5.2

Ecological and Environmental Effects of Tobacco Use

Environmental implications of tobacco

Growing tobacco impacts the environment in different ways. Like all plantation crops, tobacco requires clearing of fertile land. Since it is a remunerative cash crop in the short term, it lures farmers to clear more forests to reap more profits. This means that farmers may forsake planting subsistence crops, often risking far too much in anticipation of earning money. As tobacco is processed in stages, it consumes fuelwood, causing deterioration of forest cover. It grows in drylands, is water-demanding, and consumes large quantities of fertilizers and pesticides. The making of cigarettes and cigars also produces large quantities of waste in the form of tobacco slurries, solvents, oils and greases, paper, wood, plastic, packaging materials and results in air pollution.[13] In the United States of America, for example, the tobacco industry ranks 18th among all industries in the production of chemical waste.

In 1995, the global tobacco industry produced an estimated 2262 million kg of manufacturing waste and 209 million kg of chemical waste. Among the many waste products of the tobacco industry, which are considered toxic by the US Environmental Protection Agency (EPA), is nicotine, obtained during the production of low-nicotine cigarettes. Globally, around 300 million kg of nicotine waste are produced annually by the tobacco industry. Despite this, cigarette and other tobacco production units have no regulatory obligations. Worldwide, only six countries have any regulations on chemicals produced during and from cigarette production.[14]

Environmental costs, if incorporated into the cost of manufacturing of the product (say cigarettes), would increase the price of raw tobacco by 20% and finished product by 40%, according to Paulo De Riotta, an environmental economist with the University of Reading.[15] If regulations could push for full environmental cost accounting, companies would be compelled to raise the price of cigarettes, which would prove to be a major deterrent for consumers and the industry.

Deforestation

Global evidence of deforestation

Tobacco contributes to deforestation in three ways: forests cleared for cultivation of tobacco, fuelwood stripped from forests for curing and forest resources used for packaging of tobacco, tobacco leaves, cigarettes, etc.

Globally, according to one estimate, 38% of the forest cover losses are attributed to clearing for cultivation, about 42% is attributed to fuelwood needs, about 8% occurs because farmers abandon old farms and seek new land, and the rest (12%) meets the packaging needs of cigarettes.[16] In many developing countries, such as India, Zimbabwe and Indonesia, forest clearance for cultivation has decreased drastically because of awareness about conservation. However, sourcing of fuelwood for curing of tobacco is still done surreptitiously from neighbouring forests or is obtained from regions as far away as 50–200 km, thereby causing indirect deforestation. Packaging requirements are a constant need of the industry.

Tobacco-related deforestation is substantial and much larger than what had been anticipated by local communities and governments. Approximately 200,000 hectare of forests/woodlands are removed by tobacco farming each year.[17] Deforestation mainly occurs in the developing world, amounting to 1.7% of the global net losses of forest cover or, on an average, 4.6% of the total national deforestation in countries where

tobacco is cultivated.[17] Environmental criticality exists, or is emerging, in 35 countries with an estimated serious, high and medium degree of tobacco-related deforestation, mainly in southern Africa, the Middle East, south and east Asia, South America and the Caribbean.[17]

A study on deforestation due to tobacco plantations did not include India, because no (net) overall deforestation was reported from India. This was due to an increase in commercial plantations. However, tobacco's estimated consumption of wooded areas (44,000 hectare) far exceeds annual forest increases (7000 hectare).[17] Despite excluding India from this study, it was found that tobacco-related deforestation has global relevance, which could be found in all continents and which on an average contributes nearly 5% to overall deforestation in the tobacco-growing countries of the developing world. Tobacco is grown in more than 120 countries, thus constituting the most widely grown non-food crop (coffee is grown in 59 countries, jute and jute-like fibres in 25, *sisal* in 15). Although crop-specific deforestation occurs in developing countries spread all over the continents, tobacco has not been found to be a part of the research agenda on global environmental change during the past 10 years.

