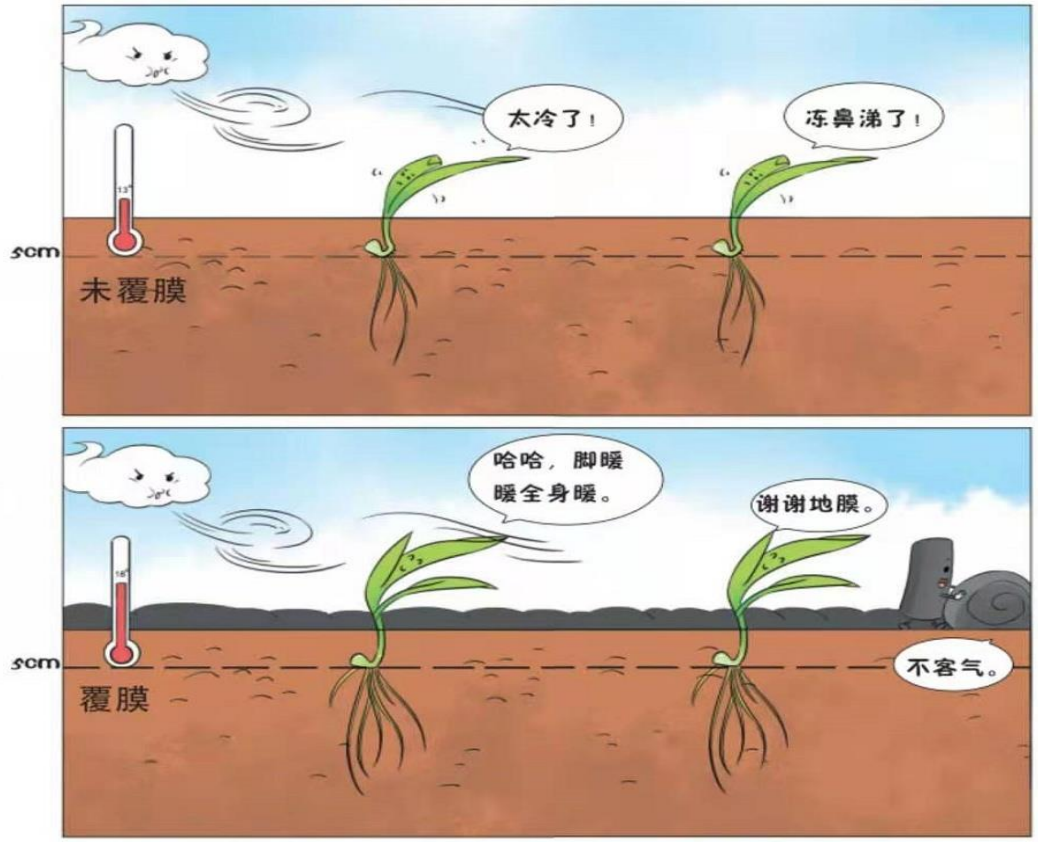
# The Tech Development Process in China

| Stage | Period | Key features |
|---|---|---|
| Beginning | 1979–1984 | • China learned mulching tech from Japan and started importing PMF<br>• Small-scale production and testing of PMF |
| Improvement | 1985–1992 | • PMF quality improvement<br>• Machine producing for film mulching |
| Application | 1993–2012 | • PMF applied successfully on large scale<br>• PMF residual pollution has occurred |
| Upgrade | 2012–now | • Multifunctional intelligent machines<br>• Newly revised PMF national standards<br>• PMF residual pollution issue put on the table |

