



# Environmental Science

*An Indian Journal*

*Current Research Paper*

ESAIJ, 9(6), 2014 [215-222]

## Rethinking plastic bag pollution problems in China

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### ABSTRACT

Plastic bag pollution problems which have caused great pressure on environmental appearance in China recently. The Chinese government has undertaken a "Plastic-bag ban (PBB)" since June 2008, but the effect is weakening gradually. This study introduces the usage and harm of plastic bags in China. The root causes and the existing solution methods for these problems are analyzed by visiting varied markets and taking public-opinion surveys in Hangzhou, Zhejiang province. Several exploratory methods are introduced to reduce plastic bag use rapidly.

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### KEYWORDS

Plastic bag pollution;  
Root causes;  
Existing methods;  
Exploratory methods;  
China.

### INTRODUCTION

Over one billion plastic bags are consumed in China per day, equalling over 20 million tons of petrochemicals being consumed yearly, according to Dong Jinshi, a secretary-general of the International Food Packaging Association. It is a huge number compared to 90 billion plastic bags used annually in America<sup>[3]</sup> and 30 billion annually in Japan<sup>[8]</sup>. The purchase value of German machinery in China's plastics and rubber processors has risen to a record value of 766.4 million Euros in 2011, 30.5 percent higher than the 2010 figure. "That is a new record for China and at the same time the German industry's highest volume of exports ever to a single country," as said by Ulrich Reifenhauer, chairman of the VDMA, the German Plastics and Rubber Machinery Association. There are over 60 thousand plastic manufacturers with different scale in China at present, but most products can not be degraded. White pollution is an appellation of environmental non-degrad-

able plastic garbage (especially plastic bags). The widespread usage of plastic bags has caused white pollution which cost up to 2.35 million Euros each year to regulate in China. The Plastic bag pollution problem has attracted great political and public attention especially when it connects closely to environmental problems. Polyethylene plastic bags are usually stable and resistant to degradation. Even though the polyethylene will naturally fragment and bio-degrade, but this process is estimated to takes up to one thousand years<sup>[15]</sup>. The production and transportation of plastic bags not only consumes energy, but also depletes resources and generates global warming emissions<sup>[20]</sup>. The wasted plastic bags mixing in soil will influence crops in assimilating nutrient and moisture and also cause a reduction of output. They provide several million habitats for mosquitoes to breed which increases the risk of malaria<sup>[1]</sup>. Plastic membrane is the main component of agricultural non-point source (NPS) pollution<sup>[16]</sup>. The exudation of plasticizer and additives may pollute the underground wa-

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ter. Being burned with urban garbage, plastic bags release toxic gases such as furan and dioxin, and leave unhealthy residues that include lead and cadmium<sup>[5]</sup>. They are also used directly to pack hot fast-food which can thermally decompose when the temperature is over 65°C, especially the unconverted chloroethylene monomer can combine with riboflavin which can be destructive to human liver.

The Chinese government has released the “Notice about Limiting the Production and Selling and Usage of Plastic Shopping Bag” in December 31, 2007, it is prohibited to produce, sell and use plastic shopping bags with a thickness of less than 0.025 mm since June 1, 2008, this notice is also called “Plastic-bag ban (PBB)”, PBB demands consumers to pay for the plastic bags, which is called “Paid use of plastic shopping bag (PUPSB)”, PUPSB should be carried out in all the commodity retail places such as supermarkets, shopping centers, peddler’s markets and so on, no plastic bags could be used for free. PBB, which has been issued and implemented for nearly six years, has been accepted by more and more people. Especially in low-income families, people tend to reuse plastic bags<sup>[21]</sup>. Charging reasonably for plastic bags in supermarkets has successfully reduced plastic bags usage by two-thirds—an introduction in a press conference on March, 2010 by Xie Zhenhua, a deputy director of the National Development and Reform Commission of China. A drop in petroleum use could be seen when the PBB was implemented. Pre-ban, China refined “nearly 5 million tons (37 million barrels) of crude oil each year” to produce plastic bags<sup>[11]</sup>. PBB has a satisfactory effect in reducing white pollution. The plastic bag management proposals’ strength lies in its integrative approach both in generating the proposal policies and their implementation<sup>[7]</sup>. However, a study of plastic bag consumption estimates that supermarkets use 25% of all plastic bags, while the remaining 75% is consumed by department stores, service outlets, retailers, and open markets<sup>[6]</sup>, free plastic bags are supplied at present in most places except supermarkets. The effect of PBB is weakening gradually.