As tobacco is grown in fragile wooded forest areas, the level of damage to these forests from clearing and curing of tobacco varies widely. In Africa, around 5% of all deforestation is caused by tobacco. In Malawi, where the ancient dry forests of the Miombo highlands are particularly under threat, tobacco accounts for 20% of the deforestation.[18]

Use of fuelwood and deforestation

About half of the tobacco leaves produced in developing countries in Africa and Asia are cured (dried out for cigarette production) with wood. Trees from a hectare of land may be needed to cure 1 tonne of tobacco. An average of 7.8 kg of wood is needed to cure 1 kg of tobacco. According to the Economist Intelligence Unit, 'One of the major consequences of tobacco production in the Third World results from the considerable energy requirements of the flue-curing and fire-curing processes; as such, tobacco is a contributory factor in some countries to the problems of deforestation now being encountered'.[19]

Fuelwood was the main reason why Brazil has globally lost some of its tobacco markets. Due to the decreasing supply of fuelwood for curing tobacco and greater conservation pressures, farmers were forced to relinquish planting tobacco. Even today, the 100,000 Brazilian tobacco farmers need wood from 60 million trees a year to cure the tobacco they produce.[20]

Legislative restrictions largely emanating from global pressures to conserve rainforests, required all farmers to preserve 20% of their farm area as natural forest, and this was seen as a threat to tobacco production. However, tobacco companies implemented programmes to restore tree coverage in production areas. By then, even local governments realized that the wood used for tobacco curing is a major cause of damage.

Brazil, India, the Philippines and most of Africa (except Zimbabwe) use fuelwood for curing tobacco. A wood shortage is looming in Malawi and Tanzania with increasing deforestation in the tobacco-growing regions.[21]

A study based on the felling of live trees (as against dead and diseased trees, permitted by green felling norms) for fuel to cure tobacco found that tobacco estates in Malawi account for 21% of the national fuelwood consumption and contribute nearly 47% to the deforestation caused by harvesting wood biomass for fuel.[22] This study highlighted that in regions where deforestation rates are high, local impacts are large, while in large countries such as Brazil and India, because of the large geographical and forest cover, even large-scale loss of forest cover in areas where tobacco is grown, gets evened out. Another study using industry and Food and Agriculture Organization (FAO) data found that one acre of tobacco plants displaces 150 trees

from natural dryland forest.[20] For cigarette paper and packaging (to produce 100 cartons of cigarettes), 80 more trees are needed. Since high-quality card paper used to make cigarette boxes and cartons are not recycled, an additional loss of 20 trees occurs.

Industry and agricultural research organizations such as the International Tobacco Consortium and the Tobacco Institute of India (TII) have claimed to have made progress in reducing wood consumption. Industry sources claim to have reduced fuelwood consumption, for example, by 40%–55%.[23] However, several small farmers and curing plants continue to use conventional techniques which are wasteful. In flue-cured Virginia (FCV) cultivation, curing accounts for 30% of the cost of cultivation. To cure every 1 kg of tobacco leaves, nearly 6–8 kg of high-quality dry fuelwood is needed. Wood used in a single barn (of 600 kg tobacco leaf curing capacity) is sufficient to provide fuelwood for cooking and other domestic consumption for 20 regular households.[23] Efforts to reduce fuel consumption include insulation of the roof, ventilators and doors of the barn with thermocole/rock-wool/strawmit, and making slight changes in the design of the barn furnace. This resulted in the reduction of 25%–30% of the fuel cost.

Research has been conducted to evaluate the efficiency of coffee husk briquettes, sawdust briquettes and paddy husk briquettes as alternate fuels for curing tobacco.[24] In most developing countries, however, the fundamentals of flue-curing have changed little. Some traditional practices have given way to direct-fired systems fuelled by natural or liquefied petroleum gas, and have completely phased out the use of fuelwood. This is largely because it has also been found that flue-curing produces tobacco-specific nitrosamines (TSNAs). Nitrosamines are produced when nitrous oxide, a product of combustion, combines with the nicotine in tobacco leaves. TSNAs are confirmed carcinogens and hence a potential source of occupational and environmental cancer.[25] With the use of cleaner fuels, retrofitted equipment and heat exchangers, the amount of TNSAs can be markedly reduced. Emission of toxic gases such as TNSAs, polyaromatic hydrocarbons and other volatile aromatic compounds are not recognized as hazards in most tobacco-growing countries.