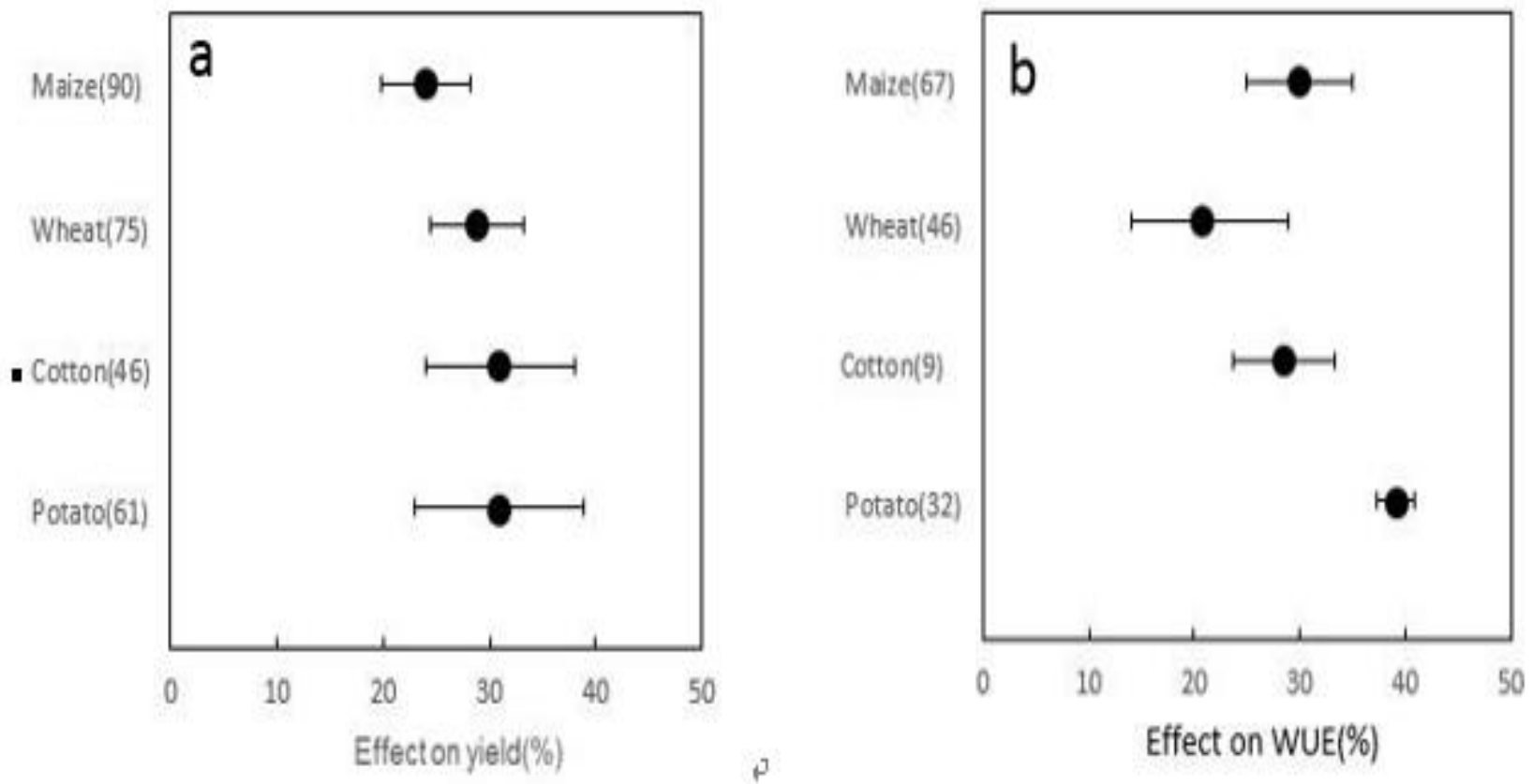
# PMF Effects on Ag-Production

## Soil Temperature and PMF




- PMF affects on the heat exchange between soil and air.
- 2-4 ℃ of daily T of 5cm layer increased.
- Crop planting area is extend, early harvesting of crop 10–15 days

# The Effects on Main Crop Yield and WUE




3,160 pairs of data (*mulched and no-mulched*) from 266 sites, the results showed that mulching led to a crop yield increase of 24.3%, and an increase of 27.6% in WUE.

