World Health Organization

Tobacco and its environmental impact: an overview

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Foreword

by Dr Oleg Chestnov, WHO Assistant Director-General

The fact that today most people are aware of the health impacts of using tobacco is a victory for global health and well-being. It moves us one step closer to a world where a billion people are less likely to die from the consequences of chewing, smoking or ingesting tobacco.

But successful advocacy to reduce the health impacts of tobacco have not been matched by successes in challenging other impacts from tobacco – including on education, equality, economic growth, and on the environment – all of which can affect a country's development.

This overview opens the lid on a Pandora's Box containing the quieter but shockingly widespread impacts of tobacco from an environmental perspective. The tobacco industry damages the environment in ways that go far beyond the effects of the smoke that cigarettes put into the air. Tobacco growing, the manufacture of tobacco products and their delivery to retailers all have severe environmental consequences, including deforestation, the use of fossil fuels and the dumping or leaking of waste products into the natural environment. Cigarettes pollute our air, as air quality testing has shown in major cities such as London and Los Angeles. Long after a cigarette has been extinguished it continues to cause environmental damage in the form of non-biodegradable butts – millions of kilograms of which are discarded every year. From start to finish, the tobacco life cycle is an overwhelmingly polluting and damaging process.

The explicit inclusion of a tobacco reduction target in the UN Sustainable Development Goals (Target 3A) makes it clear that this product poses a significant problem for sustainable global development. The scale of the environmental damage resulting from tobacco use, as described in this overview, makes clear how much more needs to be done both to monitor and counteract it. It also highlights the need for a collaborative approach to tobacco control. In the past few years, health and finance authorities have come together to use taxation as a highly successful form of tobacco control. Similar efforts could be made by environmental and health authorities, who already collaborate on shared concerns such as air pollution. A united response is a strong response.

Most importantly, the environmental consequences of tobacco consumption move it from being an individual problem to being a human problem. It is not just about the lives of smokers and those around them, or even those involved in tobacco production. What is now at stake is the fate of an entire planet. Only global action will create a solution for this global problem, and this overview aims to catalyze such action.

Foreword

by Dr Vera Luiza da Costa e Silva, Head of the WHO FCTC Secretariat

The alarming rise in tobacco consumption and related deaths has turned the battle for tobacco control from one focused primarily on educating a sceptical public about tobacco's health threat to one involving public engagement on much broader fronts – including on the subject of this overview: the severe and noxious effects of tobacco on the environment.

The articles and guidelines of the WHO Framework Convention on Tobacco Control (WHO FCTC) anticipate precisely this need to act simultaneously on multiple issues. Under Article 18 of the treaty, Parties "agree to have due regard to the protection of the environment and the health of persons in relation to the environment in respect of tobacco cultivation and manufacture within their respective territories".

This overview is the result of a decision by the WHO FCTC's governing body, the Conference of the Parties (COP) at its 2016 meeting in Delhi, to invite WHO to consider the environmental impact of the tobacco life cycle. It has been completed with commendable speed by WHO, providing a very useful summary which will be invaluable in informing future action. It is, as the authors acknowledge, the first step on a path to date largely neglected, and which now requires greater attention.

The overview highlights the current lack of scientific research into the environmental impact of tobacco, including the health and economic consequences that result from the cultivation, production, distribution, and waste of what is a highly addictive and unnecessary product. The costs of such environmental damage are not always clear, leaving policy-makers often poorly informed on the true consequences of consumption. By omitting or minimizing these true costs, tobacco companies can effectively shift their responsibility to the taxpayer, and thus enjoy a hidden subsidy.

For example, cigarette manufacturing often involves long-distance distribution to other countries using diesel-powered lorries whose emissions have an established effect in causing cancer, heart attacks and strokes. The clean-up costs of tobacco waste, like discarded cigarette butts, is generally borne by municipalities, as are the associated disposal costs for waste including heavy metals and poisons that leach from cigarette butts once in landfill, including arsenic.

The evidence is not as detailed as required – at least not yet – but we have a good idea of where to look. There is a clear chain of environmental damage throughout the tobacco cycle, from growing and curing to manufacturing and distribution; and from the effects of consumption (including second- and third-hand smoke) to post-consumption waste. There are also implications for the health of farming communities and for vulnerable elements of the population, including children.

The authors of this overview assert: "The adage 'there is no such thing as a safe cigarette' could be extended to assert that there is no such thing as an environmentally neutral tobacco industry." So what is to be done? The overview rightly highlights concepts such as Extended Producer Responsibility (EPR), which seeks to reduce a product's environmental impact by making the manufacturer responsible for its life-cycle costs. Properly implemented, this would result in tobacco product price rises, while relieving municipalities and their citizens of a significant and unreasonable cost. To cite just one example, the city of San Francisco in the USA estimated that clearing up tobacco waste costs US$ 22 million annually.

An EPR programme could initially be applied to tobacco product waste, given that tobacco litter is the biggest component of litter worldwide (around 6.25 trillion cigarettes were consumed in 2012 alone). Such policies are also likely to be popular with citizens tired of seeing urban landscapes littered with slowly decomposing tobacco detritus. And EPR could also be applied to other areas of tobacco-related damage, including agrochemical use, deforestation, CO_2 and methane emissions, manufacturing, transport and toxic waste.

The authors suggest other interesting ideas, but one in particular merits attention – the notion that we collaborate to research the harm done to the environment and present this evidence "within the context of the WHO FCTC, the Sustainable Development Goals, and other international instruments".

At a time when successful tobacco control is ever-more clearly seen as a key metric for global development, it is critical to employ newly acquired knowledge to help achieve the SDGs, which contain an explicit reference to the importance of the WHO FCTC.

Broadening the effectiveness of the WHO FCTC has already begun, with promising work now underway on less emphasized issues such as human rights, gender and legal liability. The environment is absolutely key to the extension of the tobacco control effort. The Convention Secretariat therefore embraces this report and stands ready to contribute to further work in this important area.

Foreword

by Ahmad Mukhtar, Economist, Trade and Food Security, Food and Agriculture Organization

The Sustainable Development Goals (SDGs) provide a strong focus for the work of many UN agencies, and the SDGs' multiple targets relating to different aspects of health enable these agencies to address health as part of their work. For example, the UN's Food and Agriculture Organization and the World Health Organization are working on goals related to zero hunger, good health and well-being, decent work and economic growth, climate action, and life on land. All of these goals can be linked to combatting the global tobacco epidemic and its effects on the environment, on trade, and on economies. But to effectively and systematically do this, we need reliable information and continuous monitoring.

This overview is the first of its kind to reveal the harmful effects of tobacco growing, production and manufacturing on the environment. This includes the use of agrochemicals that degrade soil and soil fertility; and tobacco workers and farmers often being unaware of the toxicity of products they are managing and consequently suffering health effects such as birth defects in their offspring, benign and malignant tumors, and blood and neurological disorders. Environmental impacts of tobacco farming include massive use of water, large-scale deforestation, and contamination of the air and water systems.

Many countries that grow and/or produce tobacco are low- or middle-income countries and some of them face substantive food insecurity, and even hunger. Land used to grow tobacco could be more efficiently used to achieve SDG 2, zero hunger. Article 17 of the WHO Framework Convention on Tobacco Control (WHO FCTC) calls for all Parties to promote economically viable alternatives for tobacco workers, growers and individual sellers. More work needs to be done to effectively provide this, and to develop a research agenda around the health, economic and environmental consequences of tobacco farming. Successful pilot projects on viable alternatives to tobacco growing have been completed in Brazil, Kenya and Uganda, and have demonstrated that it is possible to provide sustainable alternatives. The challenge is to keep the pledge articulated in Article 17 of the WHO FCTC, to work collaboratively and enhance the pace of change. Only then can the SDGs as they relate to health, food security and many other aspects of human and environmental well-being be met.

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Abbreviations

BAT British American Tobacco

CNTC Chinese National Tobacco Company

EPR Extended Producer Responsibility

ENDS Electronic Nicotine Delivery Systems

GHG greenhouse gas

JTI Japan Tobacco International

PMI Philip Morris International

PS product stewardship

THS Third-hand smoke

TPW tobacco product waste

TTC transnational tobacco companies

WHO World Health Organization

WHO FCTC WHO Framework Convention on Tobacco Control

Executive summary

Tobacco use is now a well-documented threat to global health. It kills more than 7 million people a year and is currently the world's single biggest cause of preventable death. Much of what is known about the risks of tobacco, however, concerns the direct impact (in terms of morbidity and mortality) of first-hand and second-hand smoke on people's health. What we have yet to do as a public health community is draw attention to the myriad other ways in which tobacco growth, production and consumption impact human development.

Understanding the environmental impact of tobacco is important for several reasons. These include the fact that it allows us to gauge some of the risks caused by tobacco production which are currently excluded from estimates of tobacco mortality (such as poor air quality and pesticide use), and its impact more broadly on development – including economic stability, food security, and gender equality. The Sustainable Development Goals (SDGs) show that health cannot be considered in isolation from a host of other factors, of which the environment is one. Recognizing the harmful impact of tobacco in terms of indoor pollution and on biodiversity turns tobacco from an issue of individual well-being to one of global well-being. It also means that tobacco can no longer be categorized simply as a health threat – it is a threat to human development as a whole. This issue requires a whole of government and whole of society approach and engagement.

This overview assembles existing evidence on the ways in which tobacco affects human well-being from an environmental perspective – i.e. the indirect social and economic damage caused by the cultivation, production, distribution, consumption, and waste generated by tobacco products. It uses a life cycle analysis to track tobacco use across the full process of cultivation, production and consumption: from cradle to grave – or perhaps more appropriately, to the many graves of its users. In doing so it draws attention to gaps in the scientific evidence – particularly where the only data available are those currently self-reported by the tobacco companies themselves – and indicates where objective research could hold the greatest benefits to improving understanding of the relationship between tobacco and the environment. Its purpose is to mobilize governments, policy-makers, researchers and the global community, including relevant UN agencies, to address some of the challenges identified, and to amplify advocacy efforts beyond health by showing how deep the roots of tobacco really extend.

Introduction

The world faces many environmental challenges. Healthy soil, an adequate supply of clean and fresh water and clean air are just a few of the basic necessities that enable humans to live, but which are strained by growing populations and the human demand for the Earth's precious resources.

Tobacco threatens many of the Earth's resources. Its impact is felt in ways that extend far beyond the effects of the smoke released into the air by tobacco products when consumed. The harmful impact of the tobacco industry in terms of deforestation, climate change, and the waste it produces is vast and growing, and until now these aspects of the tobacco control picture have received relatively little attention from researchers and policy-makers.

This overview aims to change this by explaining what is known about the environmental consequences of the life cycle of tobacco – from cultivation to consumer waste – and the long-term impact of this life cycle. The discussion covers all stages, from growing and curing tobacco leaves to creating and distributing tobacco products; and from the impacts of burning and using tobacco to the post-consumption waste products such as smoke, discarded butts and packaging that it generates. Estimates of the type and scale of environmental damage or waste from each phase of the life cycle are included where data are available.

This work is part of the effort to reduce tobacco consumption and raise awareness of its negative impact on human health and well-being. In 2003, World Health Organization (WHO) Member States unanimously adopted the WHO Framework Convention on Tobacco Control (WHO FCTC) – to date the only international treaty under the auspices of WHO. In discussions that led to its adoption, Member States recognized the impact of tobacco on the broader environment. Article 18 of the WHO FCTC explicitly states that: "In carrying out their obligations under this Convention, the Parties agree to have due regard to the protection of the environment and the health of persons in relation to the environment in respect of tobacco cultivation and manufacture within their respective territories."

Since it came into force, Parties to the WHO FCTC have worked to minimize the substantial negative impact of tobacco on human health. These efforts have targeted tobacco use and the protection of non-tobacco users from second-hand and third-hand smoke (residual nicotine and other chemicals left on a variety of indoor surfaces by tobacco smoke). But as the world struggles to cope with climate change, some Parties to the WHO FCTC have become increasingly concerned about the environmental impacts of tobacco too.