Evidence of deforestation in India

There are no comprehensive figures or data on how much deforestation occurs from tobacco cultivation and industry. However, evidence is available to prove that forests were cleared on a large scale in areas where tobacco is grown. One reason for not recording the decline in forests was that forests were part of revenue land, which the local administration was entitled to use for local area 'development' and conversion of forest land was permitted. In addition, large tracts of private forests have not as yet been enumerated, despite different states having promulgated Private Forest Acts. Another reason is that the relative importance of forestry as a discipline declined while agriculture dominated heavily, especially between the 1930s and 1960s. No department or ministry existed to conserve forests (Ministry of Environment and Forests came into existence in 1976). Consequently, agriculture departments took full control and diverted forest lands for agricultural purposes. There are few records on how much forest existed in dryland areas and how wood was consumed by the industry. As the forest departments classically did not consider dry and semi-arid areas as forests, no authoritative records exist for any area where tobacco was promoted.

Some anecdotal evidence of deforestation does exist. Between 1932 and 1946, promotion of tobacco spurred deforestation and scrub removal. For example, in the Kheda and Anand regions of Gujarat, nearly 64 sq. km of forests were stripped. However, local communities realized that growing tobacco was not remunerative enough as forest and grass cover was lost, and many in the community depended on milch cattle for their sustenance. By the mid-1970s, tobacco cultivation declined in Gujarat.[14] In

Motihari, Bihar, nearly 60 sq. km of land was converted from dry forest area to grow tobacco, after it was promoted in the region by the Pusa Agricultural Research Centre in the 1920s.[26]

The real success to growing quality tobacco was seen in Andhra Pradesh and later in Karnataka. In the early 1900s, cultivation of tobacco picked up rapidly but because the local administration did not offer compensation and relief during natural calamities, it soon lost favour in most districts. The interest was revived only after incentives were institutionalized and farmers knew that there were assured returns from buyers and industries. Nevertheless, from the 1940s to the 1970s, because cultivation periods were long and storage facilities were few, tobacco needed to be 'cured' quickly. Firewood and dried biomass were used excessively to desiccate the moisture and destroy the chlorophyll from harvested leaves. All neighbouring areas, especially forests and groves, were stripped of dry wood to fuel the curing process.

In the 1980s, when fuelwood was scarce, the tobacco industry took measures to protect itself. Some tobacco companies, especially those in Andhra Pradesh, promoted plantation of fuelwood trees along tobacco fields. Alternatives were also explored. In Karnataka, for example, kernel and other wastes from coffee processing is being used since 1987 to make briquettes. (Briquettes are bricks made of desiccated and compressed biomass from agricultural crops such as groundnut, coconut, coffee, etc. which are used for burning.)

In areas where fuelwood supply has decreased, farmers dry the woody stems of the tobacco plant for domestic fuel. This, in turn, has severe health impacts. A survey done in the Godavari delta of Andhra Pradesh found that in one particular village—Vadisaleru—where only tobacco and few subsistence crops were grown, fuelwood shortage was severe. The rates of tuberculosis and cataract were higher than in other villages where tobacco was not grown. Both Virginia and country tobacco (an inferior type of tobacco called Lanka *pogaku*) were cured in open barns. In this village, 10–12 quintals of wood were used for the 315 barns, or about 350 tonnes of wood consumed every year. Even for local varieties of tobacco, the cost of curing is high and energy inefficient.[27,28]

Box 5.1 How much wood may have been lost due to tobacco curing?

A scenario exercise conducted by the Indian Institute of Forest Management, Bhopal estimated that the historical use of fuelwood between 1962 and 2002, for tobacco curing and manufacture of cigarettes and other smoking consumables, has destroyed and degraded 680 sq. km of scrub forests, or nearly 868 million tonnes of wood (220 million tonnes of construction quality wood and 668 million tonnes of fuelwood), through successive extraction. In calorific terms, the wood energy lost is enough to run a thermal power plant to provide electricity to Delhi and western Uttar Pradesh for an entire year, according to this study.[16]

Unlike Brazil, the tobacco industry in India was quick to anticipate that the forest departments would not provide wood on concession. The industry devised methods to use existing varieties to be cured using other biomass (especially from other agricultural sources), solar energy, and in some areas adopted varieties that could be cured in the noon sun rather than under firewood pyres. In India, industry and agricultural extension workers have made some efforts to assuage fuelwood shortage through the supply of briquettes made of agricultural waste (coffee husk, groundnut shells, etc.) at subsidized cost.[29]