# Weed Controlling and PMF

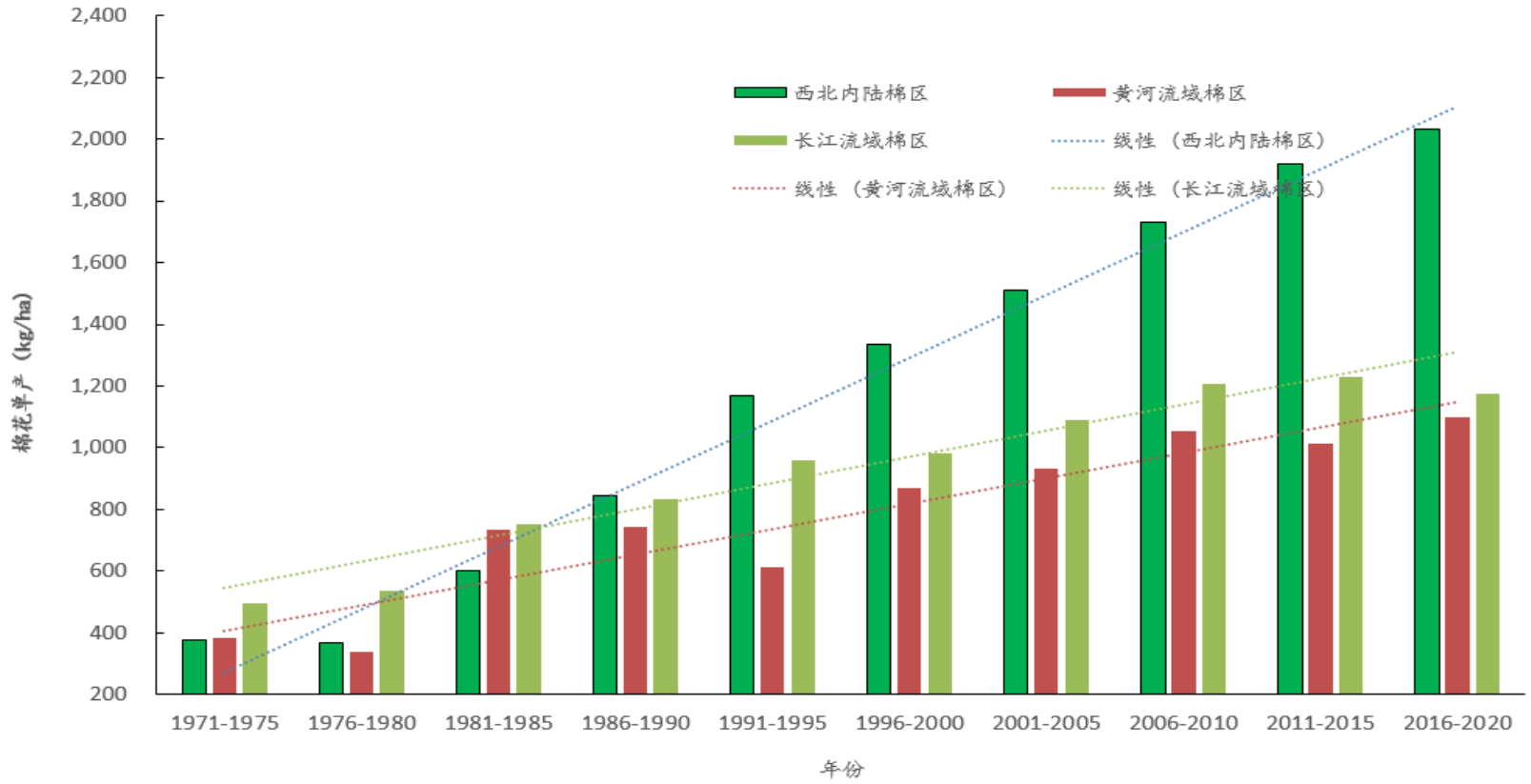
**Left:** No herbicide + No mulching

**Right:** No herbicide + Mulching

# PFM and Cotton Production

| Years | Inner Oasis | | Yellow River Basin | | Yangtze River Basin | | Subtotal |
|---|---|---|---|---|---|---|---|
| | Area | Percent | Area | Percent | Area | Percent | |
| 1971–1975 | 15.3 | 4.0 | 183.6 | 48.4 | 180.2 | 47.5 | 379.2 |
| 1976–1980 | 15.6 | 4.1 | 179.8 | 47.9 | 179.7 | 47.9 | 375.1 |
| 1981–1985 | 26.6 | 5.3 | 295.5 | 59.5 | 174.8 | 35.2 | 496.9 |
| 1986–1990 | 35.8 | 7.7 | 290.6 | 62.5 | 138.8 | 29.8 | 465.2 |
| 1991–1995 | 65.8 | 12.4 | 287.9 | 54.1 | 178.5 | 33.5 | 532.2 |
| 1996–2000 | 93.8 | 23.7 | 160.6 | 40.6 | 140.9 | 35.6 | 395.2 |
| 2001–2005 | 108.5 | 23.5 | 223.0 | 48.2 | 130.8 | 28.3 | 462.3 |
| 2006–2010 | 161.1 | 31.5 | 210.8 | 41.2 | 139.7 | 27.3 | 511.6 |
| 2011–2015 | 178.7 | 42.3 | 136.0 | 32.2 | 108.0 | 25.5 | 422.7 |
| 2016–2020 | 226.0 | 70.0 | 53.7 | 16.6 | 43.2 | 13.4 | 323.0 |