China has a population of nearly 1.4 billion and has a massive consumption of plastic bags. Reducing usage of plastic bags in China will ease environmental and energy pressures in the domestic area and even the

world. In order to follow a scientific approach of development and to construct a resource-conserving society and environment-friendly society, the consumers are guided and encouraged to use plastic bags in a reasonable way. Everyone should have a sense of reducing white pollution and protecting the ecological environment.

## MATERIALS AND METHODS

### The widespread usage of plastic bags recently

Plastic bags are popular with consumers for many reasons which include; easy availability, easy storage, easily discarded, functional, cheap, lightweight, portable and transportable on account of their thinness and lightness, and have many merits compared to alternatives such as paper bags and mesh bags. They are often made from polyethylene or polythene film. Polyethylene is a polymer that consists of long chains of ethylene monomer. Ethylene is a by-product of gas or oil refining<sup>[2,13]</sup>. The amount of plastic bags has reduced by over 24 billion equivalent to 0.6 million tons of plastic product since the implementation of the PBB policy, according to The National Development and Reform Commission on May 26, 2011. However, the use of plastic bags has become a part of the city cultural identity and perhaps the problem of plastic bag waste is ignored gradually. Kinds of plastic bags can be seen in most corners in many cities in

**TABLE 1: The basic characters of the majority of plastic bags in the survey. Plastic bags are obtained mainly from supermarkets, shopping centers, peddlers’ markets and other street vendors. The basic characters of majority kinds of plastic bags are recorded, some record by franking and some measure with a ruler, the individual weight is calculated by weighing 50 plastic bags then divided by 50, bearing capacity measure is an inaccuracy for different merchandise, and the price of them are recorded by inquiry and purchase**

Height (cm)	Bottom side size (cm)	Thickness (mm)	Weight (mg)	Bearing capacity (kg)	Price (euro)
38	25*5	0.025	501	unclear	0.012
45	30*6	unclear	849	unclear	0.012
47	42*12	unclear	2499	10	0.124
48.5	30*8	0.025	1225	7	0.025
48	29*8	0.027	1177	6	0.025
58	34*7	0.025	1453	6	0.025
58	35*10	0.027	2136	7	0.025
60	40*8	0.025	2021	unclear	0.037

China recently. The basic character of the majority of plastic bags is presented in TABLE 1.

### Methods

In this study, the usage of plastic bags was recorded simply by visiting varied markets in the daytime between October 22 and November 14, 2013, which included 15 supermarkets, 12 shopping centers, over 20 peddlers' markets and other street vendors in Hangzhou, Zhejiang province. Hangzhou is a big city in China, the plastic bag consumption in Hangzhou is an epitome of China. By taking public-opinion surveys of 400 actual number of questionnaires and 320 efficacious number of questionnaires of which responders included 79 salespersons, 9 store managers, 43 peddlers and 189

consumers in the same city, among them, 147 male and 173 female, 39 were less than 20 years old, 76 were between 21 and 30 years old, 78 were between 31 and 40 years old, 81 were between 41 and 50 years old, 29 were between 51 and 60 years old, 17 were more than 60 years old. The main questions and choices are listed in TABLE 2, responders could make multiple choices. The statistics of the questionnaire are presented in TABLE 3. The root causes of usage of plastic bags are summarized according questionnaires. The relative merits of the existing methods are presented, on this basis, new exploratory methods are introduced to reduce plastic bag numbers rapidly.

