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Factor6: Sustainable Agriculture

Prevention and Control of Agricultural Film Pollution in Agricultural Production

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Abstract:

In recent years, due to the shortage of water resources in many provinces and the climate which restricts crop growth, agricultural film is being widely applied. Agricultural film is a kind of film with strong hydrophobicity, regular structure and tight texture, which can guarantee the soil moisture, salt content and so on. However, a large number of plastic films remain in the soil after the harvest. Farmers cannot recycle and dispose effectively in time, as it is difficult to degrade. So it causes pollution and damage to the soil with increased plasticizer. Furthermore, it has an impact on economic benefits.

In this article, I will analyze the harm of agricultural residues and some countermeasures.

Key words: agricultural film, recycling, biodegradation, multi-purpose films, mechanized treatment

1. The role of agricultural films

Agricultural film is made from oil and coal, whose main component is polyethylene with strong resistance. The mulching film is used to cover farmland, which can increase soil temperature, preserve soil moisture, promote seed germination, seedling growth and inhibit weed growth. In addition, the agricultural film has many different colors to meet the special needs in different regions.

2. Residue of agricultural films**2.1 Increased farming costs****2.1.1 Affecting seeding operations**

For saving the cost of agricultural production, the plastic film widely used by farmers is the ultrathin low-density polyethylene film whose thickness is 0.004-0.008 mm. Additionally, this kind of plastic film has fast aging speed and it is easy to break down but difficult to clean up. Before crop sowing, cleaning and recycling the residual plastic film on the land is undoubtedly a huge project. If the broken film is left in the soil tillage layer, it will wind the machinery, block the seeding mouth, affect the agricultural work, contributing to low sowing efficiency, and even further affecting the output and quality of crops.

2.1.2 Increased costs of inputs

Under the condition that mechanized recycling and treatment of agricultural film hasn't been popularized at present, it is necessary to increase more labor force. In the process of cotton sowing operation, farmers should clear up films every 1000 meters or so. But at the same time, the quality of crops will not be improved.

2.2 Impact on crop growth

The agricultural film blown by special process is made of polyolefin polymer compounds which is impermeable to water as well as air. The residual plastic film is difficult to degrade in soil and can not be combined with soil colloid. The accumulation of residual plastic film will seriously destroy the physical structure of

soil, hindering water, gas and heat exchange with soil, thus reducing the permeability, heat capacity and water capacity of soil, and destroying the physical structure of soil.

Along with the increase of mulching years on soil surface, the residual strength and density of mulching film goes up, and the pH value and the content of plasticizer increase as well. These changes of soil may easily cause local secondary salinization of soil, and with this soil organic matter, alkali-hydrolyzed nitrogen, available phosphorus, available potassium and other soil nutrient quality will also decline.



Fig .1 Residues after recycling of agricultural membranes

The deterioration of land properties due to the accumulation of residual film will reduce the emergence and seedling rate of planting crops, resulting in slow emergence, low emergence rate and lack of seedlings everywhere. The results showed that the seedling emergence rate of cotton and corn decreased with the increase of residual film in soil tillage layer, and the emergence time was delayed.^[1] In addition, the most active organ for nutrients and water absorption is roots. However, the soil membrane in direct contact with the crop root system, because of its toughness and ductility, can affect the normal growth of the crop root system, force the root system to bend, change the original root configuration or distortion of the crop, hinder the root system, and inhibit the growth of the crop root system by releasing toxic substances into the soil microenvironment. In addition, the residue of agricultural film will separate fertilizer, affect fertilizer efficiency and reduce yield.

2.3 Other impacts

The residual film of the ground outcrop is often mixed with forage and straw. If cattle and sheep eat the residual film by mistake, they will block the esophagus and affect digestion. The light ones are anorexia and the heavy ones will die.

With the residual agricultural film gradually getting smaller, it will be turned into microplastic with huge specific surface area, becoming the attachment carrier of pollutants and causing harm to agricultural ecosystem.