# The Change of Cotton Yield in 3 Bases in China (1971–2020)




Note: data from National statistical yearbook of China

# Contribution of PMF to Farmer in China (estimation)

| Crop type | Mulched Area (Approx. million ha) | Net Income ($/ha) | Total (Approx. $ bn) |
|---|---|---|---|
| Low value | 6.5 | 200–300 | 1.3–2.0 |
| Middle value | 7.0 | 600–800 | 4.2–5.6 |
| High value | 6.5 | 1000–1600 | 6.5–10.4 |
| Total Income ($ bn) | | | 12.0–18.0 |

- Low value: maize, millet, etc.
- Middle value: peanut, cotton, tobacco and some vegetables
- High value: melon, garlic, ginger and some vegetables

# Others: Apples and PMF


- Bagging + Applying Silver PMF
- Bagging
- Natural Condition

- The used silver PMF

  (about 10–20 days)

# 2. Pollution and causes

- An overlooked problem
- Damages of PMF residual pollution
- Causation analysis

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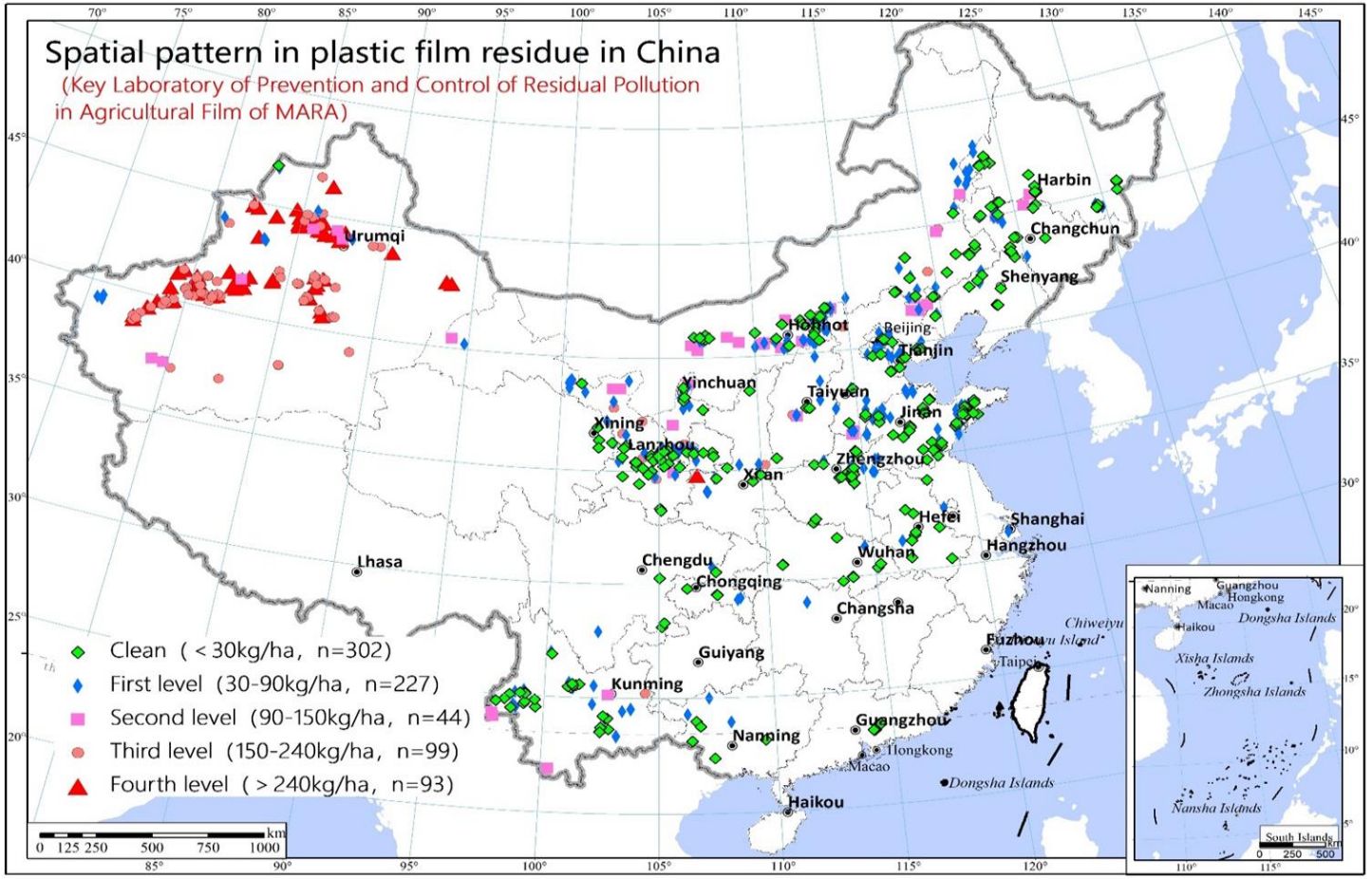
# Basic situation of the pollution in China