## RESULTS AND DISCUSSIONS

**TABLE 2 : The main questions in the questionnaire survey. The main questions are listed as below, beside these, the age, sex, profession and number of questionnaires are also recorded, some questions with different options and blank lines, interviewees can make single or multiple choices and can also write down personal viewpoints in blank lines. All the data was gathered statistically carefully in Microsoft Excel**

Main questions
Do you know plastic bag pollution problems? (Single choice) A: Know B: A little C: Don't know
The selection percentage of PUPSB when you do shopping ? (Single choice) A: <20% B: 20%--40% C: 40%--60% D: 60%--80% E: >80%
What do you think are the root causes of the plastic bag pollution problems? (Multiple choices and personal viewpoints) A: Trouble to take B: Free or low-cost C: Low usage D: Indifference to environmental consciousness E: Advantages in using F: Commercial profit Others: _____
What do you think can effectively alleviate the plastic bag pollution problems? (Multiple choices and personal viewpoints) A: Production alternatives B: Strengthen management C: Improve utilization D: Policy prohibits E: Promoting environmental protection Others: _____
What is your best price (euro) of plastic bag if you agree it can works by raising price of plastic bags? (Single choice) A: <0.037 B: 0.062 C: 0.124 D: 0.186 E: >0.249

### The amount and root causes of usage of plastic bags

The usage of plastic bags in some markets in Hangzhou, Zhejiang province is listed in TABLE 4. It can be seen that the average usage amount of plastic bags is huge. The percentage of purchasing plastic bags is nearly 80% in supermarkets and only 2% in farmer markets where free bags are supplied. The main purchaser of PUPSB is the young, especially young men, the aged and middle-aged women are more inclined to refuse PUPSB.

The root causes of usage of plastic bags are summarized below, the data statistical chart is made according to questionnaire results which are presented in Figure 1. The following causes are expressed in detail to help readers understand the outcome of the questionnaires.

- a. *It is troublesome to take plastic bags to markets especially when one can not be sure how many bags could be needed.* Most consumers have not developed the custom of bringing shopping bags themselves, many shopping behaviors are random and have no sense to prepare bags for themselves.

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**TABLE 3 : The statistics of China's plastic bag pollution problems questionnaire in Hangzhou is listed below, the number of questionnaires and choices of main questions are statistical, and also include the age, sex and profession messages**

Statistics of China's plastic bag pollution problems questionnaire - Hangzhou, 2013				
Questionnaire survey date	2013.10.22—2013.11.14			
Actual number of questionnaire	400			
Efficacious number of questionnaire	320			
Do you know plastic bag pollution problems? (Single choice)	A: 216	B:73		
What is the root causes do you think of the plastic bag pollution problems? (Multiple choices)	A: 327	B: 354	C: 87	D: 105
What do you think can effectively alleviate the plastic bag pollution problems? (Multiple choices)	A: 167	B: 153	C:133	D: 197
What is your best price (euro) of plastic bag if you agree it can works by raising price of plastic bags? (Single choice)	A:29	B:43	C:81	D: 89 E:78
Age	≤20: 39	21-30:76	31-40: 78	41-50:81
Sex	Male: 147		Female: 173	

**TABLE 4 : The usage of plastic bags in some markets in Hangzhou, Zhejiang province is listed below. It can be seen that the average usage amount of plastic bags is huge. The percentage purchasing plastic bags is nearly 80% in supermarkets and only 2% in farmer markets where free bags are supplied. The main purchasers of PUPSB are the young, especially young men (about 90%), the aged and middle-aged women are more inclined to refuse PUPSB**

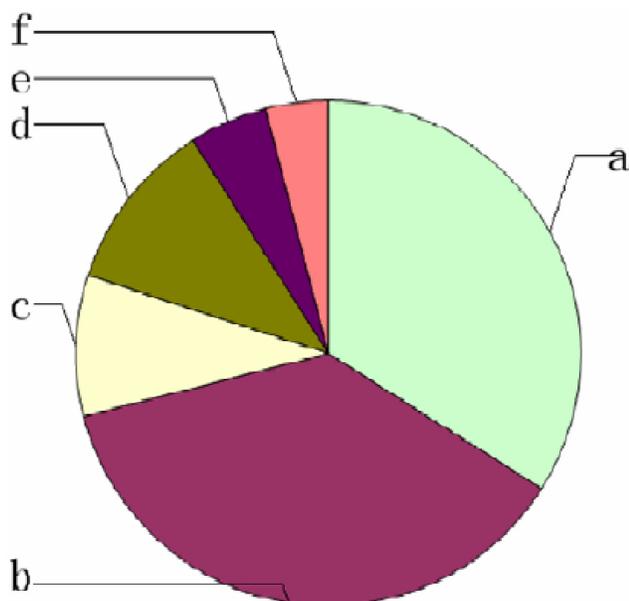
Main plastic bags consume markets	Average usage amount of plastic bags per hour	The percentage of purchasing plastic bags	The descending order of purchaser of PUPSB
Wal-Mart stores	390	73%	young women (about 80%) > young men (about 90%) > middle- aged women (about 65%) > middle-aged men (about 85%) > the aged (40%) > children (about 95%)
WU MART	410	82%	
Auchan	460	77%	
Carrefour	430	81%	
Trust-Mart	360	81%	
Metro	440	79%	
Farmer markets	680	2%	

