Biodegradable mulch film in China, opportunity and challenge

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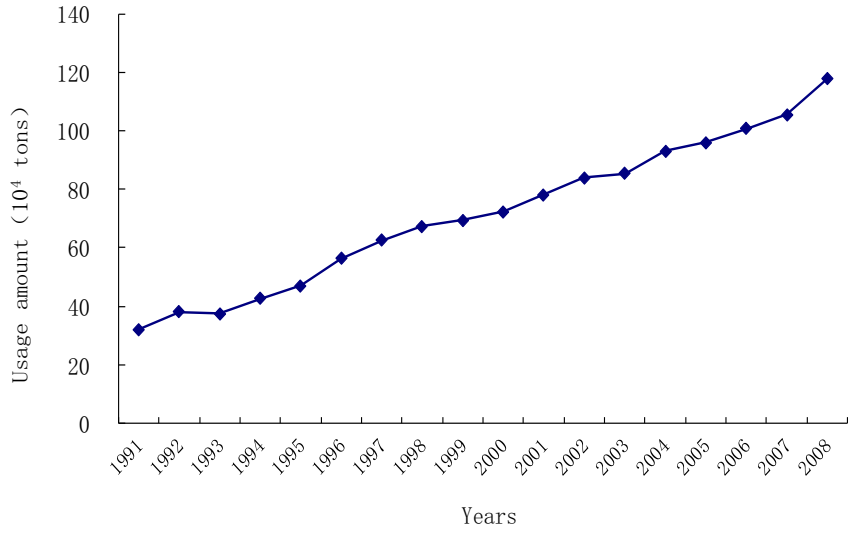
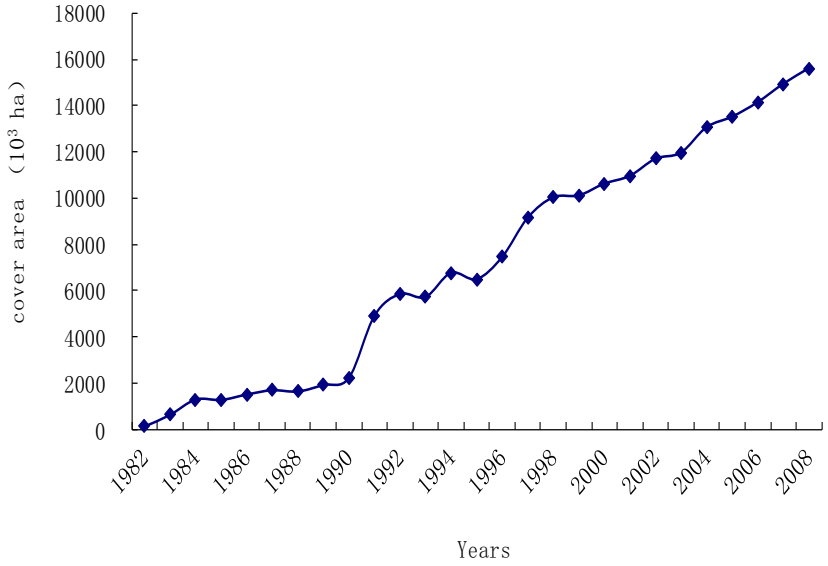
Outline

- Application of Mulch film in China
- Pollution of mulch film residue in the field
- Development of biodegradable film in China
- Degradation of R & D and enterprise status
- Evaluation of degradable mulch film in different regions
- Prospects of degradable mulch film in China