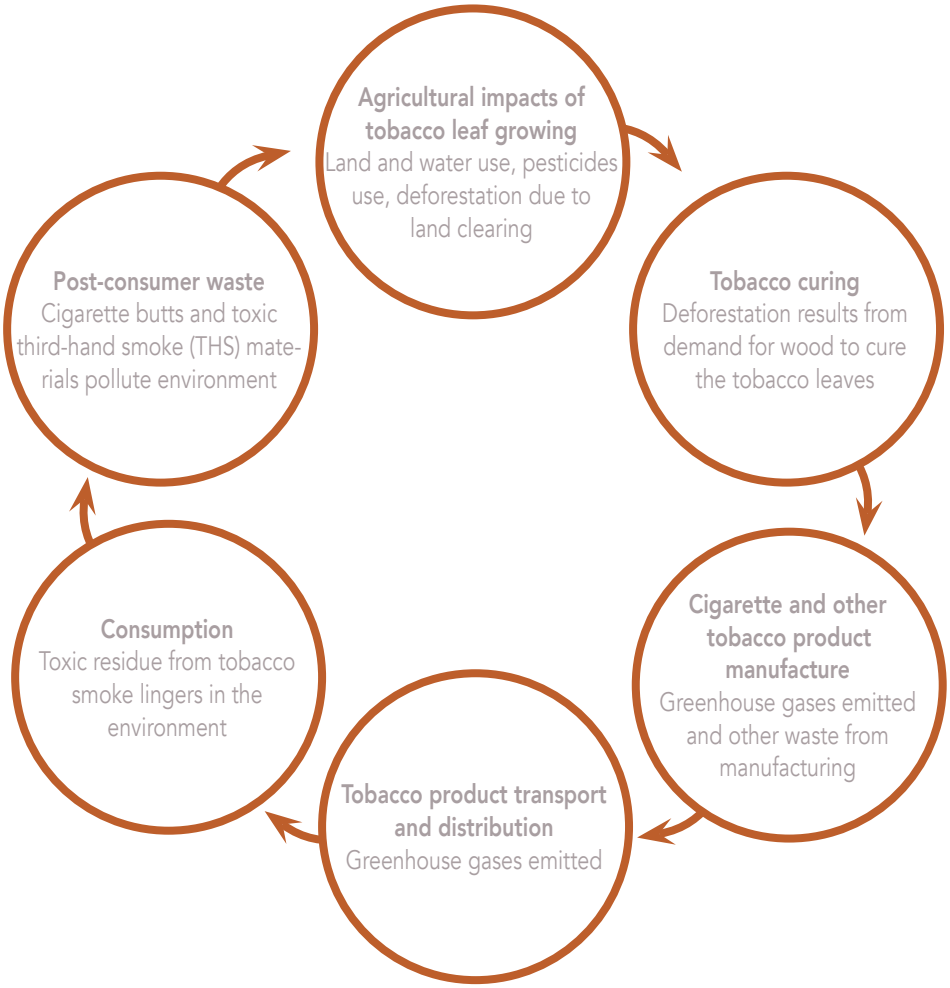
During its seventh session in November 2016, the Conference of the Parties to the WHO FCTC requested the Convention Secretariat "to invite WHO, as well as other relevant international organizations including the UN Environment Programme (UNEP), to prepare a report for COP8 [the Eighth Session of the Conference of the Parties] on the environmental impact of the tobacco life cycle, which collects technical knowledge on strategies to avoid and mitigate this impact, as well as recommend policy options and practical orientations to address it, identifying interventions that benefit public health and environment." This overview is a response to that invitation. It compiles information on various environmental aspects of tobacco in order to raise awareness of the issue among policy-makers, governments and the public. The key recommendations and findings from this overview will be used to inform the WHO report for COP8.

The life cycle impacts of tobacco (see Figure 1) can be roughly divided into five key stages: (1) growing and curing; (2) product manufacture; (3) distribution and transportation; (4) product consumption, including second-hand and third-hand smoke exposure; and (5) post-consumption tobacco product waste disposal *(1)*.

Figure 1 shows how tobacco creates waste and inflicts damage on the environment across its entire life cycle, "from cradle to grave" – or perhaps more appropriately, to the many graves of its users. Addressing the environmental consequences of tobacco requires all concerned with tobacco control to think about how these consequences link to the Sustainable Development Goals. Reducing tobacco production and consumption could support a number of key cross-cutting activities, including poverty eradication, reductions in child mortality and improvements in global food security.

A theme that surfaces throughout this overview is the uneven impact of the tobacco life cycle on different socioeconomic groups, with adverse impacts mostly affecting communities of low socio-economic status. Tobacco use tends to be greater in low- and middle-income countries. Over the past 50 years, tobacco farming itself has followed this trend, shifting from high- to low- and middle-income countries, partly because many farmers and government officials see tobacco as a cash crop that can generate economic growth. However, the short-term cash benefits of the crop are offset by the long-term consequences of increased food insecurity, frequent sustained farmers' debt, illness and poverty among farm workers, and widespread environmental damage.

Figure 1: Life cycle of tobacco – from cultivation to consumer waste



The following chapters discuss the environmental problems generated by each stage of the tobacco life cycle. Chapter 1 looks at the agricultural impacts of cultivating tobacco. Chapter 2 discusses the various negative consequences of manufacturing and distributing tobacco – from the use of fossil fuels to the production of hazardous waste. It also addresses some of the challenges in monitoring and measuring such damage. Chapter 3 focuses on the environmental damage caused by the immediate consumption of tobacco products, while Chapter 4 examines the post-consumption waste and health implications that continue to play out long after the tobacco has been smoked. Chapter 5 provides more detail on the economic implications of tobacco from an environmental perspective. Finally, Chapter 6 provides insight into which institutions have addressed these issues (and what policy approaches have been implemented to date), as well as challenges that need to be tackled.

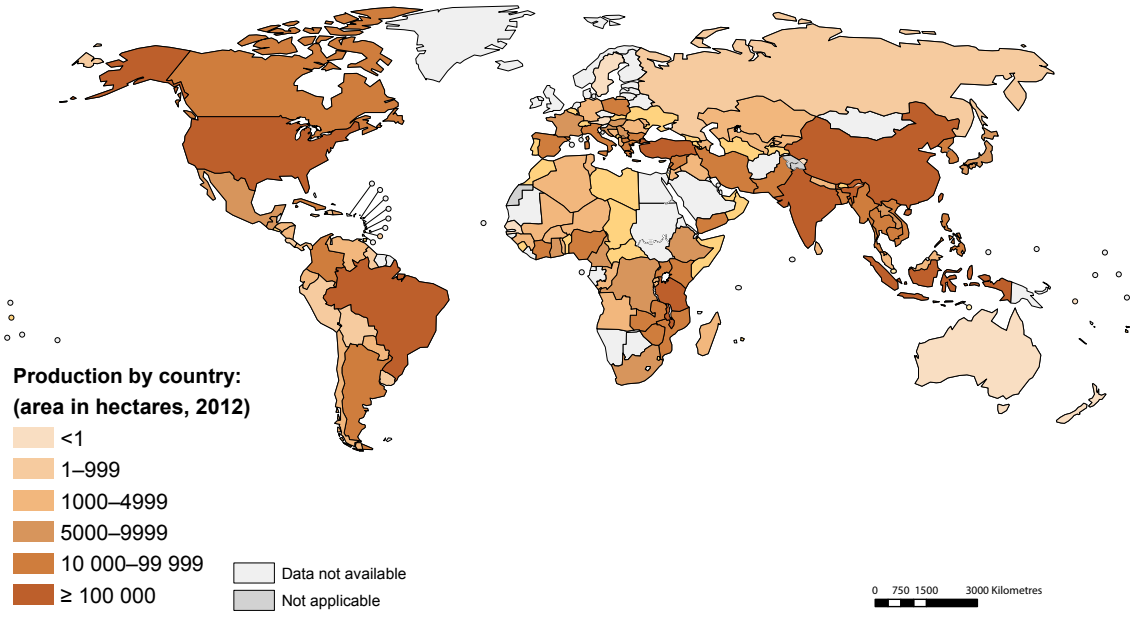
1 Tobacco growing and curing: impact on land and agriculture

Commercial tobacco farming takes place on a massive scale. In 2012 it produced almost 7.5 million metric tonnes of tobacco leaf on 4.3 million hectares of agricultural land in at least 124 countries (see Figure 2). In recent decades transnational tobacco corporations have lowered production costs by shifting tobacco leaf production from high-income to low-income countries, where around 90% of tobacco farming now takes place *(2)*. China, Brazil and India are the largest tobacco leaf growers, with China accounting for 3.2 million metric tonnes *(3)*. This chapter looks at some of the ways in which tobacco growing and curing adversely affect the environment.

1.1 Agrochemical use

Tobacco is often grown without rotation with other crops (i.e. as a monocrop), leaving the tobacco plants and soil vulnerable to a variety of pests and diseases (*4*). This means that tobacco plants require large quantities of chemicals (insecticides, herbicides, fungicides and fumigants) and growth regulators (growth inhibitors and ripening agents) to control pest or disease outbreaks *(5–7)*. Many of these chemicals are so harmful to both the environment and farmers' health that they are banned in some countries. In low- and middle-income countries, pesticide and growth inhibitors are usually applied with handheld or backpack sprayers, without the use of the necessary protective equipment, making skin and respiratory exposure to the toxic chemicals more likely *(6)*.

Figure 2: Tobacco cultivation, worldwide



Source: The Tobacco Atlas [website] (http://www.tobaccoatlas.org/topic/growing-tobacco/).

Tobacco plants also require intensive use of fertilizers because they absorb more nitrogen, phosphorus and potassium than other major food and cash crops, meaning tobacco depletes soil fertility more rapidly *(5)*. Added to this, other agricultural practices designed to attain high leaf yields and high nicotine levels (including "topping", where the top part of the crop is removed to prevent seeds forming and scattering onto the soil, and "desuckering", where lateral buds are removed) also help deplete the soil *(5, 8)*.

1.2 Deforestation and land degradation

An estimated 1.5 billion hectares of (mainly tropical) forests have been lost worldwide since the 1970s *(9)*, contributing to up to 20% of annual greenhouse gas increases *(10)*. Deforestation is one of the largest contributors to CO_2 emissions and climate change. Loss of biodiversity is another consequence, and has been associated with tobacco-driven habitat fragmentation in Argentina *(11),* Bangladesh *(12)*, Brazil *(13)*, Cambodia *(14*), Ghana *(15)*, Honduras *(16, 17)*, Kenya *(14)*, Malawi *(18),* Mozambique *(19),* Tanzania *(19–24)*, Thailand *(25)*, Uganda *(26–30)* and Zimbabwe *(19, 31, 32)*. It is also associated with land degradation or desertification in the form of soil erosion, reduced soil fertility and productivity, and the disruption of water cycles. Tobacco growing and curing are both direct causes *(33)* of deforestation, since forests are cleared for the tobacco plantations, and wood is burned to cure the tobacco leaves (in some countries, air curing is predominantly used to cure tobacco, see Box 1).

An estimated 11.4 million metric tonnes of wood are required annually for tobacco curing *(34)* (see Box 1), and after the tobacco is produced, more wood is needed to create rolling paper and packaging for the tobacco products. Wood is used less for curing in developed countries, but this is partly because curing activities have been shifted to low- and middle-income countries. Wood has been used as the fuel for tobacco curing since the mid-19th century, and few alternatives to wood-based energy have emerged since *(35)*. With production shifting to low- and middle-income countries, their wood consumption remains high *(36)* while the potential to reduce it remains low *(37)*.

Box 1: Tobacco curing

Tobacco farmers and producers refer to the drying of the tobacco leaf as "curing". There are four main ways of curing tobacco.

Air curing

Air-cured tobacco is carried out by hanging the tobacco in well-ventilated barns, where the tobacco is allowed to dry over a period of 4 to 8 weeks. Air-cured tobacco generally has a low sugar and high nicotine content.

Fire curing

Fire-cured tobacco is hung in large barns where fires of hardwoods are kept on continuous or intermittent low smoulder for between 3 days and 10 weeks, depending on the process and the tobacco. Fire curing produces a tobacco low in sugar and high in nicotine. Pipe tobacco, chewing tobacco, and snuff are fire-cured.

Flue curing

Flue curing is used in the production of high grade cigarette type tobacco. Tobacco is cured under artificial heat in flue-curing barns. All flue-cured barns have flues that run from externally fed fire boxes, which cures the tobacco without exposing it to smoke, slowly raising the temperature over the course of the curing process. The procedure generally takes about a week. Flue-cured tobacco generally produces cigarette tobacco, which usually has a high content of sugar, and medium to high levels of nicotine.

Sun curing

The tobacco is placed in the sun uncovered, and is dried out naturally. Sun curing is the most common method of tobacco curing in India. Sun-cured tobacco is used for producing bidi, chewing, hookah, and snuff products.

Deforestation

The impact of tobacco cultivation on forests since the mid-1970s is a significant cause for concern *(4, 34, 38–40)*. There is evidence of substantial, and largely irreversible, losses of trees and other plant species caused by tobacco farming that make it a particular threat to biodiversity *(41)*. In the 1970s and 1980s, 69 tobacco-growing countries, mainly in Asia and Africa, experienced fuel wood shortages related to tobacco production that probably accelerated deforestation in those countries *(42)*. By the mid-1990s, more than half of the 120 tobacco-growing low- and middle-income countries were experiencing losses of 211 000 hectares (ha) of natural wooded areas annually – around 2124 ha per country. This represented about 5% of all national deforestation *(34)*. In China in particular, tobacco farming has contributed to the loss of around 16 000 ha of forest and woodland annually – 18% of national deforestation *(34)*. In India, 68 000 ha of forests were removed between 1962 and 2002 – an average of 1700 ha annually *(43)*. In central-southern Africa, the Miombo ecosystem (the world's largest contiguous area of tropical dry forests and woodlands) also hosts 90% of all tobacco producing land on the continent, and is a global hotspot for tobacco-related deforestation *(19, 44–48)*. In Tanzania's part of the Miombo ecosystem, for example, about 11 000 ha of forests are lost annually, and curing has been the leading rural industry consuming wood and triggering deforestation *(34)*. Curing was reported to be the leading cause of demand for indigenous wood in other rural areas of tobacco-growing countries such as Malawi *(18, 49, 50)*, Zimbabwe *(51)*, and the Philippines *(52)*.

Tobacco farming has become the main cause of deforestation in countries such as Malawi *(42, 53, 54)*. In Malawi, where tobacco production accounts for the largest share of agricultural land and is among the fastest growing tobacco production areas in the world, farming was estimated to have caused up to 70% of national deforestation in 2008 *(53)*. During the most rapid period of growth in tobacco farming (1972–1991), national forest cover declined from 45% to 25% *(55)*. Today, tobacco production is the main agricultural driver of deforestation in Malawi. In the Miombo ecosystem overall, tobacco-related deforestation represents up to half the total annual loss of forests and woodlands *(56)*.

Land degradation and loss of biodiversity

Tobacco causes soil erosion because it is usually planted as a single or monocrop, leaving the topsoil poorly protected from wind and water. Desertification from tobacco cultivation has been observed in numerous countries, including Jordan *(57, 58)*, India *(43)*, Cuba *(59)*, Brazil *(4, 60)*, and, again, various countries of the Miombo zone *(18, 31, 61)*. In India, monocropped tobacco in drylands has been described as "the most erosive crop" *(43)*.