There are also no extra pockets to pack plastic bags especially when wearing cool clothes in summer. It is a strange thing when somebody goes out with their pockets full of empty bags.

- b. *It is free or cheaper to pay for plastic bags compared to the rising high price of commodities.* Anyone taking plastic bags to markets will be considered as mostly parsimonious instead of taking environment protection actions. The prevailing price of plastic bags in supermarkets is about 0.025 to 0.037 Euro, it is much cheaper compared to the high price of other commodities. The rolling plastic bags in supermarkets are usually free and there is still unlawful wholesaling of ultra-thin plastic bags. The PBB has not been practically executed in farmer's wholesale markets, almost all booths and shops still offer plastic bags for free and there is no

specific stipulation on sellers offering free plastic bags<sup>[22]</sup>.

- c. *There are almost no extra plastic bags to reuse because many of them are disposable bags and others are used as a garbage bag.* A plastic bag dirty easily and frangible, it can be reused twice or more if packing clean things, some of them are used as garbage bags after first use. A large number of illegal plastic bags could be seen in many markets, the quality of them do not meet the requirements of PBB, those plastic bags can not be reused and are thrown away directly after disposable use.
- d. *People have little sense of environment protection concerning plastic bag waste and the supervision is not strict.* There is no universally accepted opinion as to the effect of PBB on reducing white pollution. People still have no correct knowl-



**Figure 1 :** The root causes of usage for plastic bags are summarized below, the data statistical chart is made according to questionnaires results, and responders could make multiple choices during the public-opinion surveys. The root causes are presented in Figure 1. The following causes are discussed in detail to help readers to understand the outcome of the questionnaires. We can see that the reasons of “a” and “b” take a large percentage. The root causes of usage of plastic bags in questionnaires. a: Trouble to take. b: Free or low-cost. c: Low usage. d: Indifference to environmental consciousness. e: Advantages in using; f: Commercial profit

edge on the goals of implementing PBB and mistake PBB for lowering merchants’ packaging cost, which would bring negative influence on the implementation effect of PBB policy. Plastic bag manufacturing enterprises are also lacking of self-discipline. The supervision is not strict in the course of implementing PBB. There are countless petty dealers and innumerable ones operating in mobile ways in China, which makes its hard to regulate.

- e. *Plastic bags have unparalleled advantages compared to other packaging materials such as paper bags, shopping baskets and mesh bags.* For example, it is convenient to pack commodities which leak easily such as fresh products, halogen products, and cooked food products. There is also a sanitation problem. Packing with plastic bags can ensure consumers hands do not contact directly with the commodity, for plastic bags do not absorb oil and are dust free.
- f. *It is a feasible way to make a commercial profit.*

The major reason why PBB has been impeded in markets is merchants boycott. Almost all the supermarkets offered free plastic bags before implementation of the stipulation of PBB and now consumers pay the cost of plastic bags. Supermarkets have reached a consensus to use PUPSB instead of providing free for commercial competition. It is a big expense to supply free plastic bags relative to the huge usage in many supermarkets. Moreover, plastic bag production is a very profitable investment for manufacturers.