- 765 sites, the average amount is 91.2 kg/ha, regional differences are significant
- Pollution amount of about 40% of the sites are less than 30 kg/ha, mostly located in South China
- The 2nd and 3rd level pollution sites are mainly located in the North, Northeast and Yunnan
- The most seriously polluted sites are in Xinjiang, mostly over 240 kg/ha

# Damages of PMF residual on Soil

# Reduce Agri-Products Quality

- Some straws mixed into PMF residual lost fodder value, such as the peanut straw, good fodder. If animal take, it  can results in reduced growth rate or mortality increase.
- Operation process increasing: only in Xinjiang, PMF residual recycling requires an investment of 1.14 billion yuan.
- If PMF residual mixed into cotton, the grade of cotton will decrease rapidly.

# Why only in China?

| Country | Thickness（um） | Color | Price（Yuan/kg） | Recycl -ability | Main Functions |
|---|---|---|---|---|---|
| Japan | 20–30 | Black(70%) | >30 | Good | Weed control, moisture conservation |
| EU & US | 20–50 | Black(70%) | >20 | Good | |
| China | 10（7–8） | Trans(70%) | <13 | Poor | Temperature increase, moisture conservation |


- In 2019, ave. price of China,13.0yuan/kg
- In 2020, ave. price of China,12.6yuan/kg
- In 2021, ave. price of China,12.7yuan/kg

Farmer collect PMF in Japan (up)

Farmer harvest PMF in France (down)

Farmer harvest PMF in China

# The Mode and Application Scope Between China and others

| Items | China | JPN and EU |
|---|---|---|
| Crop | Almost all crops planted | Cash/Horticultural crops |
| Plant density | Over 40–400*$10^3$ plants/ha | 5–45*$10^3$ plants/ha |
| Plant scale | Over 15 Million ha | About 0.1–4 million ha |

# The Case of Cotton Field Mulched in Xinjiang, China

# Situation of Ag-Film Recycling and Disposal in China

- **Management and understanding:** Pay more attention to apply but not to harvest; the national, local and ag-film user have different cognition. National-positive, Local-medium; and user-neglect
- **Ag-film recycling tech and equipment:** The existing recycling tech and equipment cannot meet needs, and in a serious lagging situation
- **Recycling ag-film processing:** in general, simply equipment and low efficiency of ag-film recycling. And most of them, the high impurity rate (70–90%) is discarded, a very little recycled and reused

# 3. Strategies against the pollution

- Recycling of ag-plastic film residual
- Replacement by other techs
- Decrement of ag-plastic film usage

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# Recycling of ag-plastic film residual

- Effective legal, policy and standards system for ag-plastic film
- High strength tension ag-plastic film, and to improve its recyclability
- Multifunctional intelligent combine recycle machine
- A responsibility sharing mechanism, including government, producer, user, and recycle enterprise of ag-plastic film

# Replacement by other techs

- **Bio-film replace PE-film**
- **Other new techs:**
  - ✓ Conversation tech replace ag-plastic film in maize planting in Xinjiang
  - ✓ Shallow drip irrigation to replace drip irrigation under ag-plastic film in Northern China

PE-film

Bio-film





The application of bio-film for rice covered planting in China

# Decrement of ag-plastic film usage

- **Assessment tools:** to decide **where,** and **what** crops use or not use ag-plastic film
- **Changes in planting target:** from grain to fodder, such as gran maize to feed corn in some of Northwest in China