Soil erosion and related impacts

Tobacco is usually grown in dry, arid areas and Indian soils are generally poor in nutrients. Any perturbation of such a soil ecosystem means an immediate and irreversible loss of nutrients. As tobacco is usually planted as a single crop, tall tobacco plants do not offer much protection to top soil from eroding agents such as wind and rain. The use of eucalyptus, the tobacco industry's favourite tree for reforestation, is highly controversial. It grows quickly, even in dry areas, by drawing underground water. However, its fast

Table 5.6 Average annual depletion of soil nutrients in Africa by tobacco and other crops[31]

Crop (1 tonne/ hectare)	Nutrient loss (kg/hectare)		
	Nitrogen	Phosphorus	Potassium
Tobacco	24.4	15.0	9.8
Coffee	2.2	14.4	2.5
Maize	1.9	0.4	46.4
Cassava	19.5	6.7	1.9

growth is at the expense of the water table. If a lower water table results, then the ability of the land to grow crops is damaged.[30]

Tobacco growing also affects soil nutrients. It depletes nutrients at a much faster rate than many other crops, thus rapidly decreasing the fertility of the soil.[31] Table 5.6 lists the average annual depletion of soil nutrients caused by tobacco and three other crops that could be its substitutes.

Since it depletes nutrients at a heavy rate, tobacco requires regular inputs of chemical fertilizers. Tobacco depletes the nitrogen, phosphorus and potassium in soil at higher rates than any food crop and, in most cases, higher than cash crops such as coffee, tea and cotton. It is particularly potassium-hungry, absorbing up to six times as much as other crops. One of the reasons for tobacco's high uptake of soil nutrients is the practice of topping the plants to stimulate leaf growth for ensuring higher nicotine content.

The Indian Agricultural Research Institute (IARI) report of 1962 reviewed the soil erosion status due to cultivation of dryland crops. Tobacco when grown singly was the most erosive crop, causing a loss of 45 kg of top soil on every acre per year. In comparison, cotton crop lost 7.5 kg, grapes about 11 kg and groundnut 12.5 kg. Erosion of soil does not only mean the loss of a large volume of soil but also includes the loss of selective nutrients and organic matter that deposit on the top layers at a greater frequency. Due to this, the lower layers get exposed to eroding agents and lose their fertility, and therefore become prone to erosion in rapid succession.

As a result of soil erosion, water retention in the soil becomes poor. In arid areas, even marginal losses imply a considerable loss for future seasons. The impact is often felt on subsistence crops such as cereals that grow in surrounding areas. A case study from Sri Lanka shows that cash crops such as tobacco hastened erosion. In the six to eight years of growing tobacco in the region, irrigation through pumps and lift irrigation were seen as essential. The production of subsistence crops such as minor cereals, plantain and amaranth declined by about 30%.[32]

Biodiversity losses

Planting a single crop for several successive seasons is detrimental to the local biological diversity. After clearing forests, the fragile forest ecosystem usually cannot recuperate from the losses of the plant and animal community. According to a study done in Tanzania, conversion of forests to tobacco farms caused the local disappearance of several animal and plants species.[33]

Displacing the indigenous flora and fauna means that tobacco will gradually become a source of pests for other crops. Another measure of biodiversity loss is the collapse of the food web, thereby destabilizing the predator–prey relationship. It is most acutely seen in the insect and small rodent population, which live in the forest fringes. Agricultural practices dominated by maximizing the productivity of tobacco also means a loss of utilizable biomass for communities. In intercropping practices, many beneficial species of insects exist that reduce crop losses. As tobacco is mostly alien to India (having originated in the Americas), several viral, fungal and insect pest diseases crossed over to local vegetable crops. In Andhra Pradesh, a survey which compared pests in three tobacco-growing and non-growing regions found that at least 12 fungal and viral diseases, and 29 insect pests were absent in farmlands and vegetable steads where tobacco was not grown. The survey concluded that since many vegetables and cereals are grown subsequent to tobacco harvests,

tobacco farms serve as constant reservoirs for re-introduction of these pests. Neighbouring crops were more susceptible because vegetables were not offered the same intensive chemical protection as is tobacco.[34]

Use of pesticides

Tobacco is a sensitive plant prone to many diseases, especially during early growth. It therefore requires huge chemical inputs: up to 16 applications of pesticide are recommended during one three-month growing period. Aldrin and dieldrin, phased out in Britain in 1969, and DDT are among the chemicals used, especially in Africa and surreptitiously in India. Methyl bromide, widely used as a fumigant in developing countries, contributes substantially to ozone depletion and is a toxic contaminant of groundwater.[35–37] In addition to being hazardous to users, chemicals may run off into water bodies, contaminating local water supplies.

