Consumption and production waste: another externality of tobacco use

Thomas E Novotny, Feng Zhao

Abstract

Objective—To describe the waste produced by and environmental implications of individual cigarette consumption (filter tips, packages, and cartons) and tobacco manufacturing.

Study selection—All available articles and reports published since 1970 related to cigarette consumption and production waste were reviewed.

Data sources—Global cigarette consumption data were used to estimate cigarette butt and packaging waste quantities. Data from the Center for Marine Conservation’s International Coastal Cleanup Project were used to describe some environmental impacts of tobacco-related trash. Data from the United States Environmental Protection Agency’s (EPA’s) Toxics Release Inventory and reported global cigarette consumption totals were used to estimate waste production from cigarette manufacturing.

Data extraction and synthesis—In 1995, an estimated 5.535 trillion cigarettes (27 675 million cartons and 276 753 million packages) were sold by the tobacco industry globally. Some of the wastes from these products were properly deposited, but a large amount of tobacco consumption waste ends up in the environment. Some is recovered during environmental clean-up days. For the past eight years (1990–1997), cigarette butts have been the leading item found during the International Coastal Cleanup Project; they accounted for 19.1% of all items collected in 1997. The tobacco manufacturing process produces liquid, solid, and airborne waste. Among those wastes, some materials, including nicotine, are designated by the EPA as Toxics Release Inventory (TRI) chemicals. These are possible environmental health hazards. In 1995, the global tobacco industry produced an estimated 2262 million kilograms of manufacturing waste and 209 million kilograms of chemical waste. In addition, total nicotine waste produced in the manufacture of reduced nicotine cigarettes was estimated at 300 million kilograms.

Conclusions—Laws against littering relative to cigarette butts could be better enforced. Additional taxes might be levied on cigarette products that would then be directed to environmental clean-up efforts. The tobacco industry should improve the biodegradability of filters, reduce packaging waste, and educate its customers. Worksites and public buildings should be encouraged or required to supply appropriate disposal mechanisms at all building entrances. Public awareness campaigns about the magnitude and prevention of cigarette consumption waste could be developed through partnerships among environmental groups, health organisations, and environmental protection agencies. Tobacco production waste should be a source of concern and regulation by governments throughout the world; it contains numerous chemicals which may be considered health hazards, not the least of which is nicotine produced in the manufacture of low-nicotine cigarettes.

Keywords: tobacco waste, litter, environmental impact

Introduction

Externalities are the costs or effects of a consumer behaviour that may not be borne by the consumer and hence may not be included in the price of the consumed good. For example, a commonly analysed externality of cigarette smoking is the economic cost of smoking-attributable medical care for smokers, which is borne by non-smokers and by governments as well as by the smoker. Another externality is the health effects of environmental tobacco smoke on non-smokers or the private sector. Here we describe additional externalities of tobacco use involving waste production due to individual consumption as well as to the tobacco manufacturing process.

The waste products of cigarette consumption are clearly visible whenever one walks on a city sidewalk or uses a public beach. Cigarette butts, packages, cellophane wrappers, and cartons are ubiquitous forms of trash. Although
the paper and tobacco components are biodegradable, the filters and plastic wrappers are retained in the environment for long periods of time. Cigarette filters most commonly contain cellulose acetate, and some research has been undertaken by the tobacco industry to improve biodegradation of this material.3 Cellulose acetate filters may persist under normal environmental conditions for 18 months or more.4 Moreover, the butts themselves may be an acute health hazard to animals and to small children, who may eat them.5

Historically, the ocean has been a common dumping ground for human-made debris. The Statistical record of the environment reports chemicals in tobacco manufacturing waste in the United States that are treated onsite and offsite, but not released into the environment. Operating and capital investment cost estimates for abatement of these wastes are available for 1988–1992. We also reviewed older reports providing information on tobacco manufacturing waste production and pollution control.12 Finally, a single report, from Italy, describes how solid waste produced in manufacturing low-nicotine tobacco products contains high concentrations of nicotine.13

Data extraction and synthesis

CONSUMPTION WASTE

Worldwide, an estimated 5.535 trillion commercially manufactured cigarettes were consumed in 1995 (table 1). Specific estimates on filtered cigarette consumption for that year are available for 49 countries.14 These estimates were calculated as the number of units manufactured in the country, plus imports and minus exports; smuggling totals were excluded (globally, up to a third of annual exports are contraband, or smuggled15). Based on a weighted average of filtered cigarette consumption reported from the 49 countries, it was estimated that 83% of cigarettes consumed were filter-tipped. The number of packages (assumed average 20 cigarettes per package)
produced globally was estimated at 276 753 million, and the number of cartons (assumed average 10 packets per carton) was estimated at 27 675 million. Table 1 does not include estimates for other packing materials, such as the corrugated paper boxes used to package cartons and the plastic wrappers used on some cigarette packages.