Evidence also suggests that tobacco growing is much more "aggressive" in its impact on forest ecosystems than other uses such as maize farming or grazing *(62)*. In Urambo district, Tabora region – Tanzania's leading tobacco growing area – the combined annual rates of forest removal as a result of land extension (3.5%) and fuel wood extraction (3%) were 10 times higher than the overall deforestation rate for Africa (0.64%; globally 0.22%) during the first half of the 2000s *(20, 56, 63)*. In Brazil, the world's second largest tobacco leaf producer, tobacco farming is now one of the leading land uses causing vegetation losses, alongside soybeans and wheat *(53)*. In southern Brazil, 12–15 000 ha of native forests were felled annually during the 1970 and 1980s, accounting for about 95% of national production. Coincidentally, it is also British American Tobacco's biggest operational area in the world. Improved curing technology, legislative restrictions, and the planting of exotic tree species reduced these vegetation losses to about 6000 ha annually in the 1990s, but wood deficits and the destruction of natural species both remain widespread. Overall, tobacco growing in southern Brazil has substantially contributed to the reduction of native forest cover to less than 2% of its original extent *(60)*.

Tobacco contract farming

Tobacco contract farming by Chinese companies has grown steadily in southern Africa and Asia since 2000. Trade sanctions against Zimbabwe by many countries encouraged local farmers to work for the Chinese National Tobacco Corporation *(64)*, which has also been expanding contract farming in Tanzania and Malawi. In Malawi, the proportion of leaf exports to China grew from 1% in 2005 to 9.5% in 2013 *(65)* and there is also evidence that Chinese contracting is increasingly common in the Philippines and Pacific Islands such as Vanuatu (where no tobacco leaf was previously grown), and Latin America. In some cases this will further aggravate deforestation in these countries.

Tobacco production and greenhouse gases

Indirect effects of tobacco production include greenhouse gas emissions related to deforestation and the change to agricultural land use *(10)*. Between 1908 and 2000, crops such as tobacco and maize replaced 74% of forest cover (2.8 million ha) in eastern Tanzania *(66)*. In Zimbabwe and other major tobacco-growing countries, notably China, a growing trend among some farmers to use coal instead of wood for curing has helped limit deforestation but does nothing to alleviate climate change problems *(34)*.

Overall, tobacco cultivation and curing are part of one of the most environmentally destructive agricultural practices in low- and middle-income countries *(62, 67)*. Yet production in many of these countries has increased over time. Although tobacco growing may bring some economic benefits to farmers and local communities, these are offset by adverse environmental and economic impacts associated with loss of precious resources such as forests, plants and animal species, and ill health among farmers handling chemicals involved in the process. Due to shifts in production and land availability, this impact increasingly falls on low- and middle-income countries. Worst of all, the majority of these developments are largely irreversible.

1.3 Farmers' livelihoods and health

Smallholder tobacco farmers often have low incomes, high expenditure on inputs and land rent, increased health care costs because of the health effects of tobacco growing, and no reliable and sustainable food supply for their families. Food insecurity and poverty are of concern in many of the world's largest tobacco growing countries, as growing tobacco diverts agricultural land that could otherwise be used to grow food.

Poverty and low pay

Studies and data on tobacco farming in low- and middle-income countries are scarce, but those that do exist clearly indicate that smallholder tobacco farmers face an economic struggle *(14)*. Comparisons of the incomes and resources of tobacco- and non-tobacco-growing households show that the net incomes and number of durable goods owned by tobacco farmers are lower than their non-tobacco farming counterparts *(68, 69)*. For example, in the tobacco-producing Rio Pardo Valley in Brazil, social and economic development indicators are lower than for other municipalities in the state that are less dependent on tobacco farming *(70)*.

The well-documented labour intensiveness of tobacco farming largely explains why smallholder tobacco farmers generally earn very little considering their efforts – when all the days worked by every contributing household member are included, studies show that tobacco farming is less profitable than other crops *(68, 70–75)*. In some cases (for example Lebanon), profitability is so low that smallscale production is not possible without government subsidy *(76)*, while the contract system (see below) has been shown to keep smallscale farmers dependent and, in many cases, impoverished *(77)*.

Costs of fuel wood and renting or buying land are also often not factored in when assessing the profitability of tobacco growing. In Bangladesh and Malawi, for example, many tobacco farmers pay high rents for land *(75, 78)*. Another important factor is that tobacco farmers spend an ever-larger proportion of their income on health care compared to other farmers as a result of the occupational hazards of tobacco growing *(68, 79)*.

Contract farming is common in tobacco-producing low- and middle-income countries, whose governments welcome it as both as a way to attract foreign investment and export earnings, and to incorporate smallholder farmers in the national economy without drawing on government revenues and services. It typically involves legal agreements between smallholder farmers and large transnational tobacco companies, resulting in the often high cost of tobacco farming being borne by the farmers themselves *(74)*. Tobacco prices and grades are specified in the contracts and are usually determined by the buyer – leaving farmers little room for negotiation. Research from many tobacco-producing countries points to the process of grading the quality of tobacco leaves as a mechanism through which transnational tobacco companies forcibly reduce their costs and which accounts, in large part, for the high profitability of the tobacco industry. Farmers in Bangladesh, Kenya, Malawi, Uganda and Vietnam are believed to be intentionally cheated by systematic under-grading – and therefore underpricing – of their tobacco leaf *(68, 73, 75, 78, 80)*.

A final problem with contract farming is the access to inputs and services provided by purchasing agents that comes at a stiff price that is not always obvious to farmers, as inputs are advanced at the start of the season while their costs deducted from the payment at the end of the season. This causes dependency and debt, either to transnational tobacco companies or intermediary traders, and in turn pushes farmers to return to tobacco growing the following year to try to pay off their debt.

Various forms of food insecurity due to declining land quality have been reported in Bangladesh *(4, 12, 14)*, Cambodia *(14)*, Argentina *(11)*, Kenya *(4, 14)*, Uganda *(29, 80)* and Malawi *(55)*. As part of the UN Millennium Ecosystem Assessment, tobacco farmers were found to be more vulnerable because they manage less diverse (and thus less stable) agro-ecosystems, produce less food, and have less resilient livelihood strategies within the political process than non-tobacco growers of the same area *(81)*.

Such dependency and high levels of external control create unequal bargaining power between smallholders and transnational tobacco companies. Choice of crop and scope for transition to other farming livelihoods are severely limited, perpetuating the heavy work burden borne by all household members *(73, 75)*. This dynamic is seen in China, where the government exerts monopoly control over tobacco leaf and cigarette production *(72)*.

Farmer and community health

Organic pesticides such as dichlorodiphenyltrichloroethane (DDT) and 11 other persistent organic pollutants (POPs) that are banned in high-income countries but still used in many low- and middle-income countries create environmental health problems in tobacco-farming communities *(4, 5, 6)*. These pesticides are often sold in bulk and without proper labelling and instructions, leaving farmers largely unaware of the toxicity of the products, the correct dosage, and safety measures they should take *(5, 83)*. Health effects from chronic exposure to certain pesticides include birth defects, benign and malignant tumours, genetic changes, blood disorders, neurological disorders and endocrine disruption. One study assessed the impact on farmers' skin and respiratory functions of exposure to two common pesticides and a growth regulator. It found that mixing and spraying these pesticides led to significant chemical exposure *(84)*. Other studies show that even tobacco workers who do not directly work with pesticides (e.g., harvesters) are vulnerable to pesticide poisoning.

For example, in Kenya, 26% of tobacco workers displayed symptoms of pesticide poisoning *(85, 86)*, while in Malaysia, a third of 102 tobacco workers presented with two or more symptoms of pesticide exposure *(87)*. Others studies have found that pesticide sprayers may have increased risk of neurological and psychological conditions due to poor protection practices *(88, 89)*. These include extrapyramidal (Parkinsonian) symptoms, anxiety disorders, major depression and suicidal thoughts *(6, 89)*. Although research on specific exposure risks for tobacco farmers is limited, one study states that the "accumulating evidence of a link between organophosphate exposure and psychiatric diagnoses (depression and suicidal tendencies) among agriculturalists supports these allegations of psychiatric pesticide hazards among tobacco workers" *(6)*.

Green Tobacco Sickness (GTS) is a type of nicotine poisoning caused by the dermal absorption of nicotine from the surface of wet tobacco plants (*6, 90*). Tobacco harvesters, whose clothing becomes saturated from tobacco wet with rain or morning dew, are at high risk of developing GTS. Workers can avoid getting this sickness by waiting until the tobacco leaves are dry before harvesting, or by wearing a rain suit. Wet clothing that has come in contact with tobacco leaves should be removed immediately and the skin washed with warm

soapy water. Children, who do a large share of the tobacco-growing work in some regions, are also exposed to nicotine and pesticide poisoning. The potentially higher vulnerability of children to these effects remains to be studied *(6, 90)*.

Farming communities are also exposed to health risks caused by chemical pollution of their environment. For example, in Bangladesh, chemicals used to control a weed commonly found in tobacco fields were found to be polluting aquatic environments and destroying fish supplies as well as soil organisms needed to maintain soil health *(91)*. These limited studies suggest that there are observable and important skin, respiratory, neurological and psychological problems associated with tobacco farmers' exposure to agrochemicals. Pesticides used in tobacco farming may in fact be an important risk for a number of adverse health conditions that can lead to ill health or death *(5)*. Beyond farmers and tobacco workers, the victims of this health risk include many children, pregnant women, and older people who all participate in tobacco production or live near tobacco fields *(90, 92, 93)*.

In addition to farm workers' exposure to the heavy use of agrochemicals in tobacco growing, how these chemicals are transmitted to humans, animals and environments along the production chain – including the end-of-life waste – requires further investigation. In 2014 the European Food Safety Authority reported on direct consumer exposure to residues and potential groundwater contamination from the growth-regulating chemical flumetralin, and other chemicals used in tobacco farming (e.g. trifluoroacetic acid). The report concludes that a "data gap and a critical area of concern were identified in the area of ecotoxicology regarding the long-term risk to herbivorous mammals. Mitigation measures comparable to a 20-meter vegetated buffer strip surrounding water bodies were needed to address the risk for aquatic organisms" *(94)*.

2 Manufacturing and distributing tobacco products

Pollution resulting from the manufacture and transporting of tobacco and tobacco products has to date received relatively little attention *(1)*, despite the fact that it may be one of the greatest sources of tobacco's environmental damage. Although much of the environmental concern in relation to tobacco has been on cigarette butts, Imperial Tobacco has stated, "[o]ur greatest direct impact on the environment comes from our product manufacturing activities" *(95)*. As the ecological footprint of tobacco growing has been more completely assessed and is already very large *(4)*, Imperial Tobacco's statement – and the likelihood that it is the same for other tobacco companies – emphasizes the need to learn more about the environmental impact of the next step in the life cycle of a tobacco product: tobacco manufacturing and transport.

Until recently, only vague estimates of the environmental costs of tobacco manufacturing and transport were available – but even those were ominous. In 1995, researchers estimated the annual global environmental costs of tobacco manufacturing included 2 million metric tonnes of solid waste, 300 000 metric tonnes of nicotine-contaminated waste and 200 000 metric tonnes of chemical waste *(54)*. Carnegie Mellon University's Green Design Institute made an Economic Input-Output Lifecycle Assessment (EIOLCA) that in 2002 the USA's tobacco industry alone was responsible for emitting 16 million metric tonnes of CO_2 equivalents[1] *(96, 97)*.

In efforts to respond to public pressure *(98)*, transnational tobacco companies have started self-reporting selected data on the environmental harms of tobacco manufacturing and transport. This chapter critically evaluates some of those data. Besides self-reported information from the tobacco industry, few data on the actual environmental costs exist *(99)*.

2.1 Measurement

Tobacco companies admit that manufacturing is the most environmentally damaging step of tobacco production *(95)*. To understand its true scale and include it as part of the sales price of tobacco products means having reliable data on its environmental impact – without this, the real costs cannot be calculated. By not including this environmental impact as damage for which the tobacco companies should pay, governments are inadvertently subsidizing tobacco production. There is consequently significant reluctance on the part of the industry to provide data in ways that would help standardize calculation of its true environmental impact.

In general, transnational tobacco companies report basic data such as those on annual CO_2 equivalent emissions, water use, waste water effluent, tonnage of solid waste to landfill, percentage of waste recycled, and tonnage of hazardous waste. However, providing data does not necessarily indicate a willingness to help – in fact it could be interpreted as an industry move to stave off regulation that would require them to adhere to far more stringent, external environmental standards and practices *(100)*.

[1] "Carbon dioxide equivalent" or "CO_2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact.

There are three major problems with tobacco companies' self-reported data:

1. Data reporting does not follow a shared format, making comparison between different companies extremely difficult. Some tobacco companies have released reports tracking CO_2 emissions related to manufacturing, but the majority of companies have not. Instead, information is available for certain sectors of a company and for certain products, lacking unified, comprehensive environmental accounting.
2. Data often only refer to internal production processes and fail to assess the potentially large, real-world environmental impacts from manufacturing. Estimates from 1999 attribute worldwide tobacco manufacturing as producing approximately 2.26 billion kg of solid waste and 209 million kg of chemical waste *(101)* (world cigarette production has increased significantly since then, but no new data are available to update the estimates).
3. There is no independent, trustworthy process to verify the accuracy and completeness of data provided by the industry. Where third-party certification does occur, the certifying body is paid directly by the transnational tobacco company rather than by a regulatory entity; therefore, potential incentives for favorable reporting to retain lucrative certification contracts exist. Independent environmental auditing of tobacco companies overseen and paid for by the government, as opposed to the tobacco industry, would be one solution to validate the industry's touted claims of increasing efficiency and sustainability. The current practice of piecemeal reporting and in-house assessment make any scientific assessment of the environmental implications of the process virtually impossible *(102–105)*.