Application of Mulch film in China



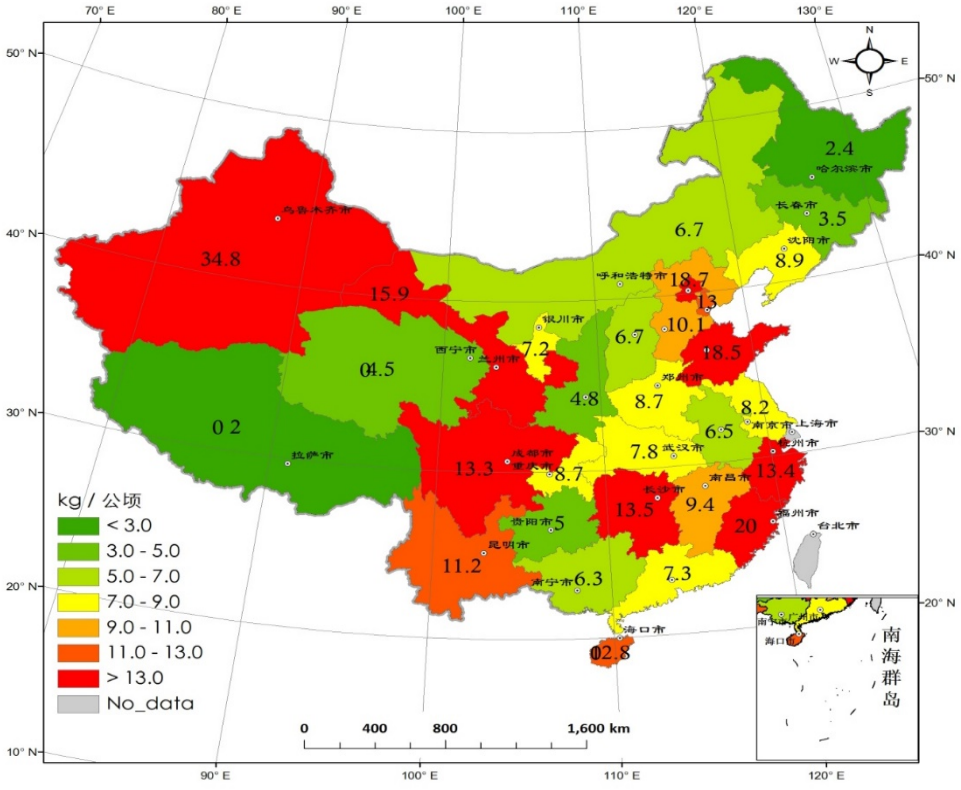


- **Amount**：The use of plastic film has increased substantially. Statistics show that the usage increased from 0.11 million tons in 1981 to 319,000 tons in 1991, 1.245 million tons in 2011, and 1.44 million tons in 2014.

- **Mulch area**：In 1981, the area covered by crops was only 15,000 hectares, reaching 15.60 million hectares in 2008 and 18 million hectares in 2014.

- **Benefit**：Some of the planting areas moved northwards by 2 to 3 latitudes, increasing production by about 30%, and the economic benefits were greatly improved.

Application of Mulch film in China



Crop	cover area (hm^2)	Coverage ratio (%)
Corn	700	20.0
Vegetable	613	30.2
Cotton	333	66.7
Peanut	233	50.0
Tuber	220	24.8
Tobacco	73	45.8
Rice	40	1.3

Effects and harms of mulch film residue pollution

- Investigation shows that the average residual film volume of the film-covered farmland is 71.9 to 259.1 kg/hm^2 in recent years.
- The amount of residual film in farmland soil in Northwest China is significantly higher than that in North China and Southwest China.

Effects and harms of mulch film residue pollution

Application and residue pollution of mulch film in different area

Region	Mulch years	Amount of mulch (kg/hm^2)	Mulch ratio (%)	thickness (μm)	Width (cm)	Amount of residue (kg/hm^2)
HEBEI	10	33	46.4	4-6	90	80.5
XIN JIANG	20	61.4	84.8	6-8	205	259.1
SHAAN XI	15	39	81	6-8	70/80	110.2
GANSU	15	75	90	8	120	136.7
LIAO NING	–	64.5	9.5	8	90	129.7
HUBEI	10	52.5	53.15	6-8	90	71.9

Effects and harms of mulch film residue pollution

Film residual pollution main hazard performance:

- Residual films impede soil moisture penetration and reduce soil permeability
- Residual film is in direct contact with the root system, hindering the extension of the root system, affecting the growth of the crop, and reducing production
- Livestock, such as cattle and sheep, could cause gastrointestinal dysfuction and even lead to death after eat foods mixed with crop stalks and residual films accidentally

Development of biodegradable film in China

- In 2015, the Ministry of Agriculture set up special funds to carry out biodegradable plastic film test evaluation across the country, and the adaptive evaluation of biodegradable plastic film has been further promoted.