### Countermeasure analysis of reducing plastic bags

#### Experience of existing methods

#### Experience of environmental protection propaganda

In order to reduce plastic shopping bags use, the Selangor state government has declared every Saturday as a “No Plastic Bag Day” which has been effective since 1st January 2010. This campaign is aimed at reducing the usage of plastic bags as well as to increase the awareness level of consumers on the negative impacts of using plastic shopping bags<sup>[17]</sup>. The Chinese government and other environment protection organizations have always been dedicated to environmental protection propaganda for many years, it makes people understand better about the environmental damage that is caused by plastic bags, which require a very long term to be disposed of naturally, and over 90% of responders know the widespread usage of plastic bags will cause white pollution, compared with the nearly 80% purchasing PUPSB, it reflects consumers’ non-conformity in thinking and doing. This phenomenon also reflects the propaganda has a certain role in mind but lacking essentially binding effect in action. The effect is not obvious by improving people’s environmental awareness and developing consumption customs for environmental protection.

#### Experience of plastic bag ban and levy

A publication of the latest data from Europe shows that the EU consumes 0.8 million tons of disposable plastic products yearly. The European Commission announced that they were considering a total ban of using plastic bags in the EU to prevent further deterioration of the ecological environment., Relevant recommenda-

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tions for the use of paid disposable shopping bags may see legislation within two years, according to a report of the British Daily Mail on March 25, 2012<sup>[19]</sup>. A study from the Hong Kong plastics industry says that contrary to expectations in the implementation of the plastic bag levy, the city's bag tax has increased the amount of plastic used in bags by more than 25 percent, the plastic bags in disposable range reduced significantly while the amount of thick garbage bags and reusable non-woven plastic bags as the substitute saw a sharp rise<sup>[18]</sup>. A ban creates an "equality of burden" for the criteria of social equality<sup>[12]</sup> and a levy is efficient because it does not make anyone much better at the expense of another. In a word, a plastic bag ban and levy is an effective measure to regulate and control the quantity of consumers purchasing plastic bags, but the effect may be short-term from the example of Hangzhou and Hong Kong.

### Degradable plastic bags

A research team led by Kimura Takao from Utsunomiya university graduate school cooperated with Tochigi antibacterial institute in Japan, by adjusting the proportion of scallop shell micro calcium compounds which is the main component of the degradable plastic, develop adjustable speed degrading plastic film successful, according to a report by Japanese newspaper Nikkan Kogyo Shimbun on May 30, 2012. Thai Bioplastics Industry Association (TBIA) and BASF launched a pilot project to highlight the potential of composting as a feasible and effective waste management option. The pilot project will demonstrate the use of biodegradable plastic bags to collect household organic waste in the most efficient way, news from BASF in press releases 2009. And Shanghai restore polymer materials Co., Ltd. developed biodegradable plastic bags in 2008. Taiwan Grabio Greentech Corporation also displayed biodegradable plastic bags in Taiwan Trade Expo in Shanghai Pudong Expo on Apr. 5-8th, 2012.

Global plastics consumption is forecast to grow five percent per annum for the period 2007 through 2015. In actual production terms, this represents an overall global production level of 330 million tons by 2015<sup>[14]</sup>. Global consumption of biodegradable plastics is about 0.3 million tons in 2007 and 0.695 million tons in 2009.

It is still less than 1 percent of the global plastics consumption. The cost of present degradable plastic bags is several times more than for polyethylene plastic bags, the loading capacity and toughness is also not as good as polyethylene plastic bags. Degradable plastic bags should be developed by using advanced science and technology, producing cheap substitute bags would be a fundamental way of limiting plastic bag usage. So it will take a long time to replace polyethylene plastic bags completely.

### Recycling of plastic bags

There is no shortage of plastic bags to collect in the U.S. with 100 billion plastic bags being used once or twice annually. Plastic bag recycling has already increased by 27 percent from 2005 to 2007. Plastic bag manufacturers working with the American Chemistry Council have set a goal to increase the recycled content of plastic bags to 40 percent by 2015.— News item published on the environment news network, April 27, 2009<sup>[9]</sup>. A similar situation will happen in China, which the recycling capacity of plastic bags will reach 15 million tons in 2015, and with 30 percent recycled content, according to a forecast of the China Plastics Processing Industry Association. A main way to recycle plastic bags is garbage collection, and classified dustbins can be seen in most cities in China also in other countries. However, the effect is not obvious for residents who always pack household garbage in a big garbage bag and the classified garbage is carried away by garbage truck unified. Classified dustbins have become formalism to some extent.