The data in Table 1 represent the potential amount of trash deposited directly into the environment, but some countries, notably Australia, have attempted to describe the nature of trash collected from various sites, including waterways, roadways, parkland, public facilities, and so forth. Overall in Australia, cigarette butts comprised 5.0% (by absolute number) of all trash items collected on one clean-up day in 1993. They ranked sixth among all items collected (figure 1); in addition, cigarette packets and cartons were the most common individual paper items (“paper pieces” in the figure). Since 1986, CMC volunteers around the world (90 countries in 1997) have participated in local clean-up efforts at approximately 5000 sites, including land-only, underwater, and shoreline sites. In 1997, 6 185 081 debris items were removed from these sites, and cigarette butts were the leading item among the top 20 items collected. Cigarette butts were almost three times as likely to be found as the next most frequent item, “plastic pieces.” Overall, cigarette butts represented 19.1% of all items collected in 1997; since 1990, cigarette butts have represented at least 12% of total items collected (figure 2) (personal communication via email, Laurie Williams, Center for Marine Conservation, August 1998).

**Figure 1** The 10 most common items of trash (52.4% of total trash) collected on Australia Clean Up Day 1993. Source: Keep Australia Beautiful National Association.
These estimates assume that all cigarette production processes around the world are similar and were unchanged with respect to waste production between 1963 and 1995 and that prices to control these wastes would increase at the same rate as the consumer price index. It may be that the price to control such waste has diminished with improved technology, but it may also be true that more stringent environmental controls, at least in industrial countries, may create higher costs of managing solid, liquid, and airborne wastes due to manufacturing.

The actual TRI chemicals reported by American manufacturers for 1996 (the last year for which data are reported) are shown in Table 3. These include sources from cigarettes, cigars, smokeless tobacco, and other manufacturing sites.17 These wastes were treated onsite, treated offsite, or released into the environment. The total (3 114 221 kg) is almost a million kilograms higher than the TRI total reported in 1992 (table 2), but a significant portion of this difference may be accounted for by the inclusion of nicotine in the TRI. A discussion of the potential environmental impact of all these chemical releases is beyond the scope of this paper.

Nicotine is an interesting tobacco production waste product. The tobacco manufacturing process and all activities that use tobacco produce solid or liquid wastes with high concentrations of nicotine.18 Partly in response to information about the addictive nature of nicotine,19 the market for low-nicotine cigarettes has been growing. Thus, an ironic outcome of this market growth is the increased need to detoxify nicotine in tobacco production waste. A non-recyclable, powdery, nicotine-containing waste is formed during tobacco production, which has average nicotine content of 18 g per kg of dry weight. This waste is classified as “toxic and hazardous” by European Union Regulations when the nicotine content exceeds 500 mg per kg dry weight. According to a 1997 study from Italy, an average 3 million kilograms of this waste are reported in 1995 by the tobacco industry to be produced from 55 300 million cigarettes manufactured in that country.20 If manufacturing processes and waste outputs per million cigarettes produced in the United States and globally are similar to those reported in Italy, it is estimated that 38 870 000 kg of nicotine waste was produced in the United States in 1995, and 300 274 000 kg was produced globally in the same year. Denicotinisation of waste requires chemical-physical treatments or biological methods with microorganisms to reduce the nicotine content of released wastes below the threshold of 500 mg per kg. In the United States, nicotine has been included on the TRI list since November 1994.20 Nicotine itself is an anti-parasitic plant pesticide.