- The study selected biodegradable plastic film products produced by more than 20 companies.

- Experiments were conducted in 11 provinces (districts), 23 counties (cities), and 7 crops in northeast, north, northwest, and southwest regions.

Development of biodegradable film in China

Area	Province & City	Test Location	Crop species
North China	Beijing	Shunyi Disctrict	Corn
	Hebei	Cheng'an County	Cotton，Vegetable
		Dingzhou	Vegetable
	Shanxi	Wutai，Yangqu County	Corn
	Shandong	Haiyang，Junan County	Peanut
Northeast	Liaoning	Zhangwu County	Corn，peanut
Southwest	Hubei	Yunxi County	Rice
		Yichang City	Tobacco
	Chongqing	Yubei District	Corn
	Yunnan	Yuxi District	Tobacco
		Huize County	Corn
Northwest	Gansu	Yuzhong，Anding District	Potato
		Huachi，Liangzhou District	Corn
	Inner Mongolia	Siziwang Banner	Potato
		Harqin Banner	Corn
Northwest oasis	Xinjiang	Bole，Weili County	Cotton

Development of biodegradable film in China

What's we have done?

Development of biodegradable film in China

The research results of the project :

- From the perspective of crop filming time, most biodegradable plastic films have shorter suitability for crops (such as tobacco and peanut) than those with long plastic film (such as corn)

- Regionally, the suitability of North China and Southwest China is higher than that of the Northwest China.

Development of biodegradable film in China

The study also revealed the general problems of biodegradable plastic film in agricultural production in China:

- Many factors affecting the degradation time, the impact mechanism is complex, and the rupture time is often too early.
- Mechanical strength needs to be improved, and the film is easily broken, making it difficult to perform mechanized operations.
- Characteristics of temperature-enhancing and soil-preservation are quite different from those of PE plastic film, especially in the early stage of crop growth, which has a greater impact on crop growth and yield and yield.

Degradation of R & D and enterprise status

Company Name	Nation	Basis	Capacity (thousand ton)	Advantages and problems
NatureWorks	USA	PLA	140	Establish Application Industry Alliance
BASF	Germany	PBAT、PBAT/PLA	70	Polymerization Technology Patents
Showa denko	Japan	PBS	10	Technology patents
Novamont	Italy	PBAT/Starch/PLA	30	Mature starch modification technology, development of PBAT polymerization technology
BIOTEC	Germany	PBAT/Starch	5	Stable self-producing starch raw materials, mature starch modification patented technology
FKUR	Germany	PBAT/PLA	3	Mature PLA/PBAT Blending Technology
Heritage	USA	PLA/Starch	5	BASF Partner in USA, PLA/$CaCO_3$/PBAT Blends
Limagrain	France	PBAT/Farina	＜10	Farina self-produced, has a certain cost advantage
Wells	UK			Oxidative degradation agent with cost advantages

In recent years, the share of biodegradable plastic film in the mulching film market has continuously increased and currently exceeds 10% in Japan and Europe.

Degradation of R & D and enterprise status

- Cooperation in the research and development and application of biodegradable films has become increasingly since .
- Japanese Showa Denko Co., Ltd., Germany BASF, French Limagrain company cooperated with Chinese agricultural research and technology promotion department.
- Research and demonstration of large-scale biodegradable plastic film in Xinjiang and other places in northwestern China, Yunnan and other places in the southwest, and Beijing in North China.
- The scope of application has been further expanded to cover major crops such as cotton, corn, tobacco, potatoes, etc.
- For example, in Yunnan, the Limagrain company in France conducted demonstrations of biodegradable plastic film covering more than 1,000 hectares and more than ten species of crops.

Degradation of R & D and enterprise status

- China has made great progress in the research and application of biodegradable plastic film.
- Form core technologies and processes with independent intellectual property rights.

- breakthrough of key catalyst technology in PLA synthesis
- starch modification technology
- synthesis technology in different PBS pathways, processing technology

- Production formula and process have also been further improved, the production capacity has been continuously expanded, and trial demonstrations have been carried out on multiple crops in multiple regions.