### Attitude to use of plastic bags and PBB

The issue of usage of plastic bags remains contentious. On one hand, plastic bags pose a serious environmental threat. On the other hand, the advantage of plastic bags can not be replaced by other materials at present. We do not advocate a total ban on plastic bags and do not abandon modern civilization completely. Our proposition is to reduce the use of plastic bags gradually and produce plastic bag substitute or modify the nature of plastic bags energetically, and to construct a resource-conserving and environment-friendly society. However, the most important thing right now is to stop the widespread use of plastic bags which has caused great pressure on environmental pollution.

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The implementation of PBB has reduced the usage of plastic bags to some extent. However, PBB should be implemented and strengthened consistently by relevant government departments. Customers now pay most bills for plastic bag pollution instead of markets and government as before. It is the responsibility of government, markets, manufacturers, franchisers, customers and everyone in society to reduce plastic bag pollution. The most fundamental way is to reduce the use of plastic bags rapidly. It will not only resolve plastic bag pollution problems but also the economic burden of customers.

### New exploratory methods of reducing plastic bags rapidly

The method of developing plastic bag substitutes or calling for environmental protection is effective, but it requires a very long term to reduce plastic bags. One important thing is certain, that the negative impacts associated with plastic bag consumption will continue to exist unless measures are undertaken effectively. Great pressure of environmental pollution asks us to resolve it as soon as possible. There is a long-standing academic consensus on the superiority of market instruments over direct controls and regulation in terms of both static and dynamic efficiency<sup>[10]</sup>. The idea that a charge for plastic bags could be used as an optimal pigouvian intervention is problematic on a number of counts<sup>[4]</sup>. New exploratory methods of reducing plastic bags rapidly are described in detail below:

#### Replaceable and high price plastic bag

The price of plastic bags can increase to 0.12-0.2 Euros according to questionnaire, which is much higher than the prevailing price (0.025 to 0.037 Euros). Many consumers will abandon purchase of high prices plastic bags and look for other alternatives. These plastic bags can replace new ones at relatively low price anytime and any markets, pictures or words that depict the environmental damage that is caused by plastic bags should be posted in a conspicuous location. All the markets should use uniform plastic bags which are supplied by relevant departments, and the replaced bags should be recycled regularly with unified treatment.

#### Plastic bag subsidies

Customers will get different plastic bag subsidies

each time according to the amount of consumption, and the purchasers of plastic bags will pay the subsidies. Government and markets should maintain plastic bag subsidies measures if the follow-up subsidies are not enough. This method not only rewards customers to refuse PUPSB, but also an economic punishment to those purchasing ones.

#### Green basket plan

Besides the measure of plastic bag subsidies, reusable baskets with personal registration should be placed in varied markets. These baskets are free for first time use and demand a high price when applying for a new one, they are generalized in all markets and can be lent and returned in any market for free using a personal card. It is convenient for consumers because they do not worry that the baskets will be lost and avoids the trouble to always take a basket. The raw material of baskets can be bamboo, twig, vine and reusable polyethylene plastic. These materials are vice like and cheap. For example, a bamboo basket price is less than 1 Euro and it can be used for many years, the bamboo resource is rich and production cost is cheap in China. Consumers are also encouraged to bring their own baskets.

#### No garbage bag action

Home use garbage bags are always poor quality and for disposable use. It is a very common phenomenon that people use plastic bags as trash can liners, which maybe convenient or sanitary for the individual but cause negative impact on our living environment. We should leave our small garbage cans or wastepaper baskets unlined and dump garbage directly into large garbage cans or dumpster. No garbage bag should be provided in markets.

## CONCLUSION

The widespread usage of plastic bags after PBB has caused great pressure on the environment in China. It is an urgent thing to reduce the amount of plastic bags opportunely and effectively. The plastic bags consumption is huge in China, the main root causes of usage of plastic bags are involved with trouble to take, free or low-cost, low re-usage, indifference to environmental

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consciousness, advantages in using and commercial profit. By learning from experiences of existing methods, new exploratory methods include replaceable and high price plastic bag, plastic bag subsidies, green basket plans and no garbage bag action are introduced aiming to limit usage of plastic bags rapidly.

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