There are also concerns about the high levels of pesticide use leading to the development of resistance in mosquitoes and flies, making the control of diseases such as malaria more difficult. Excessive use of DDT and other pesticides have been responsible for the resurgence of malaria and possibly DDT-resistant malaria in certain states.[38] Incidentally, in Gujarat, Bihar, Maharashtra and Andhra Pradesh, the earliest recorded resistance to insecticides in malarial vectors emerged in areas where tobacco was grown.[38] However, the intensive use of pesticide in tobacco farms continues unabated. Tobacco companies and cooperatives extend cash incentives to large- and medium land-owning farmers. In comparison, commodity buyers and promoters of other crops cannot offer the same support. Health, safety and environment issues related to tobacco are, therefore, often ignored by farmers and buyers.[39] Spurred by incentives from both the government and industry, pesticides and fertilizer consumption by tobacco farmers is about 1.5–2 times greater than any cereal cultivators in their region. On an average, normal application rates approach 30 kg of pesticides per hectare. These levels increase in dry years and can climb as high as 100 kg of organophosphates per hectare.[40] A study done in Karnataka found that frequent contact with, and spraying of, chemicals and storage of tobacco in the residential premises of farmers have adverse health effects. Chemicals caused respiratory ailments, skin irritation and allergies; problems of reduced appetite, nausea and headache are reported particularly among women and children of tobacco-cultivating households.[41]

There are several pests associated with tobacco farms. In nurseries, before sowing seed beds, several toxic pesticides are recommended for application (Table 5.7). The most important insecticides are chlorpyrifos, monocrotophos, acephate and methomyl, all used separately in large doses or in conjunction with one another.

At almost every stage of tobacco plant growth, chlorpyrifos is recommended for use. Acephate and monocrotophos are other popular pesticides used for the control of moths and caterpillars. In all tobacco-growing countries, DDT and other chlorinated hydrocarbon pesticides (except endosulphan) are banned for use on tobacco.

Fungal diseases also require a special set of chemicals to prevent their occurrence. Several fungi such as black shank (*Phytophthora parasitica* f. *nicotianae*) are serious pests. Fungicides such as Bordeaux mixture (a mixture of 40 g of copper sulphate and lime in water), copper oxychloride (fytolan or foltaf or blitox) ziram, ridomyl, carbendazim and several new-age chemicals, many of which have not been adequately tested for animal and human safety, are used. Many chemicals are sprayed in nurseries or standing crops just before the onset of the rains, which means that leaching of these chemicals in the groundwater is high. Growing and adult plants are treated with dithane, indofil, plantamycin, streptomycin and streptocyclin for fungal diseases. Nematodes (or soil worms) are another major threat.

Table 5.7 Pesticides commonly used in the tobacco industry and their health effects[14,42–44]