Degradation of R & D and enterprise status

Company Name	Basis	Capacity (thousand ton)	Advantages and problems
Kingfa	PBAT/PBSA	30	Collinear synthesis technology with independent intellectual property rights, extrusion technology, alloying technology
Jiangsu TORISE	PLA	＜10	Independent synthesis with cost advantages
Shandong Bikeda	PBAT/Starch	2	BASF Oceania Market Partners to Supply Oceanic Modified Starch Products
Guangdong Shangjiu	PBAT/Modified Starch	＜10	Market instability
Suzhou Hanfeng	Starch	15	Mature starch and PLA blending technology
Wuhan Huali	Starch	60	Mature modified starch plasticizing technology
Mengxi High-tech	PPC	3	
Henan Tianguan	PPC	5	
Taizhou Bangfeng	PPC	10	Carbon dioxide-based plastics with environmental advantages and price advantages
Shanghai Tongjieliang	PLA	1	
Zhejiang HISUN	PLA	5	
Xinjiang Blue Ridge Tunhe	PBAT	5	
Shanxi Jinhuizhaolong	PBAT	20	Mature PBAT and PLA Blending Technology
Shandong Huiying	PBAT	25	
Zhejiang Xinfuphar	PBAT	10	
Tianjin Greenbio	P3/4HB	10	P3/4HB has environmental advantages
Shenzhen Ecomann	P3/4HB	5	
Anqing Hexing	PBS	10	Products have been certified in Europe and America

Degradation of R & D and enterprise status

KINGFA Tech

Factory exterior

Material tank

Synthesis device

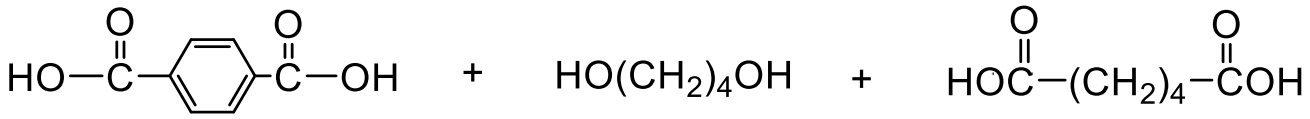
Feeding workshop

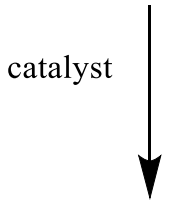
Packaging workshop

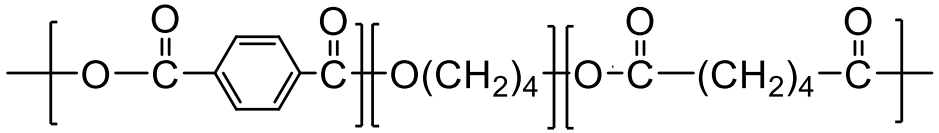
Product exhibition

Degradation of R & D and enterprise status

KINGFA Tech







PBAT

Mn=60000-100000

- ✓ Simple craft
- ✓ Less material consumption and equipment input.
- ✓ Low production costs

Degradation of R & D and enterprise status

KINGFA Tech

- Suitable for large equipment or handcraft




- Controllable degradable film induction period (60-90 days)
- Land warming and conservation effect


0 day


30 days


60 days

90 days

Degradation of R & D and enterprise status

- With the support of the Ministry of Agriculture, the Institute of Agricultural Environment and Sustainable Development of the Chinese Academy of Agricultural Sciences cooperates with related companies at home and abroad.

- Biodgradable film suitability evaluation bases have been established since 2011 in nine provinces and municipalities in China, including:

- Shihezi City in Xinjiang
- Cheng'an County in Hebei Province
- Fuxin City in Liaoning Province
- Enshi Prefecture in Hubei Province
- Qujing City in Yunnan Province
- Jiaozhou City in Shandong Province
- Wuchuan County in Inner Mongolia
- Zhenyuan County in Gansu Province
- Haiyuan County in Ningxia Province