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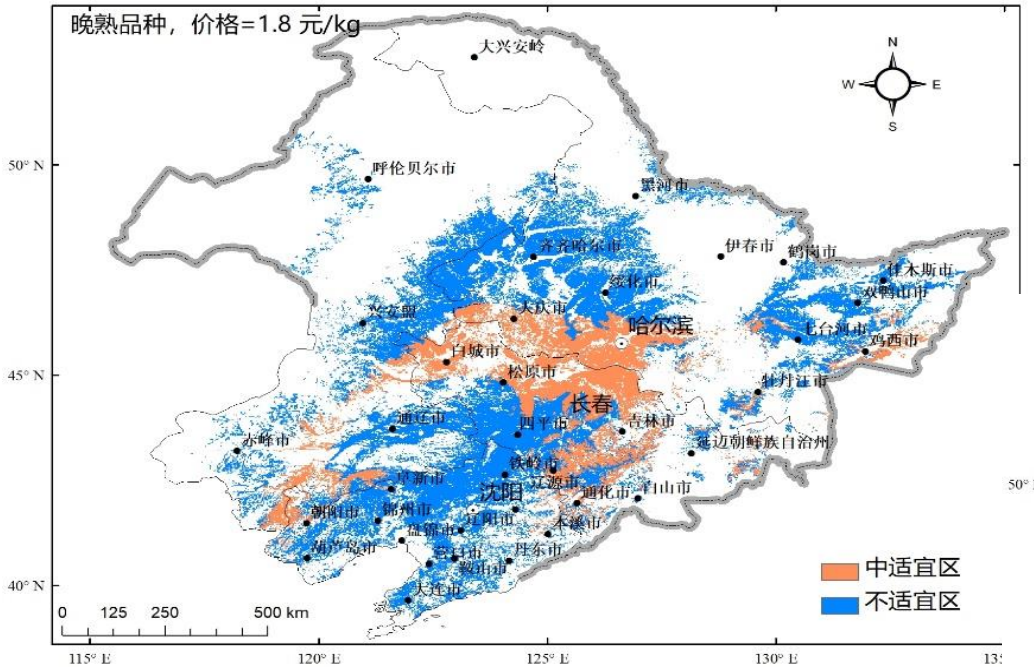
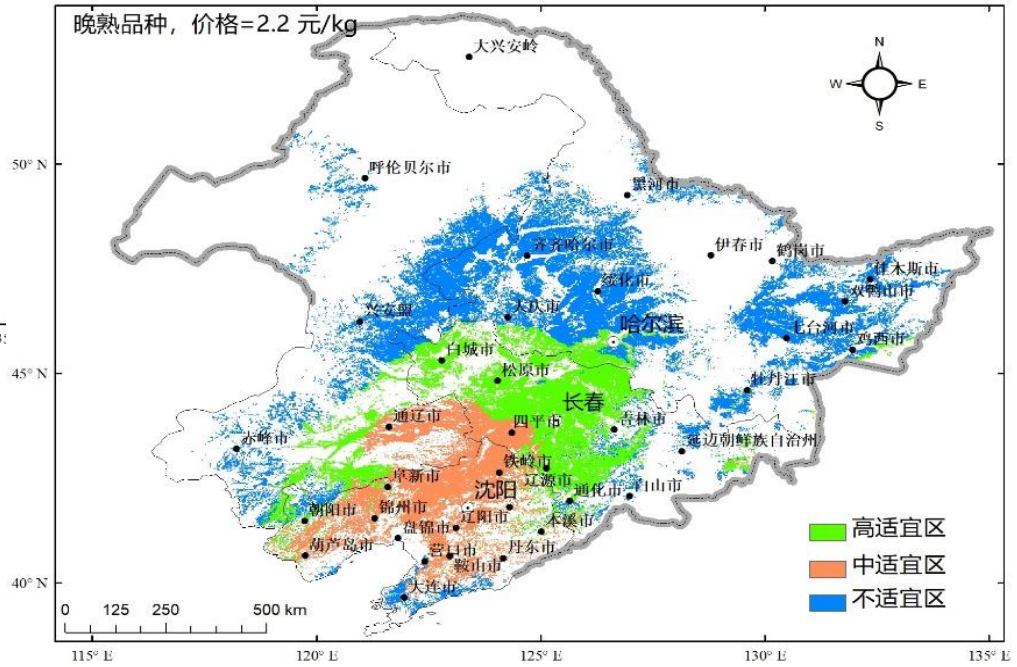
定位功能