Pesticide	Health impact
Aldicarb	One of the most acutely toxic pesticides. Less than one-thousandth of an ounce is a lethal dose for humans. It causes chronic damage to the nervous system, suppresses the immune system and adversely affects foetuses. In human cells, aldicarb causes genetic damage. Aldicarb's agricultural formulation contains a toxic contaminant, dichloromethane, that causes damage to hearing, vision, the kidneys and liver, and is both carcinogenic and mutagenic.
1,3-D or Telone	A highly toxic soil fumigant that causes respiratory problems, skin and eye irritation, and kidney damage.
Chlorpyrifos	It has chronic neurobehavioural effects such as persistent headache, blurred vision, unusual fatigue or muscle weakness, and problems with mental functions including memory, concentration, depression and irritability.
Acephate	It is a possible human carcinogen and has been shown to have mutagenic effects and reproductive toxicity.
Monocrotophos	A highly hazardous chemical. Severe poisoning affects the central nervous system, producing slurred speech, loss of reflexes, and eventually paralysis of the extremities and respiratory muscles.
Imidacloprid	Acute effects of exposure are difficulty in breathing, loss of the ability to move, staggering, trembling and spasms. Exposure to imidacloprid causes thyroid lesions.
Thiamethoxam	It is a possible carcinogen.
Acephate	It is a carcinogen. Acute exposure causes dermal and inhalation toxicity. It is also an eye irritant.
Endosulphan	Affects the kidneys, developing foetus and liver. There is immunosuppression, decrease in the quality of semen, increase in testicular, prostate and breast cancer, and increase in defects in male sex organs. It is also mutagenic.
Methomyl	Possible carcinogen
Bordeaux mixture	Corrosive to the mucous membranes and cornea. Causes irritation of the skin, eyes and respiratory tract. Has a metallic taste and causes nausea, vomiting and stomach pain.
Ziram	Adversely affects the reproductive system and also causes endocrine disruption.
Ridomyl	Causes birth defects in mice and guinea pigs. It is a possible human teratogen.
Carbendazim	It is a potential human hormone-disrupting chemical and reduces the sperm count and affects the development of the testicles.
Basamid	Causes eye irritation and may cause irritation of the skin and mucous membranes.
Oxydemeton methyl	Possible carcinogen
Calyxin	Adversely affects the reproductive system and also causes endocrine disruption.
Dithane	Suspected mutagen
Carbendazim (bavistin)	Possible human teratogen
Karathane	Adversely affects the reproductive system
Thiovit	Inhalation of large amounts may cause inflammation of the nasal mucosa, complicated by emphysema and bronchiectasis.

The Central Tobacco Research Institute (CTRI) has a list of recommended and banned pesticides. Yet, some tobacco companies promote the use of organochlorine and organophosphate insecticides. As they are cheap and still available despite been banned, companies promote their use as a preventive measure and convince farmers that they would reduce costs before harvests. The dusting of crops with pesticides is also not permitted, yet it is widely prevalent.[24]

As tobacco leaves are fleshy and dominate the total weight of biomass compared to other parts of the plant, pesticide accumulation is greatest in the leaves. Often companies recall batches of cigarettes if there is any evidence of trace of toxic chemicals. For example, in 1995, Philip Morris recalled 8 billion cigarettes because traces of the chemical methyl isothiocyanate (MITC, a chemical closely related to the toxin that caused the Bhopal gas tragedy) were found in the cigarette filters.[45] This chemical, a severe skin and eye irritant, is used for making paperboard for cigarette hard packs and has also been used as a pesticide. Subsequent analysis by the Centers for Disease Control and Prevention (CDC) also found MITC in Philip Morris cigarettes made after and up to a year before the recall as well as in cigarettes of other manufacturers.

Exporting countries are increasingly monitoring their export produce for traces of pesticides. Countries import tobacco only with acceptable levels of pesticide residues, though domestic rules dominate over the nascent *Codex Alimentarius* standards for pesticides. Many importing countries have established guidance residue levels (GRL) and maximum residue levels (MRL) for most of the pesticides used for tobacco. Such guidelines discourage the indiscriminate use of pesticides. Apart from the irrational use of pesticides, the use of banned pesticides or those not recommended for tobacco are closely monitored. For example, chlorinated hydrocarbons such as endrin, chlordane, aldrin and toxaphene remain in the environment for long periods after their use and tobacco plants may take up these pesticides from the soil, resulting in pesticide residues in cured leaves.[46]

Use of fertilizers

Tobacco is heavily dependent on fertilizers because it is grown in dry and semi-arid areas and needs to grow rapidly, often with irregular rainfall. With increased irrigation, mistimed fertilizer application causes excessive leaching, including that of nitrogen and potassium. Depending on the soil type, anywhere between 80 and 200 kg of chemical fertilizers are applied per acre before transplantation. Urea, diammonium phosphate and other chemical fertilizers are prescribed, and provided as a part of the subsidy to farmers by the State Governments and tobacco companies.

Crop rotation is a simple and logical method of retaining soil nutrition but is seldom practised. Globally, monocropping of tobacco is discouraged as it leads to development of pests and diseases in addition to decreasing soil fertility. Yet, most of the tobacco crop produced is from monocrop fields. Crop rotation not only gives additional returns to farmers but also maintains the fertility and health of the soil. For different types of tobacco, suitable crop rotations have been worked out without jeopardizing the tobacco quality. One-year and two-year rotations, long-term cropping sequences, mixed cropping wherever feasible and cropping systems were developed to suit a particular region.