3. The current situation agricultural film recycling and disposal

3.1 Characteristics of China's agricultural film products

At present, the plastic film products used in our country are single, seriously homogenized, and based on single-layer colourless plastic film. So high-end plastic film products are lacking. The current plastic film types are polyethylene (PE) film,

polyvinyl chloride (PVC) film and ethylene-vinyl acetate polymer (EVA) film. The main type is PE which has the problems of fast aging speed, easy to break, very difficult to clean up, so many areas adopt a negative attitude towards plastic film recycling and disposal.

Besides, the quality of the film is worrying, because the qualified rate is low.

Table 1 Comparison of Main Physical Performance Indexes of New and Old Plastic Film

Pilot projects	Old national standard	New national standards		
	8-20 μ m	10-15 μ m	15-20 μ m	20-30 μ m
Stretch load (vertical/ horizontal)/N	≥ 1.3	≥ 1.6	≥ 2.2	≥ 3.0
Fracture nominal strain (vertical/horizontal)/%	≥ 120	≥ 260	≥ 300	≥ 320
Right angle tear load (vertical/horizontal)/N	≥ 0.5	≥ 0.8	≥ 1.2	≥ 1.5

3.2 Macro-management and awareness dimensions

Overall, people attach more importance to application than recycling. Our state has paid enough attention to the recycling of agricultural films, but farmers haven't. Taking my hometown Hebei Province as an example, Hebei Province is a large province with films. The plastic film has been used for a long time, and the area of land covered with mulch used for more than 20 years accounts for 34.02% of the total investigated cultivated land, and the cultivated land used for more than 10 years accounts for 60.99%. However, due to the decrease of mechanical strength and a large number of broken plastic films after use, the recycling of residual film is backward, the efficiency of manual picking up residual films is low, the cost of picking up residual film is high and the labor intensity is large.

Table 2 Recycling and disposal methods of Plastic film for land covered with mulch in Hebei Province

	Mechanized recycling	Manual pick-up	Landfill waste	Acquisitions by companies
Recycling	9.0%	90.8%		5.59%
Disposal			93.85%	

3.3 Technology and equipment for agricultural film recycling

Firstly, the pattern of agricultural film recycling is simple in general. For a long time, farmers pick up large pieces of residual films and burn them in the field. Farmers in some places even directly break the films into farmland or soil, which seriously pollutes the soil and the surrounding ecological environment, and also leads to a great waste of resources. Secondly, the existing recycling technology equipment can not meet the needs of agricultural production, in a serious lagging situation. In general, there are "three lows" in domestic plastic film recycling

machines with low collection rate, low working efficiency and low reliability, as well as a high rate of plastic-film inclusion.

4. Means of prevention and control of agricultural film pollution

4.1 Use of new plastic film

Biodegradable plastic film is a new kind of mulching film, which enables microorganisms such as bacteria, fungi and actinomycetes erode plastic film. After they attack plastic film, the polymer components undergo hydrolysis, ionization or protonation, consequently leading to mechanical damage, and splitting into oligomer fragments. Enzymes secreted by fungi or bacteria decompose or oxidize water-soluble polymers into water-soluble fragments to form new small molecular compounds. Eventually, it breaks down into CO₂ and H₂O.

The application of biodegradable plastic film is beneficial to the improvement of soil ecological and has little adverse effect on crop growth. And related studies show that biodegradable plastic film has similar functions as common PE plastic film.

At present, the application of biodegradable plastic film in China has begun to take shape.

Table 3 Basic information on the application of biodegradable plastic film products in China

But there are still three problems to be solved before large-scale application:

Year	Provinces	Main Crops	Scale
2015	Yunnan, Guizhou, Wuhan, Chongqing, Beijing, Hebei, Shandong, Liaoning, Gansu, Xinjiang, Inner Mongolia	tobacco, corn, potato, peanut, cotton, vegetables	a few hundred <i>mu</i>
2016	Hainan, Yunnan, Guizhou, Hubei, Chongqing, Gansu, Liaoning, Xinjiang, Inner Mongolia	tobacco, corn, potato, peanut, cotton, vegetables	a few hundred <i>mu</i>
2017	Hainan, Yunnan, Guizhou, Hubei, Chongqing, Beijing, Hebei, Shandong, Henan, Gansu, Liaoning, Xinjiang, Inner Mongolia	tobacco, corn, potato, peanut, cotton, vegetables	A few thousand <i>mu</i>
2018	Hainan, Yunnan, Guizhou, Sichuan, Hubei, Chongqing, Beijing, Hebei, Shandong, Henan, Shanxi, Liaoning, Jilin, Heilongjiang, Gansu, Xinjiang, Inner Mongolia	tobacco, corn, potato, peanut, cotton, vegetables	60 thousand <i>mu</i>
2019	All the provinces except Tibet	tobacco, corn, potato, peanut, cotton, vegetables, coarse cereals, rice	100 thousand <i>mu</i>
2020	All the provinces except Tibet	tobacco, corn, potato, peanut, cotton, vegetables, coarse cereals, rice	150 thousand <i>mu</i>

operability, functionality and economy. The operability refers to whether the tensile strength of the product can meet the requirements of film mulching operation.

Large-scale mechanized farming areas demand the high tensile strength and mechanized film mulching operation. Functionality refers to the ability to maintain suitable time in farmland before cracking so as to meet the requirements of increasing temperature, preserving moisture and suppressing grass, etc. Economy means that the cost of products should be gradually reduced by means of material production scale and product formulation precision so that the comprehensive costs are comparable or even more competitive with ordinary PE films.

4.2 Multi-purpose films

One membrane multipurpose technology refers to a no-tillage, steaming moisture-keeping technology for the stubble crops planted on the original mulching film in the spring of the year or the following year after the harvest of the mulching crop without removing the film. The purpose is to cover the film for one time so as to plant crops for many years, reduce the production cost, prolong the mulching time, preserve the rainfall in autumn and winter, and make maximum use of natural precipitation. In consequence, the amount of mulching film as well as the residual pollution of mulching film will be effectively reduced.

I have learned from the "the propaganda material about prevention and control of plastic film pollution " of Hebei Agricultural Environment Department that the multi-purpose technology of one film not only played the role of plastic film covering, but also reduced the disturbance of tillage to soil and decreased the damage of water and wind erosion to soil in winter and sprang through the reuse of plastic film of previous crops. In particular, it is beneficial to reduce plastic film input and alleviate the problem of plastic film residual pollution. But at the same time, there are some limitations and problems in multi-purpose film technology, especially the problems such as the inability to fertilize a large amount at a time, the low efficiency of topdressing operation and the mismatch with mechanized operation, which are the main obstacles to the expansion of the application area of the technology.

4.3 Mechanized recycling

4.3.1 Recycling of residual film on the surface at the seedling stage

At seedling stage, residual film on the surface is generally removed before crop toppings in order to facilitate weeding, fertilization and irrigation. At this time, the plastic film is used for a short time, not aging, and has a certain strength. Besides, there is less soil on the film, and the film is convenient to uncover, which is a lot easier to collect films. The recycling machine is represented by the MSM-3 cotton seedling residual film recycling machine and the CSM tooth chain suspension film collector. The structure is simple, the work reliable, and the film recycling rate is generally above 80%.

4.3.2 Recycling of surface residual film before ploughing

The recycling of surface residual film before tillage is to collect the residual film in the field after crop harvest and before cultivated land. Application of residual film recycling machine before tillage mainly includes: first, using straw returning machine

to construct a 30-50m wide film unloading channel perpendicular to crop planting line, then using stand straw film machine to gather the film into the film unloading channel, finally using forklift truck to clean the film out of the field; second, using a specific culm pulling and film lifting machine to pull cotton straw up and lay on the surface and complete membrane soil separation, then using finger-disk grass collecting machine to collect strips, finally manually sorting the film and straw; third, with crushing and returning machine and film working parts effectively combined, during the operation, the straw crusher will crush the straw and sprinkle it to the rear of the machine and tools, followed by the film parts for film operation; the fourth is to use horizontal straw crushing machine to crush the cotton straw and sprinkle it to the rear of the machine, then use pick-up parts to pick up the film and transport the residual film to the film collecting box to unload the film in the field.