Evaluation of degradable mulch film in different regions

Area	Province & City	Test Location	Crop species
North China	Beijing	Shunyi Disctrict	Corn
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		Dingzhou	Vegetable
	Shanxi	Wutai，Yangqu County	Corn
	Shandong	Haiyang，Junan County	Peanut
Northeast	Liaoning	Zhangwu County	Corn，peanut
Southwest	Hubei	Yunxi County	Rice
		Yichang City	Tobacco
	Chongqing	Yubei District	Corn
	Yunnan	Yuxi District	Tobacco
		Huize County	Corn
Northwest	Gansu	Yuzhong，Anding District	Potato
		Huachi，Liangzhou District	Corn
	Inner Mongolia	Siziwang Banner	Potato
		Harqin Banner	Corn
Northwest oasis	Xinjiang	Bole，Weili County	Cotton

Evaluation of degradable mulch film in different regions

Degradable mulch film in Xinjiang

Film mulch

Cotton seeding stage

Cotton seeding stage

Corn seeding stage

Cotton Opening period

Cotton Opening period

Corn harvest

Degradation

Evaluation of degradable mulch film in different regions

0 day

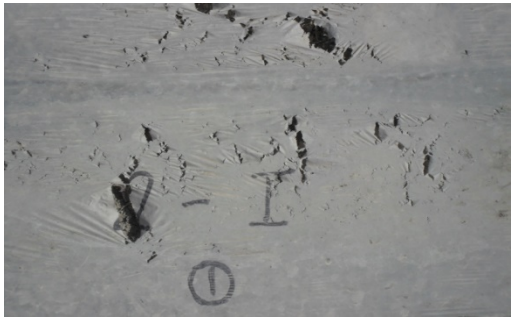
20 days

30 days

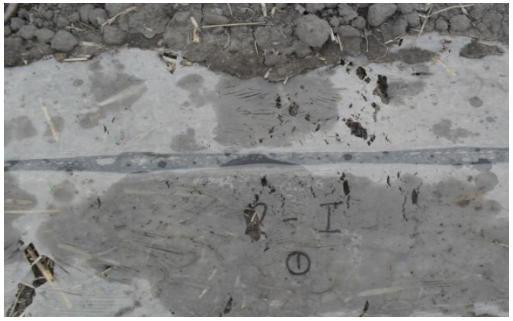
40 days

50 days

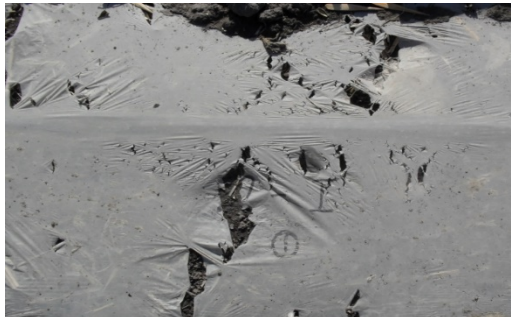
60 days



70 days



80 days



90 days

Evaluation of degradable mulch film in different regions

Results in Xinjiang

- Degradable mulch film for the test has good physical and mechanical properties, which could meet the needs of laying cotton cultivation machinery in Xinjiang. During the sowing process, no matter whether it is the evenness or fracture of the hole, there is no difference with the ordinary film.
- Degradation of the tested mulching film in the field is significant, but in different years, there is a difference in degradation rate. Overall, the degradation rate in the season can reach more than 30%. From the field observation and measurement results, the exposed and exposed parts The degradation rate of the plastic film is obviously faster than that of the buried part.
- The effect of degraded plastic film on crop yield is affected by external influence. Different climatic conditions and different field management measures would lead to different degradation rates and yields.
- No heavy metals and other toxic and hazardous substances were detected in the degraded plastic film