The limited and opaque nature of tobacco manufacturers' self-reported data poses a major barrier to evaluating the true impact of tobacco. An additional barrier is the concept of proprietary information, which makes tobacco industry manufacturing processes closely guarded secrets *(95)* in the name of combatting counterfeiting. But without a stable, historical or uniform baseline, global projections on the environmental impact of tobacco can only be extrapolated from existing industry data. On the rare occasion that self-reported data are publicly available, it is difficult to locate. This means that when a company such as China's National Tobacco Company (CNTC) does provide a small amount of data, it is nigh on impossible to gauge whether it is more or less polluting than its peers. At best, we can assume that a company as large as CNTC is no less polluting, given the little that is known about other Chinese manufacturing processes *(106)*. This situation leaves those working towards an objective evaluation very much in the dark.

2.2 Voluntary corporate social responsibility versus regulation

To avoid the weight of corporate responsibility, transnational tobacco companies' manufacturing activities have often moved away from countries with strong environmental regulations to pollute countries with less stringent environmental standards instead. Here they also pursue other economic incentives such as low export tariffs. In March 2016, British American Tobacco (BAT) announced they were closing a Malaysian cigarette manufacturing plant because of increased excise taxes (110% over 5 years) and Malaysia's informal discussions on introducing plain packaging *(107)*. In reality, BAT had already made plans for a new manufacturing plant in southern Vietnam, well before either the discussions on plain packaging or the excise taxes *(108)*.

The tobacco industry is known for shifting its operations away from countries to avoid facing the consequences of its activities, including environmental harms *(109, 110)*. In 2013, BAT closed a manufacturing plant in Uganda after environmentalists mobilized against the air pollution the plant had caused. Community leaders near the Ugandan plant complained of polluted air, so the Ugandan parliament moved to draft a law that would lead to stricter regulation of the production and sale of tobacco in the country. BAT's response was to close its Ugandan plant and move the facility to Kenya *(111)*. This epitomizes how, in many instances, when citizens

petition for better environmental practices or more socially responsible business conduct, transnational tobacco companies simply uproot their operations and ignore the long-term environmental damage that they have caused, and take them to a new location where they can repeat the environmental damage.

2.3 Types of environmental costs

Some of the highest environmental costs of one tobacco product alone – cigarettes – result from the large amounts of energy, water and other resources used in its manufacture, and the waste generated by this process (a lack of data means information on the environmental costs of smokeless tobacco and e-cigarettes is not available). While not an exhaustive list, these costs include:

- chemicals used e.g. in the preparation and treatment of the tobacco leaf;
- metals involved in the manufacture and shipping of cigarette-making machines;
- energy used for manufacturing and distributing tobacco products (coal, gas, etc.);
- wood pulp and effluent left over from cigarette paper and packaging manufacture;
- energy required for, and effluent created by, extraction, extrusion and processing of cellulose acetate filters;
- all effluent from the cigarette-making process;
- thousands of chemical additives, including flavourings and pH modifiers such as ammonia; and
- energy used in the manufacture and fuelling of trucks, ships and planes to transport tobacco products from production plants to retailers.

Several of the largest tobacco companies (Altria, Philip Morris International, Reynolds American, Japan Tobacco International, Imperial Tobacco, and British American Tobacco) began reporting their environmental production resource use and waste streams in the past decade. However, the China National Tobacco Company (CNTC) currently has no publicly available comprehensive environmental reports, despite the fact that it produces roughly 44% of cigarettes consumed globally *(112)* and China consumes roughly 10 times as many cigarettes as any other nation *(113)*. Without reliable data from CNTC, an evaluation of the environmental impacts of tobacco manufacturing and transport would only account for roughly half the total global impact.

A recent report by the United Nations Environmental Programme found that many major industries, including tobacco, would not be profitable if they paid for the environmental impacts of their manufacturing (*114, 115*). There are 560 cigarette manufacturing facilities in the world, producing more than 6 trillion cigarettes every year (by 2009, 2.3 trillion of these were being manufactured in China *(116)*). There is also the environmental cost of manufacturing other smoked forms of tobacco such as cigars and bidis – the impact of which is not yet fully documented. Stanford University's Citadels industry manufacturing facilities map[2] gives tobacco control researchers some insight into the scale of pollution caused by the hundreds of tobacco manufacturing facilities worldwide. Not only are the majority of tobacco product costs in manufacturing, but the majority of their environmental costs are in manufacturing as well – 43 cents of every US$ 1 earned by tobacco companies from cigarette sales in the USA go on manufacturing, while only 7 cents are for non-tobacco materials and 4 cents are for the tobacco leaf itself (*117*).

[2] See https://web.stanford.edu/group/tobaccoprv/cgi-bin/map/.

2.4 Resource use

Cigarette manufacturing

Manufacturing cigarettes and their packaging is highly resource intensive. Manufactured cigarettes comprise 80% of tobacco industry revenue in high-income countries and 90% of tobacco industry revenue worldwide (the remaining revenue is generated by smoked products such as cigars and bidis, smokeless tobacco or electronic nicotine delivery systems). This largescale production involves significant use of natural and human resources.

Previous estimates conclude that for every 300 cigarettes produced (roughly 1.5 cartons), one tree is required to cure the tobacco leaf alone *(118)*. Other processes contributing to the environmental impact of cigarette manufacturing and marketing include:

- growing raw tobacco leaf, which uses land, water, pesticides (see Chapter 1 on tobacco growing);
- shredding and assembling the tobacco, which uses energy and metals to manufacture the machines to do this;
- processing and coating the tobacco, which uses thousands of chemicals and dry ice (see below);
- Dry Ice Expanded Tobacco (DIET) equipment and supplies, and fuel energy used to freeze and artificially expand the surface area of the tobacco;
- rolling paper, which uses bleaching agents and generates effluent (from paper production mills, etc.) and which represents additional deforestation;
- producing filters, which uses acetate tow;
- producing packaging, which uses paper, plastic wrap and aluminum foil;
- manufacturing and logistics, which uses computer equipment.

Dry Ice Expanded Tobacco (DIET) technology, developed by Union Engineering on behalf of the Philip Morris company in the 1970s, is a process involving high-pressure carbon dioxide inputs to fill the tobacco with air. The effect is to reduce the amount of tobacco leaf needed for each cigarette, cutting manufacturing costs. Many companies have entire facilities dedicated to DIET processing, which has become the industry norm, increasing finished-product volume by approximately 100% *(119)*. While this reduces the amount of tobacco leaf in each cigarette, it increases the resource demand to power the DIET technology.

Packaging issues are relevant when assessing the overall environmental impact of tobacco manufacturing. The impact of the packaging process extends from production to disposal as post-consumption packaging waste. The market research group Wise Guy Consultants Pvt. Ltd. forecasts the global tobacco packaging market will grow by a compound annual rate of 2.47% from 2016–2020, with Amcor, Innovia Films, ITC, International Paper, and Philips Morris International as the main packaging vendors *(120)*. Extracting data from these companies, and changing their processes if possible, will be crucial in any attempt to reduce the environmental damage created by tobacco manufacturing.

The information presented here is compiled from tobacco industry self-reported data, and thus is limited. While some of the companies employ third-party verification entities to certify their numbers, inconsistencies between the companies of similar size (such as Altria and Japan Tobacco International – JTI) point to a lack of standardization of reporting and potential measurement error in this process.

Furthermore, as many of the transnational tobacco companies themselves make clear, the verification process does not include all the potential environmental pollutants and does not use all available sources of data. This is compounded by their use of third-party providers in different parts of their supply chain, which makes tracking or standardizing data even more challenging, and further limits the usefulness of the self-reported information on environmental pollution *(121)*.

Emissions

BAT's 2015 emissions amounted to a self-reported 876 000 metric tonnes CO_2 equivalents *(122)*. If BAT's total global market share is 10.7% according to the 2016 Euromonitor *(123)*, then that means that total emissions due to tobacco are roughly 8.76 million CO_2 equivalent – which amounts to the emissions of nearly 3 million transatlantic flights. Other sorts of emissions also are unknown. China's edition of *Fortune* magazine, for example, reports that for CNTC, "... total industrial emissions of sulfur dioxide, [are] 5688 metric tonnes, down 29.8%; chemical oxygen demand emissions [are] 2751 metric tonnes, down 11.7%" *(124)*. No baseline is given in the article. However, one CNTC subgroup, Jia Yao Holdings Limited, "... incurred environmental costs of approximately RMB 451 000 and RMB 589 000 for the years ended 31 December 2014 and 2013, respectively", according to its annual report. It is unclear whether these are government fines for polluting or other costs, and Jia Yao's percent market share in the overall Chinese tobacco market is not certain. Jia Yao purports to comply with China's Law on the Prevention and Treatment of Solid Waste Pollution and Law of the People's Republic of China on the Promotion of Clean Production. Such environmental claims are undermined by blanket statements such as "[t]he Directors are also of the view that our production process does not generate hazards that will cause any significant adverse impact on the environment" *(125)*. The judgements are clearly at odds with what is commonly known about the environmental impacts of tobacco manufacturing as reported by other tobacco manufacturers.

This is a snapshot of some of the difficulties encountered by tobacco control researchers in calculating the emissions of tobacco production. Voluntary reporting in this case alone appears to be incomplete or unreliable. It is therefore unlikely that anyone could estimate the actual environmental impact of all companies' combined tobacco manufacturing. Countries such as Brazil and Canada have mandated their tobacco manufacturers to disclose information on manufacturing practices, product ingredients, toxic constituents and toxic emissions in order to evaluate the environmental impacts *(126)*.

Energy use

The energy used to make tobacco products is reported by some companies (see Table 1). Manufacturing intensity refers to how much of a given measure – such as energy, CO_2 emissions, water use, or waste production – is needed or created per unit of product *(127)*. For example, from 2009 to 2013 JTI required roughly 10% more energy per cigarette, 5% more CO2 emissions per cigarette, but 10% less water per cigarette than other companies according to a comparison of these companies' annual reports.

Table 1: Examples of total reported yearly energy use for some of the largest tobacco companies

Company	Gigawatt hours/year	Kilowatts per million cigarettes
Imperial Tobacco (2015)*(128)*	1004	2051
Altria (2014) *(129)*	1380	Unknown
British American Tobacco (2011) *(130)*	2504	2864
Japan Tobacco Incorporated (2014) *(131)*	2804	1832 (2012)
Philip Morris International (2015) *(116)*	2539	Unknown

For comparison, the combined energy use of Starbucks' more than 22 000 coffee houses is 1392 gigawatt hours per year *(132)* – roughly equivalent to Altria's annual energy use. Combined, the tobacco companies' energy consumption is equivalent to building around 2 million automobiles. Predictably, tobacco companies claim to be "greening" their energy use. For example, in its 2014 Corporate Social Responsibility Report *(129)*, Altria states that it "converted coal-fired boilers to natural gas boilers at three manufacturing facilities, significantly decreasing Scope 1 greenhouse gas emissions. This also eliminated a significant coal ash waste stream." These kinds of measures are touted as reducing the ecological impacts of the manufacturing process, but Altria operates other manufacturing facilities in the United States, and it is not know whether others were converted. In addition, natural gas is not a clean replacement – it also has a large ecological footprint."

There are also issues around the data formatting. Reporting per million cigarettes only, instead of absolute numbers, obscures rising overall environmental costs, as the company produces more cigarettes each year. While during the 2000s and early 2010s the standard unit of measurement for intensity was "x amount of [water, CO2, energy, etc.] per million cigarettes produced," a recent trend has been to obscure the amount of environmental impact per cigarette produced, by using a variant of proportional calculation: measuring intensity in environmental costs per million of US dollars or British pounds in net tobacco revenue *(128)*.

Water consumption

Tobacco manufacturing is extremely water-intensive (see Table 2). Significant amounts of water are used in areas where tobacco manufacturing facilities are located, including for DIET treatment, making inks and dyes for packaging, and tobacco pulp processing. If these areas are dry, this can put severe stress on local water reserves.

In 2014, Altria's water use for one manufacturing facility in a water-stressed region totalled 36 million litres *(129)*. Altria claims that it is 50% water neutral because it "supported the restoration of 6.4 billion litres of water through contributions to the National Fish and Wildlife's Western Waters Initiative". But instead of achieving reductions through conservation, these environmental water "savings" are achieved through offsetting, such as treating polluted water onsite or conserving water despite increased usage *(129)*. BAT also boasts a 24% reduction in water use since 2007, the mechanisms for which are unclear. While the transnational tobacco companies all claim incremental gains in water conservation on previous years, their impact remains substantial and unmitigated overall.

Table 2: Water consumption used during manufacturing

Company	Thousands of cubic metres	Per million cigarettes (cubic metres)
Imperial Tobacco (2015)	1675	3970
Altria (2014)	11 247	Unknown
BAT (2011)	4621	3890
JTI (2012)	10 330	2720
PMI (2015, 2011)	3886	5140

2.5 Carbon dioxide (CO_2) pollution

Some tobacco companies have released reports tracking their tobacco manufacturing-related CO_2 emissions (see Table 3), but the majority of companies have not. If the distribution of environmental costs as set out by Philip Morris International (PMI) is representative, the bulk of CO_2 release happens at the tobacco growing stage, followed by the manufacturing stage, and finally the distribution and logistics stage *(130)*. Manufacturing pollution and distribution and logistics (transport) pollution, while still comprising approximately a third of the environmental costs of tobacco, are relatively easy to control in comparison.