4.3.3 Recycling of residual film after tillage

The recycling of residual film after tillage is mainly aimed at the residual film in the tillage layer of the past years, and it is carried out in combination with autumn turning and spring ploughing (before crop sowing) operation. At present, the recycling machine widely used in production is the dense projectile tooth film machine, the flat film joint operation machine and the ground preparation machine with the film rake and the film roller. The working depth is less than 5cm, and the recycling rate of the residual film is 50 percent. Mostly, manual film removal is required, which has the trouble of low-operating efficiency and high-labor intensity. In order to improve the recycling efficiency, we should focus on the automatic film removal mechanism, the depth of film collection and the convenience of film unloading.^{[2][3]}

4.4 To enhance law enforcement by the government

In 2020, the People's Republic of China issued No .4" Measures for the Management of Agricultural Film ", so the management of agricultural film in China has been governed by laws.

4.4.1 Promotion of Source Reduction

Hebei is trying hard to explore solutions to the reduction of agricultural film and increasing the efficiency. At present, the comparative evaluation experiment of total biodegradable plastic film has been carried out in Dingzhou, Chongli and Cheng'an County, Hebei Province for typical coated crops such as vegetables, cotton and potatoes. Apart from this, in the areas with good water and heat resources, we should reduce plastic film mulching by breeding drought-resistant varieties, crop rotation, uncovering plastic film in suitable period, etc. For areas with poor resource endowment, the efficiency and intensity of the film should be increased and reduced by means of structural adjustment, multi-year use of films and improvement of coverage.

4.4.2 Promotion of Full-course Supervision

The market supervision departments should be responsible for the quality

supervision and management of agricultural film products, perform the inspection duties. It must be banned to purchase or sell agricultural films that do not meet the national standards .

The agricultural and rural departments should actively cooperate with the market supervision and other departments to do a good job in the quality supervision of plastic film products and film residual monitoring to prevent off-standard plastic film from entering the market and spreading into the farmland at the source, and to monitor the residual film in strict accordance with the national standards at the agricultural film recycling stage.

Competent departments of industry and information technology must shoulder the responsibility for guiding production, urging and educating producers to implement relevant standards in accordance with the law, without slacking off or shifting responsibilities.

The departments of ecological environment are supposed to supervise and administrate the process of recycling and reusing to check if it causes environmental pollution or not.

4.4.3 Combine rewards and punishments

The combination of rewards and punishments, first of all, needs to establish the operation mechanism of the whole industrial chain of plastic film application and recycling. According to the relevant laws and regulations, the main body responsible for the removal of plastic film shall be punished so that the problem of plastic film recyclability will be effectively solved. It is also a good choice that subsidies can be applied to farmers so as to promote large growers to clean and recycle plastic film in the field, realizing the combination of "use" and "collection ". Moreover, privileges on land, electricity, water, credit and tax should be provided for waste agricultural film recycling enterprises to support the socialized service organizations and enterprises engaged in waste agricultural film recycling so as to enhance the acquisition rate of enterprises.

I hope that through the above measures, all aspects of the use, recycling and reuse of agricultural films will be further improved, and government departments will cooperate with each other. Farmers should also realize the harmfulness of agricultural film residue, improve their enthusiasm and undertake the responsibility for recycling agricultural films.

Last but not least,I'm really grateful to my teachers' guidance and efforts.Even though it is seemingly a impossible and highly tough task that I have to finish a paper within a month,my teachers still believe in me and support me whenever I need their help.Secondly,I would like to thank the Department of Agriculture in Hebei Province for their professional help,which plays a crucial part in my thesis writing.Finally,I am indebted to my parents for encouraging me to do whatever I want to do.

Reference:

[1]Zhang Zhiyou, Xie Peigeng, Dai Minghua. Analysis on the harm and prevention and control measures of residual pollution of mulching film [J]. Agricultural Science, 2018, 8(8): 848-863.

[2]Present situation of s223 plastic film recycling machine and the development of related mechanized technology [A]. Green Industry ,2016,9(11):1003-1650