APP for PMF tech suitability of spring maize in Northeast

# The changes of maize suitable areas of PMF under different price in Northeast China



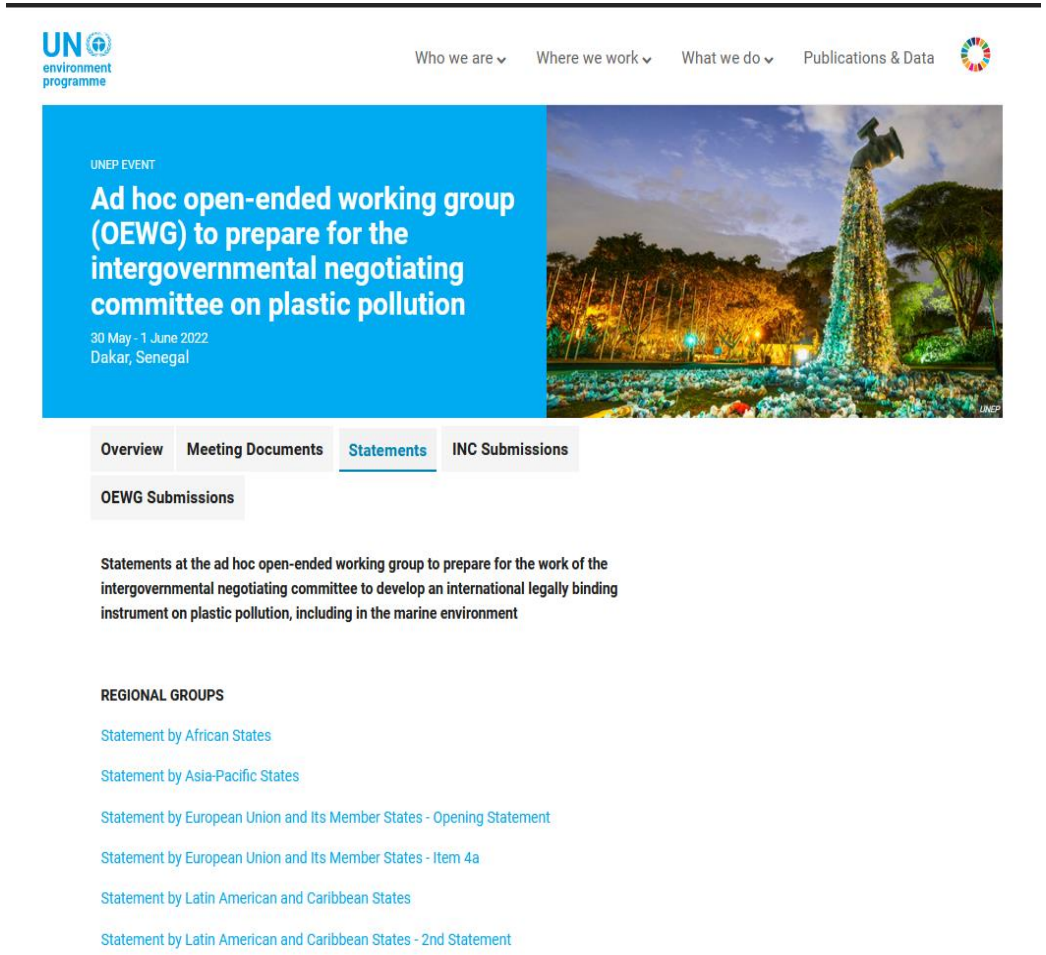



# Ag-plastic film potential market


- Drive force：More ag-products need
- Limited factors：No-friendly effects
- Chance：More bio-mulch need in developed region
- Market：Asia-pacific has the largest, and EU follow

# How to realize plastic pollution? – New era

- **«Global Assessment of Soil Pollution»** was issued by FAO+UNEP in Jun. 2021
- **«Assessment of Ag-plastic and Their Sustainability: Call for Action»** was issued FAO+UNEP in Dec. 2021
- **«End plastic pollution: Towards an international legally binding instrument»** was issued by UN in Mar. 2022
- The 1st OEWG of UNEP was hold in May 2022



# 4. Conclusion and discussion

- PMF is one of the most widely used agri-tech, playing a critical role in guaranteeing safety of agricultural production.
- PMF Residual pollution on farmland is a critical problem, which has caused a great environmental problem, and it cannot be ignored and must be controlled.
- We must pay more attention on how to treat with PMF waste? Burning on field is safety? and what are real damages in the soil to environment and human?



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# Thank you!