BAT's 2014 report claimed a 45% reduction in CO_2 emissions since 2000 *(4)*, and other companies highlight what they are doing to mitigate greenhouse gas emissions from their production facilities. While some companies such as PMI categorize their emissions, such reporting is not yet done by other transnational tobacco companies. As with reporting overall, there is no standardized formula for comparing the sites and processes involved in emission measurements, even when tobacco companies have declared them.

Table 3: CO_2 Equivalent emissions from tobacco manufacturing

Company	Thousands of metric tonnes CO_2 equivalent	Metric tonnes per million cigarettes
Imperial Tobacco (Annual report 2015)	218	0.513
Altria (2014)	406	Unknown
British American Tobacco (2015)	795	0.717 (down from 1.4 in 2000)
Japan Tobacco Incorporated (2014) (anomalously high)	5304[1]	0.59
Philip Morris International (2014)	627	0.66

[1] 882 of which are from transporting goods

2.6 Transport

The tobacco industry's rapid globalization has been accompanied by two opposing trends. In setting up regional plants for the manufacture of tobacco products, companies increasingly produce tobacco goods for nearby regional markets, rather than shipping pre-made products from other countries or continents. To a certain degree this practice has reduced the environmental costs of transport from manufacture to the point of sale.

However, the globalization of tobacco growing also means that tobacco grown in Malawi, for example, gets shipped to Australia, China, the United States and other distant sites for processing and manufacturing. Thus, transportation impact must include two separate measurements: CO_2 emissions from transporting the leaf to the processing plant, and emissions from transporting the processed leaf from manufacturers to shelves. Both steps carry significant environmental consequences.

Transporting a finished pack of cigarettes to its point of sale often involves extensive transport costs, usually via diesel-driven trucks. Diesel gas is a known carcinogen, and a recent study has shown that particulate matter in environmental outdoor air pollution leads to accelerated build-up of calcium in arteries, which can increase the rate of arteriosclerosis by 10–20% and consequently the risk of heart attacks and strokes *(133)*. WHO lists air pollution from transport in trucks as one of the primary causes of disease-related air pollution *(134)*.

There is very little reporting by the industry on their transport-related environmental impacts. JTI, however, does separate out its CO_2 emissions for transporting tobacco goods, which amounts to 882 000 metric tonnes. PMI's vehicle fleet emissions amount to 115 182 metric tonnes CO_2 equivalent, not including its 4289 metric tonnes of emissions resulting from aircraft use *(135)*. Combined, this amounts to less than half of PMI's manufacturing emissions *(135)*.

Another part of the challenge in addressing issues around transport pollution is that tobacco companies often use ecological modernization as an opportunity for greenwashing their activities. Manufacturers are aware that consumers increasingly scrutinize the environmental aspects of tobacco products, and some companies, such as du Maurier, have consequently made reduced packaging and more ecological manufacturing practices a selling point for their brand. Others have emphasized their investments in "green transport". This greenness is likely to be relative as opposed to absolute.

2.7 Use of plastics as packaging material

The indiscriminate use of plastic sachets/pouches has become a new environmental concern in a number of countries where smokeless forms of tobacco such as *gutkha, pan masala* etc. are packaged and sold. The environmental, human and ecological damage of plastic waste materials, especially to marine biology, is well documented *(136)*. The problem of using plastic pouches for packaging smokeless forms of tobacco was initially limited to south Asian economies, but in the last decade or so it has become a global concern. This is due to aggressive marketing and introduction of gutkha and pan masala into new markets in Asia and Africa.

In India, civil interest groups concerned by the scale of plastic pouch litter took the matter to court. On the Supreme Court of India's direction, in 2016 the Government of India banned the use of plastic material in any form in packaging for all smokeless types of tobacco *(137)*.

2.8 Solutions

Comprehensive implementation of the WHO FCTC means Member States should consider the environmental impact of tobacco product manufacturing and transport, as recommended by the Convention's Article 18. It should also expand the current focus on the environmental impact of tobacco growing to include a more comprehensive environmental approach, incorporating True Cost accounting. By building the full environmental costs of tobacco production into the retail price of tobacco products, for example through taxation, governments would be able to recover some of the health costs resulting from production and consumption of tobacco.

Many tobacco manufacturing plants are now located in countries with few environmental protections or mandated disclosures for industry. As noted, the tobacco industry has routinely moved plants when social conditions and environmental regulations have become too stringent for them to be willing to bear, proactively shirking their responsibilities instead of absorbing the price of complying with higher labour standards or reduced environmental harms. The only way to avoid this is to harmonize global standards for reporting and regulation, so that the tobacco companies have nowhere to run.

At the same time, transnational tobacco companies clearly respond to public outcry and pressure. In countries where environmental sustainability is an important political issue, transnational tobacco companies trumpet their ecological modernization – which is in fact a process of rationalizing production to save money while adopting some greener technologies *(138)*. In countries with less oversight, this does not happen. Holding the tobacco industry accountable – everywhere, not just in countries where environmental concerns have high visibility – and establishing a core set of environmental indicators is vital to obtain a fair assessment of the product's true cost and to start to take action to reduce it.

3 Consumption

Tobacco smoke pollutes indoor and outdoor environments and remains a pervasive and persistent source of toxicants long after the cigarette has been extinguished. It is estimated that in 2012, some 967 million daily smokers consumed approximately 6.25 trillion cigarettes worldwide *(139)*. This chapter follows the environmental consequences of lighting, smoking and discarding a cigarette – a process that takes minutes but whose consequences last a lifetime.

3.1 Tobacco smoke

Mainstream and sidestream smoke

Tobacco smoke is a complex mixture of thousands of chemical compounds in the form of gases and microscopically small droplets suspended in the air *(140–142)*. Because the composition of this mixture depends to a large extent on the physical conditions under which it was generated and the behaviour of the smoker, it is important to distinguish two major types of tobacco smoke: mainstream smoke and sidestream smoke.

Mainstream smoke is emitted at the filter end of a cigarette when a smoker draws air through the burning cigarette to inhale, and the tobacco burns at a high temperature (up to 950°C) due to the increased supply of oxygen. In contrast, sidestream smoke is generated at a lower temperature between puffs (600–800°C) and is emitted at the smoldering tip of the cigarette. Sidestream smoke contains more toxic chemical compounds than mainstream smoke – for example, 147 times more ammonia; 16 times more pyridine; 15 times more formaldehyde; 12 times more quinolone; three times more styrene; and twice as much nicotine.

Freshly emitted sidestream smoke particles are on average half the size of mainstream smoke particles, allowing them to penetrate deeper into the lung and transfer more easily into the bloodstream *(143)*. Inhaled fresh sidestream smoke is approximately four times more toxic and sidestream condensate is two to six times more carcinogenic than mainstream smoke *(144, 145)*.

Tobacco smoke composition

With the exception of the filter, the entire cigarette is fuel for the production of tobacco smoke. This includes the processed tobacco leaf; the material that holds together the processed tobacco leaf (i.e. paper); the substances intentionally added to affect appearance, taste, odour, colour, and uptake and availability of tobacco smoke constituents; and residual substances from processing, curing and storing tobacco. All of these constituents contribute to the amount and composition of tobacco smoke and their long-term environmental impact.

With a nearly 1 billion smokers in 2012 consuming an estimated 6.25 trillion cigarettes worldwide, tobacco smoke from cigarettes globally release significant amounts of toxicants and pollutants directly into the environment. Table 4 shows the global contributions in 2012 of selected constituents of mainstream and sidestream smoke *(146, 147)*. In a single year, global tobacco smoke contributed thousands of metric tonnes of known human carcinogens, other toxicants, and greenhouse gases. Toxic emissions include 3000–6000 metric tonnes of formaldehyde; 12 000–47 000 metric tonnes of nicotine; and the three major greenhouse gases found in tobacco smoke – carbon dioxide, methane, and nitrous oxides *(148–150)*.

Table 4: Estimated annual contribution to the global environment from tobacco smoke by all cigarette users, 2012

Tobacco smoke constituents (IARC Cancer Risk Classification)[1]	Mass in sidestream smoke (per cigarette)[2]	SS/ MM ratio[3]	5–year contribution single smoker			
			SS only		SS + M S	
			Estimates (1000 kg)		Estimates (1000 kg)	
			LB[4]	UB[4]	LB[4]	UB[4]
Total 'tar'	10.5–34.3mg		65 625	215 000	137 740	451 264
Ammonia	4.0–6.6 mg	147	25 000	41 250	25 170	41 531
Nicotine	1.9–5.3 mg	2.31	11 875 000	33 125 000	17 016	47 465
Pyridine	195.7–320.7 mg	16.1	1223	2004	1299	2129
NNK (1)	50.7–95.7 mg	0.4	0.317	0.598	1.109	2.093
NNN (1)	69.8–115.2 mg	0.4	0.436	0.720	1.451	2.394
Styrene (2B)	23.2–46.1 mg	2.6	145	288	201	399
Toluene (3)	134.9–238.6 mg	1.3	843	1491	201	399
Benzene (1)	70.7–134.3 mg	1.1	442	839	855	1624
Isoprene (2B)	743.2–1162.8 mg	1.1	4645	7267	8986	14 060
1, 3 – Butadiene (1)	81.3–134.7 mg	1.3	508	842	899	1489
Acetaldehyde (2B)	1683.7–2586.8 mg	1.3	10 523	16 168	18 556	28 509
Acrolein (3)	342.1–522.7 mg	2.5	2138	3267	2983	4558
Formaldehyde (1)	540.4–967.5 mg	14.8	3378	6017	3606	6455
Carbon dioxide	79.5-759 mg	9.7	2 800 000	4 743 750	3 088 660	5 232 796
Methane	1.3 mg	4.0	19 375	19 375	24 280	24 280
Nitrous oxides	0.051 mg	3.6	319	319	406	406

Notes:

1 IARC classification of carcinogens: 1: carcinogenic to humans; 2A: probably carcinogenic to humans; 2B: possibly carcinogenic to humans; 3: carcinogenicity to humans not classifiable

2 Ranges of estimates of sidestream concentration of selected tobacco smoke constituents *(140)*

3 SS: sidestream smoke; MS: mainstream smoke. SS/MS ratio: ratio of mean mass of compound in SS divided by mean mass of compound in MS

4 LB: lower-bound estimate. UB: upper-bound estimate. Based on 2012 global averages *(139)* and estimated concentration in SS and MS tobacco smoke *(140)*. Estimates of greenhouse gases from these sources – methane *(148, 149)*; carbon dioxide; nitrous oxides *(150)*.

3.2 Third-hand smoke pollution

Third-hand smoke is the long-lasting residue resulting from second-hand smoke that accumulates in dust, in objects and on surfaces in indoor environments where tobacco has been smoked, and which can end up in landfills and waste. To understand the composition of third-hand smoke and its contribution to the pollution of indoor and outdoor environments, it is important to understand how third-hand smoke evolves from second-hand smoke.

Formation of third-hand smoke

Third-hand smoke is the residue of tobacco smoke and its constituent chemicals that remain on surfaces and in dust after tobacco has been smoked. When cigarettes and other tobacco products are regularly smoked over periods of months or years in an indoor environment (e.g., office, home or car of a daily smoker; a casino; a smoking-allowed hotel room), a significant mass of the emitted tobacco smoke pollutants can accumulate in dust, on surfaces and in objects and materials *(151, 152)*. These can have an effect on the environment and air quality when they react with oxidants and other compounds in the environment, and yield secondary pollutants *(153, 154)*. Third-hand smoke-polluted indoor environments can then expose users of these spaces to involuntary and unnoticed tobacco smoke pollutants long after the cigarettes themselves have been extinguished.

Compounds found in third-hand smoke include many of those found in second-hand smoke, such as highly mutagenic and carcinogenic tobacco-specific nitrosamines (TSNAs) (e.g., NNK); toxic metals (e.g., lead, cadmium); alkaloids (e.g., nicotine); more general products of combustion of organic materials (e.g., polycyclic aromatic hydrocarbons – PAHs); and various volatile organic compounds (e.g., acrolein and other aldehydes) *(153)*. Third-hand smoke ages chemically, so the compounds it contains change and become more toxic over time. Notably, nicotine, a ubiquitous contaminant in third-hand smoke, can react with common indoor air pollutants to create additional toxic compounds not present in the original mixture. The reaction of nicotine with nitrous acid, a gaseous pollutant associated with outdoor sources such as traffic or indoor sources such as gas stoves, can create the carcinogen NNK *(155)*. In addition, new TSNAs can be formed through ageing, such as NNA, which is not found in second-hand smoke *(156–158)*. Nicotine can also react with ozone to create secondary organic aerosol in the ultrafine particle size-range *(155)*. This creates an important health concern because ozonation (the infusion of ozone into water) is commonly used to treat the unpleasant odour associated with tobacco smoke residue in homes and hotels.

Third-hand smoke in indoor environments

Infants and very young children are especially vulnerable to the effects of third-hand smoke because of their immature immune systems, incompletely developed organs, developmental behaviours (e.g., mouthing), and time spent indoors *(159)*. Young children living with parents or carers who smoke can even be exposed when no one smokes nearby, through physical contact with toxicants on the clothes and body of a smoker, playing with polluted toys, and through house dust in carpets and on furniture *(160, 161)*. While third-hand smoke levels decline over time because of off-gassing, ventilation and cleaning, they have been demonstrated to stay elevated for months after smoking has ceased *(162–168)*. Cancer risks to young children from cigarette toxicants in smokers' house dust in Spain were estimated to exceed the USA's Environmental Protection Agency thresholds *(169)*. Third-hand smoke levels are higher in countries with higher smoking rates and prevalence (e.g., China, Spain) and with more permissive smoking norms and policies *(170, 171)*. In addition to posing a health risk, third-hand smoke can become an environmental pollution risk when the furnishings or building materials from a smoking location are incinerated or disposed of in landfill, or are informally dumped.