Conclusions and recommendations

The health consequences of cigarette smoking to smokers and exposed non-smokers are well known. Cigarette products and production may also affect environments in other ways that require attention from environmental groups, industry, and government. Cellulose acetate filters from cigarette butts do not rapidly biodegrade; thus, they are a relatively long-lasting environmental problem, especially in waterways and run-offs from urban environments. At least 4.5 trillion filter-tipped cigarettes are deposited annually somewhere in the world. Many will find their way into appropriate disposal facilities, but the CMC clean-up data suggest that a large number end up on beaches and in other aquatic environments.

Smokers may not consider that a cigarette butt is litter, but these waste products seem to be ubiquitous. Perhaps because of the proliferation of restrictions on smoking in worksites and public places, it is common for building entrances to have a collection of cigarette butts nearby. These collections come in large part from smokers discarding cigarettes before they enter the building and from workers smoking on breaks. Some worksites have made special attempts to provide appropriate disposal facilities (figure 3).

Nevertheless, cigarette butts are frequently a source of urban blight and environmental pollution. In addition to the environmental contamination by cigarette butts, consumption waste left in ashtrays in the homes of smokers may be a source of poisoning for young children. In 1994–1996, the Rhode Island Department of Health identified 40 cases of cigarette butt ingestion among children aged 6 to 24 months as reported by the poison-control system in that state.13 Thirteen of the cases of ingestion produced symptoms such as vomiting, gagging, and lethargy.

### Table 2

<table>
<thead>
<tr>
<th>Cigarette production* (million pieces)</th>
<th>Total waste‡ (kg)</th>
<th>Total chemical waste§ (kg)</th>
<th>Total cost for TRI chemical abatement§ (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States 716 500</td>
<td>292 794 224</td>
<td>20 048 044</td>
<td>52 139 710</td>
</tr>
<tr>
<td></td>
<td>(projected)</td>
<td>(projected)</td>
<td>(projected)</td>
</tr>
<tr>
<td>Global 5 353 059</td>
<td>2 261 874 818</td>
<td>208 640 754</td>
<td>402 786 213</td>
</tr>
<tr>
<td></td>
<td>(projected)</td>
<td>(projected)</td>
<td>(projected)</td>
</tr>
</tbody>
</table>

*Source: Table 1, United States Department of Agriculture.  
§Source: Statistical record of the environment 1995 (TRI chemicals only), costs inflated from 1992 by consumer price index increase from 1992 to 1995.

### Table 3

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Total quantity released (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>946 155</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>8 936</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>407 371</td>
</tr>
<tr>
<td>Hydrogen fluoride</td>
<td>27 937</td>
</tr>
<tr>
<td>Methyl ethyl ketone</td>
<td>340 821</td>
</tr>
<tr>
<td>Nicotine and nicotine salts</td>
<td>980 377</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>58 970</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>6 804</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>67 228</td>
</tr>
<tr>
<td>Toluene</td>
<td>349 022</td>
</tr>
</tbody>
</table>

*Source: Right to Know database, 1996; includes air, water, land, underground injection, and offsite transfers.
Tobacco consumption and production waste

The authors would like to thank members of Globlink, who provided valuable information used in this report, as well as Laurie Williams of the Center for Marine Conservation for providing data from the Coastal Cleanup Project and Emmanuel Guindon of the World Health Organisation for providing data on cigarette consumption. The opinions expressed are solely those of the authors and do not represent official positions of the United States Centers for Disease Control and Prevention or the Johns Hopkins University.

5 Collazo H, Haynes SK, McDonough MM. The mechanisms of degradation of cellulose acetate in the environment. Abstract No 5021, Tobacco Chemists’ Research Conference, 1996.
13 Civitini M, Domenis C, Sebastianutto N, et al. Nicotine decontamination of tobacco agro-industrial waste and its...
Reconstituted tobacco, known as “sheet” in the cigarette industry, is a major ingredient in modern cigarettes. It is manufactured from the recycled stems, stalks, scrap, collected dust, and floor sweepings from tobacco manufacturing plants. Various patents have been awarded to tobacco manufacturers for processing waste such as this into sheet. The ground-up materials are denicotinised, and chemicals, fillers, glue, and other agents are added to the slurry. The sheet is then pressed out and puffed, renicotinised, and ground into tiny curls before being incorporated into cigarettes. The waste constituents used in this process are imported and exported, depending on economic conditions. In 1995, 1,135,755 kg of tobacco stems and refuse were imported and 1,989,786 kg were exported by the United States.

Source: US import and exports history database, US Department of Commerce.
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