Evaluation of degradable mulch film in different regions

Degradable mulch film for corn in Shanxi province


42 days


49 days

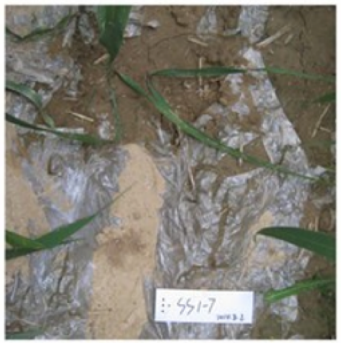

56 days


63 days


70 days


77 days


84 days


90 days


97 days


104 days


111 days


118 days


125 days


132 days

Evaluation of degradable mulch film in different regions

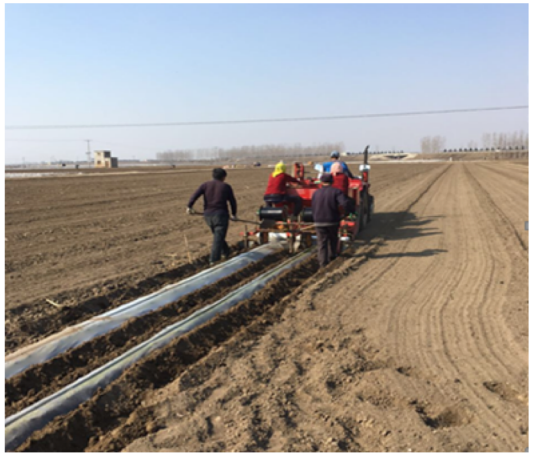
Degradable mulch film for corn in Shanxi province

- No significant degradation was observed 42 days before coverage.
- After 49 days, small cracks and cracks began to appear.

  A small amount of weeds can “break” the mulch.
- Slow degradation begins after 70 days
- Degradation of plastic film after 104 days
- Degradation of the pellicle was not completed after 132 days, and the mulching film was clearly visible on the ridge.

Evaluation of degradable mulch film in different regions

Degradable mulch film for potatos in Qingdao



Evaluation of degradable mulch film in different regions

Degradable mulch film for potatoes in Qingdao

- Degradable plastic film has good tensile strength and meets the requirements of mechanical laminating operations
- good degradation and performance, to meet the potato growth needs
  - There are difference between the rupture and degradation of the two types of biodegradable plastic films demonstrated.
  - They basically start to break down and degrade in the middle and late May.
- Degradable mulch film has a positive effect on potato yield
  - Demonstration data show that biodegradable plastic film has a good effect on early spring potato in North China intensive farming area.
  - Both types of biodegradable plastic film can significantly increase potato production, increase the proportion of large and medium-sized potatoes, reduce the proportion of sweet potatoes, and substantially increase the commodity rate of potato products.

Evaluation of degradable mulch film in different regions

Degradable mulch film for peanuts in Liaoning

12 days

46 days

62 days

69 days

69 days

76 days

90 days


97 days


111 days


119 days

125 days

130 days

Evaluation of degradable mulch film in different regions

Degradable mulch film for peanuts in Liaoning

- The mechanical properties of both degradable mulch films can meet the actual needs of peanut production in the test area.
- Both types of mulch film can be degraded in the field, but the degree of degradation and controllability of degradation and the matching with the growth and development of peanuts still need to be improved. Compared with ordinary PE, the soil temperature and moisture content are reduced, which ultimately leads to crop reduction.
- Although the degraded mulch film shows a certain degradation effect, there are still many residual films in the field, and the plants carry more residual film, and the effect of controlling weeds is poor (if there are few weeds in the field or the herbicide has better selection effect) Maybe the problem can be solved).

Prospects of degradable mulch film in China

Problems of biodegradable film development.

- Mechanical strength is generally insufficient, and it is difficult to operate on a large scale. This is one of the important reasons for limiting the wide application of biodegradable mulch film.
- Degradation time of biodegradable plastic film and the controllability of degradation are poor, and the function of increasing temperature and keeping the dust is poor. It is difficult to meet the requirements of different climatic conditions and crop growth.
- Compared with ordinary PE plastic film, high cost is an important limiting factor for the large-scale application of biodegradable plastic film.

Prospects of degradable mulch film in China

Development direction of biodegradable mulch film

- Intensive research on degradation mechanism and regulation technology
- Price reduction
  - Reduce the production cost through the means of large-scale production of raw materials, complete formulas, and improvement of processing techniques.
  - Evaluate the cost of mulching film and promote the large-scale application of degradable plastic film, not just the cost of raw materials.
- Develop independent intellectual property rights to promote the transformation of research results into degraded plastic film products
- Increase policy support. It is recommended to adopt subsidies or preferential policies for the application of biodegradable mulch film products.

THANK YOU