Third-hand smoke in the outdoor environment

Because of the massive consumption of tobacco products, nicotine and tobacco byproducts such as cotinine end up in many solid-waste landfills or dumps. These compounds have been classified as contaminants of emerging concern *(172)*.

Nicotine and cotinine enter landfills through tobacco waste products (cigarette butts, cigarettes), third-hand smoke-polluted objects (such as building materials, carpets), and through human waste products mixed in landfill. In fresh samples of landfill leachate (liquid that drains out before any storage or processing), cotinine was among the most frequently detected chemicals *(172).* Cotinine has been detected in groundwater contaminated with landfill leachate and in reclaimed water used to irrigate fields in the USA (and in soil samples from those fields) *(173)*, underscoring the potential of humans and the environment to be exposed to tobacco waste products via many environmental routes *(174)*. Nicotine and related compounds are so ubiquitous in human wastewater that they have been proposed as a marker for the discharge of wastewater into water bodies *(175)* and have been used to track nicotine consumption patterns *(176)*. Worryingly, tobacco chemicals can also persist in treated wastewater *(175)*: after conventional processing in a drinking water-treatment plant, elimination efficiencies were 79% for nicotine and 94% for cotinine. Even advanced treatment cannot completely eliminate the compounds *(177)*, meaning that these compounds can pollute waterways and potentially contaminate water used for consumption.

Pollution from tobacco smoke in outdoor air has also come under increased scrutiny, with high local concentrations in proximity to smoking *(178–182)*. In addition to localized high levels, tobacco smoke can measurably contribute to ambient (widespread) air pollution in a city, with a measurable contribution to outdoor air pollution demonstrated for cities such as Los Angeles *(183, 184)* and London *(185)*. This form of tobacco smoke pollution is completely invisible to anyone exposed to it.

4 Post-consumer waste

Tobacco waste ends up everywhere and it is a well-known public nuisance for many communities, especially those with few resources to remove it. Clean-up and disposal are costs of tobacco use that are not currently borne by manufacturers, distributors, or users of tobacco products.

This needs to change. Programmes that make producers responsible (known as Extended Producer Responsibility and Product Stewardship programmes) should be set up to assign accountability and thereby help keep tobacco product waste out of the environment. Consumer-related controls could also be introduced, such as strengthening anti-litter and outdoor smoking bans and fines. This chapter looks at how and why some of these controls should be introduced.

4.1 Reducing harm caused by tobacco product waste

With up to two-thirds of every smoked cigarette discarded onto the ground, between 340 and 680 million kilograms of waste tobacco product litters the world each year. But it is not just the volume of this waste that is a problem. Tobacco product waste also contains over 7000 toxic chemicals, including known human carcinogens, which leach into and accumulate in the environment. This toxic waste ends up on our streets, in our drains and in our water. Research has shown that harmful chemicals leached from discarded butts, which include nicotine, arsenic and heavy metals, can be acutely toxic to aquatic organisms; research into their longer term effects on water supply are ongoing *(186)*.

Clean-up and disposal are costs of tobacco use not currently borne by either producers or users of tobacco products, but rather by government and local authorities – an unsustainable situation. To solve this, the environmental "precautionary principle" should be employed, meaning the use of preventative measures to avoid harm to the environment and human or animal health in the first place. Extended Producer Responsibility and Product Stewardship programmes would be one way of achieving this. EPR programmes and legislation would require the tobacco industry to pay for take-back programmes and incentives that help to keep tobacco product waste out of the environment. These initiatives should be funded by tobacco producers, but carried out by independent third parties with no links to the tobacco industry – this would be consistent with the WHO FCTC Article 5.3 *(187)*. Establishing Extended Producer Responsibility and Product Stewardship programmes would also contribute to public health outcomes such as reducing tobacco use and increasing the cost of tobacco products; enacting new tobacco product regulations and labelling to make the product less marketable; and strengthening existing anti-litter and outdoor smoking bans. This could also include large campaigns to raise public awareness of the environmental effects of tobacco waste, building momentum for advocacy against their irresponsible disposal.

Extended Producer Responsibility and Product Stewardship criteria

Numerous criteria can be used to determine how tobacco product waste should adhere to Extended Producer Responsibility and Product Stewardship principles and standards. Table 6 presents a criterion tool in the form of 18 questions. The responses for any particular consumer product provide information as to whether that product would qualify for inclusion in an EPR/PS-based policy, and any subsequent legal, regulatory and/or voluntary regime *(188, 189)*.

Table 5: Extended Producer Responsibility and Product Stewardship criteria (answers relate to tobacco)

Does the product create or cause adverse risks to the environment or to public health or safety?	Yes
Are toxics or hazardous constituents present?	Yes
Are adequate and mandatory contaminate controls in place to address these risks?	No
Does the product's post-consumer waste significantly burden government solid waste or other clean-up disposal programmes?	Yes
Do local governments and taxpayers bear most or all of the management costs?	Yes
Does the waste have the potential to act as a contaminant in those programmes, in relation to stormwater contamination or other diffuse, uncontrolled disposal?	Yes
Are existing voluntary clean-up/disposal programmes effective?	Very few
Is clean-up/disposal of the waste done in a safe, responsible way?	No
Is most or all of the waste created by the product part of these programmes?	No
Are there examples of success in collecting and processing other toxic or non-toxic products in other states or countries?	Yes
Do those other examples involve products that result in environmental or public health or safety risks similar to those associated with the product at issue?	Yes in some respects, no in other respects
Do other states or countries have problems applying similar rules to the product at issue, relative to programmes for other products addressing comparable risks?	It is likely that they have problems in that regard
Are existing EPR or PS programmes for the product at issue viewed as ineffective?	Yes
Do existing programmes lack mandatory measures necessary to achieving a sufficient degree of compliance and success?	Yes
Has the producer been uncooperative in trying to find effective solutions to address the necessary safe clean-up and disposal of the product?	Yes
Does the product have potential for enhanced resource conservation?	Yes
Potential resource recovery and material conservation?	No
Are there opportunities for environmental design/increased reuse or recycling?	No

Source: (204)

A number of states in the USA, including California, Oregon and Washington, have already started using similar criteria to decide whether or not consumer product wastes should be managed by EPR and/or PS approaches *(190–192)*.

Answers to most, if not all, questions in Table 6 provide strong support for EPR and/or PS approaches to tobacco product waste management. This should therefore be considered as an enforcement tool for countries and communities looking to prevent, reduce and mitigate problems from tobacco product waste, now and in the future.

4.2 Product waste

Tobacco product waste is the end point of the life cycle for tobacco products, and cigarette butts are by far the largest single type of litter by count *(193)*. Since the 1980s cigarette butts have consistently comprised 30–40% of all items picked up in annual international coastal and urban clean-ups. Given that the weight of 20 cigarette filters is 3.4 g, the estimated discarded waste from global cigarette consumption in 2014 could be anywhere between 340–680 million kg. This does not include the weight of remnant tobacco and other byproducts of the discarded waste.

In addition to tobacco product waste, there are other waste products associated with tobacco use such as the 2 million tonnes of paper, ink, cellophane, foil and glue that are used in tobacco product packaging. This waste ends up everywhere, including on our streets, and in our drains, rivers and other aquatic environments. In most areas, the responsibility for cleaning up tobacco product waste falls to citizen advocacy groups, local communities and governments using taxpayer funding *(194)*.

In the past, cigarettes were unfiltered, but in the 1950s the tobacco industry started marketing filtered cigarettes as a "healthier" alternative to unfiltered cigarettes. This shift altered the market forever and made filtered cigarettes the bestselling tobacco product. As we now know, claims that filtered cigarettes were "healthier" were fraudulent. The only thing filters may have done is make smoking easier and less harsh, increasing both the risk of addiction for smokers and the overall burden of the non-biodegradable and toxic cellulose acetate filters in our environment *(195)*. Tossing a cigarette butt on the ground has since become one of the most accepted forms of littering globally and borders on a social norm for many smokers. In the United Kingdom, "Keep Britain Tidy" – an advocacy group supported by the tobacco industry – reported a 43% increase in tobacco product waste as a result of a ban on indoor smoking. A separate observational litter study conducted in Washington, USA, estimated that one in three smoked cigarettes was discarded directly into the environment *(196)* while other studies have shown that most smokers admitted to throwing their cigarette butts on the ground or out of a car window at least once in their lives *(197)*. Even when appropriate waste receptacles were available, smokers still discarded their tobacco product waste into the environment *(198)*.

Toxicity

Research shows that cellulose acetate-based cigarette filters do not biodegrade under most circumstances because of their compressed make up and the presence of acetyl molecules *(199, 200)*. However, under specific circumstances (with sunlight and moisture), the cigarette filters may break into smaller plastic pieces containing and eventually leaching out some of the 7000 chemicals contained in a cigarette. Many of these chemicals are themselves environmentally toxic, and at least 50 are known human carcinogens *(201)*.

Studies have also shown that harmful chemicals such as nicotine, arsenic, polycyclic aromatic hydrocarbons (PAHs) and heavy metals leach from discarded tobacco product waste, and can be acutely toxic to aquatic organisms such as fish *(202, 203)*. One recent study used the USA's Environmental Protection Agency standard toxicity assessment protocols to show that cigarette butts soaked in either fresh or salt water for 96 hours have a lethal concentration that killed half the exposed test fish *(204)*. These chemicals come from across the tobacco production process, including pesticides and fertilizers, additives, the cellulose acetate filter, and combustion products generated by smoking cigarettes *(205)*. All in all, a cigarette butt may look like the

end of the damage wrought by a cigarette, but there is still a way to go in addressing post-consumer waste clean-up and responsible disposal.

4.3 Waste disposal (landfill)

Some, but not all, transnational tobacco companies report on their manufacturing waste disposal – tobacco and non-tobacco. The scale is large – for example, JTI annually purchases over 300 000 metric tonnes of non-tobacco materials for processing, much of which ends up in landfill *(206)*. In 2012, JTI reported 75 kg of waste per million cigarettes manufactured. CNTC disposes of an estimated 175 000–600 000 cubic metres of wastewater per year, which contains fine suspended particles as well as aromatic compounds and nicotine. In 2015, Imperial Tobacco reported 11.5 million kg of waste *(126)*, while in 2014 Altria reported 10.3 million kg of waste *(127)*.

4.4 Recycled waste disposal

There is a void of information on recycled waste disposal. If few companies provide information on general waste disposal, even fewer document the percentage of waste they recycle from the manufacturing process. Again, it is unclear what type of handling of materials is included under the heading "recycled", and how much environmental effect these efforts have, without more detailed and transparent reporting.

4.5 Hazardous waste

According to the Toxic Release Inventory Database, over 456 000 kg of toxic chemicals were released in 2008 from tobacco manufacturing plants, including ammonia, nicotine, hydrochloric acid, methanol, and nitrates *(207)* – none of which is good news for either human or environmental well-being. In 2011, BAT reported that 1973 metric tonnes of hazardous waste were produced during the tobacco manufacturing process *(208)*.

According to its CSR report, Altria discharged around 450 kg of phosphorus in wastewater in the USA in 2014, and around 7700 kg of nitrogen *(127)*. As the tobacco industry closes manufacturing plants in countries with higher labour costs and environmental regulation standards, their profits are increased. Since better environmental manufacturing practices often cost more, it is unlikely that tobacco companies operating in countries with lax standards will go above and beyond the minimum regulations.

4.6 Environmental manufacturing goals

Many transnational tobacco companies have established "environmental goals" for their manufacturing processes *(127, 209)*. These include reduction in energy use, increases in the proportion of recycled or reused facility waste, and reduced CO_2 emissions and water consumption, among others. BAT emphasized its green credentials based on its inclusion on the Dow Jones Sustainability World and Europe Indexes in 2011 *(208)*. It claimed, "To reduce our carbon footprint, we address our energy use, our waste to landfill and our business travel. We are also beginning to explore opportunities for generating and purchasing renewable energy." However, as with other tobacco industry voluntary measures, without regulations and independent oversight, it is unknown if these "goals" will have any positive impact.

While such measures are certainly welcome, at the same time BAT reported that, in addition to the 909 496 metric tonnes of tobacco leaf used in their products, they also used 442 893 metric tonnes of other materials including cigarette paper, wrapping, packaging, filters, glues and inks, in addition to 41 951 metric tonnes of materials used indirectly such as cleaning agents *(4)*. In terms of understanding the full extent of the environmental dangers of manufacturing, we may only be beginning to scratch the surface.

Electronic nicotine and non-nicotine delivery systems

Electronic Nicotine Delivery Systems (ENDS) and Electronic Non-Nicotine Delivery Systems (ENNDS) are devices containing a battery that heats a coil to vapourize a liquid matrix (e-liquid) which may contain nicotine, delivering an aerosol to the user. Other electronic devices such as Heat Not Burn (HNB) products are based on a similar technology but contain tobacco. The ENDS/ENNDS industry, also known as the e-cigarette industry, includes many brands competing in a mostly unregulated or inadequately regulated market *(210)*.
Several countries do not consider ENDS/ENNDS as a tobacco product nor the ENDS/ENNDS industry as tobacco industry, while other countries, like Singapore, have prohibited the sale of ENDS *(211)*. Given the lack of regulatory consistency both in product availability and production reporting, there are almost no data available about the environmental impacts of the manufacturing of these products *(212)*.

There is marked variability in manufacturing practices, as the chemical content of e-liquids and the design of the devices vary widely. E-liquids imported from China, for example, often have a different chemical mix than those originating from the USA. Introducing new classes of plastics, metals, cartridges, batteries, and concentrated nicotine solutions, however, involves significantly more environmentally intensive manufacturing processes than products that are primarily made of plant material. Currently, the majority of ENDS/ENNDS are not reusable or recyclable. In fact, it is quite the opposite: many contain elements (such as cartridges) that are disposable, rather than reusable or refillable. While independent ENDS/ENNDS manufacturers tend to sell refillable "open" system e-cigarettes, the transnational tobacco companies have so far tended to sell throw-away, one-use "closed" system products, presumably to boost sales via repeat customers. The few "tank" systems that are sold as refillable still use plastics, metals, batteries and other non-biodegradable substances that become waste products, invariably ending up as electronic waste in landfills. This is also true for HNB. If the lax environmental habits of many smokers in any way translates to ENDS or ENNDS users, we may be finding e-waste on beaches, circulating in oceans and contaminating cities and landscapes *(213)*.

Hard plastic disposable ENDS/ENNDS liquid cartridges may become the cigarette butts of the future. Some companies have set up recycling programmes for their batteries and used e-liquid cartridges. Others claim their products are "eco- friendly" or "green", despite the lack of any supporting data or environmental impact studies *(99)*.

Extended Producer Responsibility must be in place to take stock of the environmental harms that will result from these new devices. Any projected declines in the market for conventional cigarettes needs careful mapping as the tobacco industry has launched alternative nicotine delivery systems that heat but do not burn tobacco, and is developing nicotine inhaler technology that does not require a heating mechanism *(214)*. It is not yet known whether these new products may be more environmentally harmful than conventional cigarettes. The way in which companies get others to pay the true cost of their products – keeping the profits for shareholders while making society pay for their environmental and social impacts – must be avoided, or at least heavily regulated. Products that have no social benefit, such as tobacco, must be subject to full-cost accounting to accurately reflect and embed the costs of the harms they cause to both this generation and the next.

5 Calculating the economic cost

The economic cost of waste generated by the tobacco industry, its contribution to climate change, and the loss in productivity resulting from poor farmer health must all be further understood in order to account for the full cost of the tobacco epidemic. Economic models can be built to answer what is less known about tobacco markets – e.g. who the major exporters and importers are, and the type of trade (tobacco leaf or cigarettes) that they do; what drives them; and what other markets might develop if there were no tobacco.

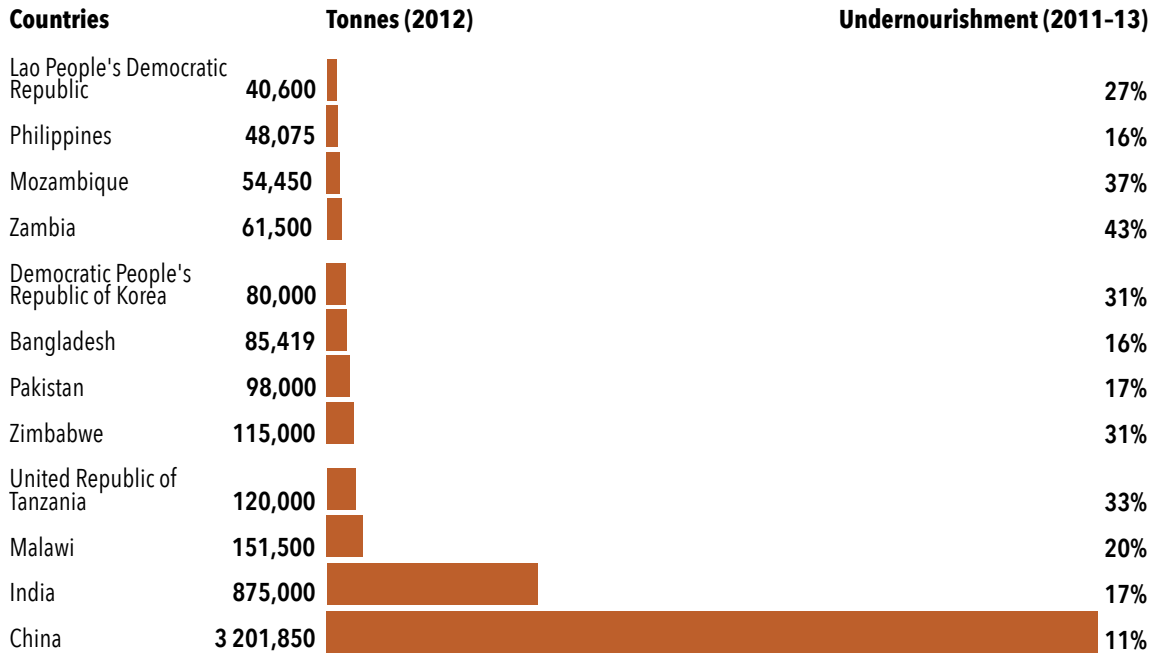
Poverty and tobacco use

Tobacco and economic underdevelopment are common bedfellows. Tobacco use is concentrated among the poor and other vulnerable groups, meaning tobacco use accounts for a significant share of the health disparities between rich and poor. As an industry, tobacco is growing because it targets more vulnerable communities to generate demand for its highly addictive product. To counteract this, market trends must be better understood.

Several countries that are large tobacco producers are also food insecure (see Figure 3). FAO defines low-income, food-deficit countries to be poorer (with an average annual net income per person of less than US$ 1395); unable to produce enough food to meet all of their needs; and lacking sufficient foreign exchange to fill the gap by purchasing food on the international market. While it would require economic assessments and policies on a region by region basis, land used for tobacco growing in these countries could be better used by producing food instead of tobacco.

A more complete understanding of the environmental and associated economic impacts of tobacco is required, but can only be achieved if there is greater support for research in this area.

Figure 3: The top 25 tobacco leaf producing countries that have more than 10% undernourishment



Source: Graph by The Tobacco Atlas, using data from the Food and Agricultural Organization's FAOSTAT Gateway.

5.1 Determining economic implications

Tobacco can inhibit economic progress in various ways. This overview is concerned with the impact in terms of negative environmental impact, and the waste and pollution associated with tobacco production. Historically there has been little economic modelling around this issue, perhaps in part due to the poor data available on the environmental impact of tobacco manufacturing (see Chapter 2).

This overview calls for a more comprehensive analysis of the environmental effects of the life cycle of tobacco, including cigarette production, trade and disposal. One way to do this is to use economic modelling to include environmental costs in the overall costs of the tobacco trade. Another would be to assess the economic viability of crops other than tobacco with a lesser environmental impact. To achieve the first, a variant of a Computable General Equilibrium (CGE) analysis of the effect of the tobacco trade on the environment could be created. Indicators of environmental concerns could be incorporated into these existing models to add an environmental component. By using the results of CGE modelling (alongside established cost-benefit methodologies), environmental effects could be costed (while offsetting other effects) in order to arrive at a figure on the net costs of tobacco and cigarette production that takes account of environmental impact.

A comprehensive approach that considers the environmental and economic impact of a world where tobacco product use is reduced is important, as is looking at a world where tobacco agriculture itself is reduced. One approach is to examine the economic effects in areas where tobacco has already been replaced by alternative crops.

Additionally, tobacco growing and curing could be offset against alternative crop data from the FAO to examine the costs and benefits. This would help researchers and policy-makers determine which alternative crops would provide the strongest environmental argument against tobacco, and which could consequently displace it as a crop of choice in an area or community. In the long term, supporting crops with significantly lower processing costs will be wiser for both the environment and for other development concerns, such as food security.

Crop substitution programmes

While anecdotal evidence supports the finding that tobacco could be substituted with other crops that may be equally profitable, a systematic analysis of this issue is needed. A natural starting point would be a thorough and comprehensive analysis of the effects of removing farmers from tobacco production altogether on economic variables such as employment, skills, output, wages etc. Recent research has shown that smallholder farmers are receptive to shifting out of tobacco production when conditions allow. In order to scale up these initiatives, however, results show that government policies and programmes are needed to improve market structure, public extension services and subsidies, and access to credit and loans for alternative crops *(67)*. Tobacco farmers, like most smallholder farmers in low- and middle-income countries, need policy reforms that put agricultural development at the centre of public services *(215)*. Recognizing that such policy reforms can take time, and that growing tobacco undermines the economic growth and human and environmental health of farming communities, the development of government programmes designed specifically for the transition of tobacco farmers to alternative sustainable livelihoods are desirable in the immediate term.

The economic burden related to waste is also an issue that should be costed. Tobacco product waste abatement-associated costs need to be calculated for countries globally to better understand the global economic burden of such waste.

6 Current frameworks and possible solutions

In 2003 the WHO FCTC treaty laid the groundwork for the environmental impacts of tobacco to be addressed, but years later the issue is only just being confronted with the level of commitment it requires. How can this work be advanced?

International treaties to regulate the environmental impacts of tobacco form a core part of any approach, because tobacco companies regularly exploit the differences in national regulations to avoid declaring or paying for the environmental damage caused by their activities.

There are now several international treaties and multinational environmental organizations concerned with the environmental impacts of the tobacco use life cycle. While most of these (listed at the end of this chapter) have as their focus, for example, issues such as hazardous waste, marine life or climate change, they nevertheless provide a starting point. They also help identify areas where control of the environmental impact of tobacco could help strengthen other aspects of development, such as population health, sustainable agriculture, water protection, and waste management. In addition, there is momentum for achieving the SDGs, including target 3A on tobacco reduction. This chapter considers how these could provide a basis for the development of additional treaties and frameworks.

6.1 Relevant WHO FCTC articles

The WHO FCTC encompasses all aspects of the environmental impacts caused by tobacco production and use, including health, economic, social, environmental sustainability, and food security concerns. The environmental concerns have been expanded through recent research initiatives to include tobacco product waste, agrochemical abuse, climate change, dirty manufacturing processes, product transport waste, consumption-related indoor and outdoor harms, and post-consumer waste disposal. These concerns re-emphasize the need to confront the vested interests of tobacco companies and the adverse effects of these interests on the environment.

The WHO FCTC's "Part V: Protection of the Environment" explicitly deals with the environmental consequences of tobacco, though it is not the only section that advocates a more responsible environmental approach. Within the WHO FCTC there are a number of articles that could play an important role in educating the public and in reducing the harm caused by short- and long-term consequences of the tobacco use life cycle. The following WHO FCTC articles reflect issues that relate to tobacco's impact on the environment.

Article 5.3 (General obligations): This subsection of Article 5 should be applied to exclude the tobacco industry from participating in decision-making, management and other activities regarding regulating the environmental impact of their production processes. Stronger application of this Article would push tobacco companies to be more explicit in their sustainability reporting about activities across the life cycle of tobacco products, given that they currently tend to use opaque, unclear and imprecise language.

Article 8 (Protection from exposure to tobacco smoke): This Article broadly recognizes the need to adopt measures to protect people from exposure to tobacco smoke. The scientific evidence is now clear that tobacco smoke does not simply disappear after a cigarette has been smoked: its constituents accumulate and persist in

indoor and outdoor environments, creating exposure risks long after the original cigarette has been consumed. This evidence should be used to review existing legislative, administrative, executive and other measures to address the long-term consequences of tobacco smoke emissions.

Article 9 (Regulation of the contents of tobacco products): This Article serves as a potential policy measure for regulating the contents of tobacco products in order to reduce or eliminate agrochemical and other additives, and compounds that contribute to the accumulation and persistence of toxicants in outdoor and indoor environments, ground water, sewage, and landfill leachates. Further research is needed on the use of agrochemicals in tobacco agricultural practices, and how these chemicals are transmitted along the production, consumption and post-consumption chain to consumers and beyond. Moreover, because the scientific evidence regarding third-hand smoke is relatively new, existing product disclosure requirements should also be reviewed and revised to reflect new evidence on the persistence of tobacco smoke carcinogens and other toxicants in indoor environments where tobacco has been regularly smoked, especially in homes.

Article 12 (Education, communication, training and public awareness): This Article could be applied by looking at measures that concern educational and outreach activities and materials that promote and increase awareness of the environmental impact of the tobacco life cycle. These include: programmes to reduce health risks; benefits of cessation and tobacco-free lifestyles; and awareness on the part of public and private agencies and nongovernmental organizations about the economic and environmental problems created by the tobacco industry. For example, public websites should be created that include information on signage, written materials, and template warning notices about the environmental impact for retailers to disseminate to all purchasers of tobacco products at the time of sale.

Article 13 (Tobacco advertising, promotion and sponsorship): This Article presents national and subnational level opportunities to undertake comprehensive bans on all tobacco advertising, promotion and sponsorship. For governments unable to undertake a comprehensive ban because of their constitutional principles, alternative restrictions can be considered. The aim of the Article is to ban or restrict false CSR activities by the tobacco industry such as promoting re-forestation, and child labour protection efforts in tobacco growing and manufacturing. The tobacco industry's poor human rights and environmental stewardship record should also be more heavily publicized. These efforts should be linked to efforts under Article 5.3.

Article 17 (Provision of support for economically viable alternative activities): Article 17 and 18 both fall under the WHO FCTC's "Part V: Protection of the Environment". While a Working Group on Articles 17 and 18 has met and produced reports on several occasions *(216, 217),* there has been little attention concerning the impact of tobacco on the environment. Of the two articles, Article 17 has to date generated more interest, mainly as a way to identify alternative, viable livelihoods for tobacco farmers. Greater use of the Article should be made to shift support away from tobacco farming to environmentally sustainable activities. This process should also be monitored to document how it can most effectively be managed, and to evaluate the longer-term benefits of the transformation.

Article 18 (Protection of the environment and the health of persons): Before 2016, not much attention had been devoted to this Article. However, during a meeting of the WHO FCTC's governing bodies in 2016 (the Seventh Annual Conference of the Parties, or COP7), the WHO FCTC Secretariat invited WHO and other relevant international organizations to prepare a report for COP8 on the environmental impact of the tobacco life cycle. The intention is for this overview to be used to outline policy options and practical orientations to help Member States mitigate tobacco's environmental impact. At the same time, COP7 also requested the WHO FCTC Secretariat to help Parties advance Sustainable Development Goal initiatives aimed at raising awareness about occupational and environmental risks related to tobacco growing. Organizations and treaties with the capacity to support this are listed at the end of this chapter.

Article 19 (Liability): This Article can be used to hold the tobacco industry liable for environmental damage and chemical exposures to farmers (including those who suffer from Green Tobacco Disease); manufacturing and transport employees; consumers; and those affected by post-consumer waste. The persistence of third-hand smoke pollutants is a good example of the kind of liability issues that the industry should face, given the longevity of their impacts. Because third-hand smoke may persist for months or years, owners, buyers, and users of third-hand-smoke polluted homes, apartments, hotel rooms and cars face consequences long after the cigarettes have been smoked. In the USA, it is now common for hotel and car rental companies to charge customers a penalty after someone has violated a non-smoking policy. Similarly, third-hand-smoke polluted homes and cars stay longer on the market, and tend to sell for a lower price. Liability for damage and harm done by third-hand smoke should be clarified, as this could play an important role in overall tobacco control efforts.

Article 20 (Research, surveillance and exchange of information) and Article 21 (Reporting and exchange of information): There is an important but as yet unmet need for surveillance, research, and exchange of information on the accumulation of tobacco smoke in both the indoor and outdoor environment. It is particularly important from an international perspective, given the significant variation between countries and locations with different levels of tobacco consumption and tobacco policies. Differences observed in third-hand smoke levels in Spain, China and the USA point to the potential impact of tobacco control policies on third-hand smoke to reduce smoking prevalence and de-normalize tobacco use. Scientific evidence suggests that cotinine and other tobacco smoke constituents should also be monitored to better understand their implications – how they enter, accumulate in and pollute water, become embedded in indoor environments, and affect human health long after the cigarettes have been smoked. Greater focus on this Article should also be leveraged to encourage more research, surveillance and exchange of information in low- and middle-income countries on the environmental impacts of tobacco agriculture. This is particularly important given industry interference in environmental and tobacco science and policy. It should include specific research on how changing trends in leaf production, such as contracting and curing practices, impact on local environments.

6.2 Industry accountability

Since the 1970s *(218)* tobacco companies have promoted voluntary policies that help them avoid all environmental responsibility as producers. Tobacco companies also attempt to divert public attention away from the environmental costs of their activities through corporate social responsibility programmes and "greenwashing" claims. With the rise of CSR in the past decade, the largest transnational tobacco companies have begun self-reporting the environmental resource use and waste resulting from their production processes. Overall, though, the efficacy of external verification agencies remains limited. Among other challenges, all producers should be required to compensate the environmental harms caused by deforestation, water use, waste, etc. through offsets in order to ultimately reduce the long-term ecological harm their business causes.

Protecting the public against the tobacco industry's efforts to obfuscate the environmental impact of its business is then aligned with WHO FCTC Article 5.3 and its guidelines, which remind Parties that: "There is a fundamental and irreconcilable conflict between the tobacco industry's interests and public health policy interests."

For other products that generate hazardous waste, such as paint and pharmaceuticals, there are preventive environmental approaches to manage waste based on the Extending Producer Responsibility and Product Stewardship principles (see Chapter 4) *(10)*. It can be argued that the tobacco industry should similarly be responsible for numerous environmental problems throughout the tobacco product life cycle. With regard to

tobacco product waste, the industry has firmly held that "the responsibility of cigarette waste belongs to the smoker" *(218)*. Extended Producer Responsibility and Product Stewardship are environmental principles that apply throughout the life cycle of toxic or environmentally unsustainable products *(219)*.

The Extended Producer Responsibility concept dates back to the early 1990s when Thomas Lindhqvist, a Swedish graduate student, prepared a report for Sweden's Ministry of the Environment that called for manufacturers to be responsible for the entire life cycle of the their products *(220)*. Lindhqvist defined Extended Producer Responsibility as an "environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life cycle of the product and especially for take-back, recycling, and disposal of the post-consumption waste".

Two central tenets of this concept are especially relevant with respect to tobacco's harm to the environment: to embed the environmental costs of products in their retail price; and to shift the economic burden of managing toxicity and other environmental harm associated with post-consumer waste away from local governments and taxpayers and on to producers.

In practical terms, Lindhqvist identified four specific categories of producer responsibility:

1. Liability: The responsibility for proven environmental damages caused by the product in question; the extent of liability is determined by legislation and may embrace different parts of the product life cycle, including consumption and final disposal.

2. Economic: The producer covers part or all of the expenses for the collection, recycling, or final disposal of the products manufactured (with these expenses paid for directly by the producer or through a special fee collected by vendors).

3. Physical: As a general rule, the producer is involved in the physical management of the product and its environmental impacts throughout its life cycle (although given the special circumstances with regards to the tobacco industry, Article 5.3 limits the industry's involvement to financially underwriting the cost of management and programmatic activities).

4. Information: The producer must supply information on the environmental risks of the products manufactured *(4)*.

Extended Producer Responsibility and Product Stewardship-based laws have already been enacted at the state level in the USA, the EU, and in several other countries for a number of other products, including paint, batteries, electronics, pesticide containers and packaging *(221)*. There is clear scope for tobacco-specific ones to be produced and introduced.

While Extended Producer Responsibility and Product Stewardship are discussed in Chapter 4, tobacco product waste is used as the sole example of a potential entry point for mandating tobacco producers' financial responsibility. This is because it is the most collected litter item globally. Nonetheless, in theory, other life cycle stages of tobacco use should also be included: agrochemical abuse, deforestation, CO_2 and methane emissions, manufacturing, transport, and post-consumption toxic waste.

Ultimately, tobacco producers should be responsible under Extended Producer Responsibility for liability, economic costs, and providing information on environmental impacts of tobacco use. Product Stewardship approaches would provide a foundation for other stakeholders, including governments, citizens' groups, green businesses, distributors, and academic researchers, to engage in complementary activities to help reduce, prevent, and mitigate environmentally harmful and unsustainable practices in tobacco growing, manufacture, transport, consumption, and post-consumption waste disposal.

6.3 Recommendations

This overview has presented evidence to support the case that tobacco is causing massive harm to the environment. It recommends the following:

1. Identify, prevent, treat, and monitor health effects related to tobacco growing and manufacturing among farmers and workers.
2. Make it mandatory for tobacco manufacturers to supply timely and regular information and data on the environmental and health risks of tobacco throughout production and distribution.
3. Establish a collaborative effort to a) evaluate the types and extent of harm to the environment from tobacco throughout its life cycle in relation to WHO FCTC Articles 17, 18, and others; and b) present the evidence on these issues to advocates and Member States within the context of the WHO FCTC, the SDGs, and other international policy frameworks.
4. Develop strategies to free tobacco farmers, and their children, from unsafe agricultural and labour-related practices involving exposure to tobacco pesticides or other chemicals, in relation to WHO FCTC Article 17.
5. Strengthen regulation of tobacco agriculture to prevent deforestation and land degradation.
6. Adopt and implement Extended Producer Responsibility regulations requiring tobacco producers to finance independently established and managed stewardship organizations to prevent, reduce and mitigate tobacco product waste, as well as other life cycle stages of tobacco, where possible.
7. Extend regulations and tax policy on tobacco products and sales to eliminate single-use filters – including any biodegradable varieties – to reduce post-consumption waste.
8. Engage litigation, legislative, and other economic interventions to recover the costs of tobacco industry misconduct and environmental damage.
9. Innovate, improve and enforce new and existing environmental regulations and agreements that may apply to tobacco manufacturing, transport, consumption and post-consumption waste.
10. Address the important, unmet need for surveillance, research and exchange of information regarding the accumulation of third-hand tobacco smoke constituents in indoor and outdoor environments.

In the case of tobacco product waste in particular, clean-up costs to cities and communities are substantial and a nuisance. From a tobacco control perspective, a variety of interventions can help prevent, reduce, and mitigate the environmental impacts of tobacco product waste. These measures include:

- banning smoking in all public outdoor, indoor and workplace areas;
- applying additional litter fees on tobacco products to pay for clean-up and anti-tobacco product waste educational and advocacy programmes;
- levying and enforcing fines for littering that specifically include tobacco product waste. While not yet operational, other potential initiatives include:
- banning the sale of single-use, disposable filters;
- prosecuting damages associated with the environmental impacts of tobacco product waste;
- labelling tobacco product waste as hazardous waste;
- enacting laws that make tobacco manufacturers financially responsible for cleaning up and safely disposing of tobacco product waste, with programmes and other activities carried out by non-tobacco industry actors (to enforce third-party objectivity), such as civil society and other agencies.

Some of these are already starting to happen. Canada, for example, has recommended a legislative bill that could fine anyone disposing of tobacco products improperly with a fine of up to CAD 3000, or US$ 2288 (set out by the Legislative Assembly of Ontario, 2010). These kinds of enforcement programmes can help reduce the social acceptability of littering with cigarette butts, thereby providing better environmental protection *(222)*. It could also see a knock-on effect on smoking reduction rates, reinforcing intentions to quit – not just as an individually responsible, but also a socially responsible, thing to do.

6.4 The road ahead

No matter how much more efficient the tobacco industry becomes, and how much better regulated, the industry will never be environmentally benign. In the past decade, tobacco control policies have threatened tobacco industry profits more than ever. The tobacco industry sees the ratification and implementation of the WHO FCTC across the developing world as a major threat. In response the industry has been very pro-active in lobbying governments and intervening in policy-making to block or water down tobacco regulation. Industry representatives, with the help of front groups such as the International Tobacco Growers' Association, claim that that implementation of WHO FCTC-based policies is economically harmful to farmers in low- and middle-income countries. At the same time, they downplay the negative impacts of tobacco farming in communities and shift attention away from it through inappropriate or weakly developed and misleading corporate social responsibility campaigns.

While all transnational tobacco companies have goals to reduce the environmental impacts of tobacco manufacturing and/or transport, the fact remains that the tobacco industry is a highly unsustainable enterprise. The adage "there is no such thing as a safe cigarette" could be extended to assert that there is no such thing as an environmentally neutral tobacco industry. However, that should not be used as an excuse by the tobacco industry not to bother trying at all. At the very least, transnational tobacco companies should be required to compensate the environmental harms they cause in order to lessen the long-term, global ecological harms and climate change generated by the tobacco business.

It is also down to the rest of the world to make it extremely difficult for the industry to shirk its responsibilities. There are many other activities based on the WHO FCTC that go well beyond the activities described in this chapter, including stronger surveillance, better data reporting, greater legal and political support to counteract industry pressure, more public advocacy, increased collaboration with environmental organizations – the list is endless.

Successful strategies to reduce tobacco use and mitigate its environmental harms will vary significantly. Overall, however, they will all be founded on the same two principles: that the status quo is unacceptable, and that success will require bold, new and fundamentally different approaches. These will need to include a diverse mix of ideas and new partnerships in order to succeed. Support from multiple sectors – health, agriculture, labour, finance, trade and environment – will be needed to address the environmental impacts of tobacco production and use.

It is clear by now that tobacco control intersects with other pressing global issues such as those addressed by the Sustainable Development Goals, the Rio+20 environmental commitments, climate change science, new global trade agreements, and environmental justice. By taking broad-based but effective action, including assigning liability for the environmental hazards created by the tobacco industry, the demand for tobacco products will be further reduced. With stronger environmental policies and the internalization of the true cost of tobacco production and use, there will be increased costs for tobacco products and a decreased social acceptance of tobacco use.

This overview is constrained by limited data on tobacco manufacturing impacts and the existing disconnect between the perception of the environmental externalities of tobacco production and the widely known harms of tobacco use. Consumers, environmental policy-makers, and even smokers do not fully recognize the environmental impacts wrought by tobacco, and hence, strategies that deserve more recognition and adoption vis-à-vis the environment have not been considered. Raising awareness of this is perhaps the single most important action to undertake.

Ultimately, every effort made will move us a step nearer to a world that recognizes tobacco as a serious problem for the entire planet. And it is imperative that we act fast. The human, financial and environmental costs are simply too great for us not to.

Examples of major environmental treaties

Global atmosphere

United Nations Framework Convention on Climate Change (UNFCCC)

Vienna Convention and Montreal Protocol

Convention on Long-Range Transboundary Air Pollution (LRTAP)

Water and marine environment

The United Nations Economic Commission for Europe (UNECE) Water Convention

Marine Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)

Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)

UN Convention on the Law of the Seas (UNCLOS)

Hazardous substances

Stockholm Convention on Persistent Organic Pollutants (POPS) Prior Informed Consent (PIC) Rotterdam Convention

The Accident Convention

Basel Convention on the Control of Transboundary Movement of Hazardous Wastes

Land and biodiversity

Ramsar Convention on Wetlands of International Importance

Convention to Combat Desertification in Countries Experiencing Drought and Desertification

Convention on Biological Diversity (UNCBD)

Bern Convention

Examples of international environmental organizations

Intergovernmental Panel on Climate Change (IPCC)

United Nations Environment Programme (UNEP)

United Nations Economic Commission for Europe (UNECE)

United Nations Commission on Sustainable Development (Rio+20)

Secretariat of the United Nations Convention to Combat Desertification (UNCCD)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

International Maritime Organization (IMO)

Organization for Economic Cooperation and Development (OECD)

World Meteorological Organization (WMO)

United Nations Forum on Forests World Conservation Union (IUCN)

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