In India, for *kharif*, black gram, dry paddy, groundnut, gingelly, maize or pearl millet are recommended when tobacco is planted in the *rabi* season. The temptation for farmers to continue with tobacco is immense, though the Tobacco Board and local extension workers advise against two successive seasons of planting. Despite CTRI claims and the push for protocols for green manure and use of integrated pest management, tobacco companies encourage farmers to use more chemical fertilizers and pesticides. Biopesticides (microorganisms or products obtained from microorganisms which are lethal to insect pests, such as *Bacillus thuringiensis* var. *kurstaki*) are seldom used.[24]

Social costs of tobacco cultivation

In Africa, fewer children of tobacco growers attend school compared with children from families who do not grow tobacco. They also start going to primary school at a later age. Even when the school fees are paid, children are kept at home during periods of peak activity in the tobacco fields. A company in Malawi in its promotion posters announced that the 'riches and the bounty of the harvest will be so large that your children will be rich anyway'. Child labour is not unique to tobacco. In conditions of poverty, other crops also make use of child labour. But tobacco's longer growing season and the curing process seem to place a particular strain on children's health.

In India, according to a report by an advocacy group, Global March Against Child Labour, New Delhi, an estimated 20,000 children work in tobacco farms and another 27,000 children work in *beedi*-making or packing cigarettes.[47] Tobacco engages the land for a longer period than other crops, and utilizes labour-intensive practices, irrespective of the farm size. This is also reflected in the high rates of absenteeism from school seen during the tobacco planting, harvesting and

curing seasons.[47] Child labour and hired labour exploitation was also rampant.[47] Tobacco also gave low returns when compared in terms of net returns, based on the high doses of pesticides and chemical fertilizers needed for its cultivation.

Women, in particular, carry the heaviest burden of small-holder tobacco growing in developing countries. In addition to carrying out farming-related tasks, they have to collect wood for the barns as well as for domestic use. As fuelwood and water supply run out, they need to travel further to collect water. Meals become irregular and sparse during the busiest months. Vegetable gardens and markets are neglected, as a result of which households depend on the sale of crops to procure food.

5.2 ECOLOGICAL AND ENVIRONMENTAL EFFECTS OF TOBACCO USE

KEY MESSAGES

- Tobacco contributes to deforestation in three ways: forests cleared for cultivation of tobacco, fuelwood stripped from forests for curing and forest resources used for packaging of tobacco, tobacco leaves, cigarettes, etc.
- Tobacco growing depletes soil nutrients at a much faster rate than many other crops, thus rapidly decreasing the fertility of the soil.
- Tobacco displaces the indigeneous flora and fauna and will thus gradually become a source of pests for other crops. It leads to collapse of the food web, thereby destabilizing the predator–prey relationship.
- Tobacco requires huge chemical inputs. Such chemicals may run off into water bodies, contaminating local water supplies. High levels of pesticide use may also lead to the development of resistance in mosquitoes and flies.
- Frequent contact with and spraying of chemicals, and storage of tobacco in residential premises of farmers have adverse health effects.
- Tobacco is heavily dependent on fertilizers. With increased irrigation, mistimed fertilizer application causes excessive leaching, including that of nitrogen and potassium.
- In India, an estimated 20,000 children work in tobacco farms and another 27,000 work in *beedi*-making or packing cigarettes.

References

5.1 Health care costs

1. Stoddart GL, Labelle J, Barer M, Evans R. Tobacco taxes and health care costs. *Journal of Health Economics* 1986;**5**.
2. Collins D, Lapsley. Estimation and disaggregation of the social costs of tobacco. In: Abedien I, *et al.* (eds). *Proceedings of the Conference on the Economics of Tobacco Control: Towards an optimal policy mix.* Cape Town: Applied Fiscal Research Centre, University of Cape Town; 1998:159.
3. Warner KE. Economics of tobacco and health: An overview. In: Abedien I, *et al.* (eds). *Proceedings of the Conference on the Economics of Tobacco Control: Towards an optimal policy mix.* Cape Town: Applied Fiscal Research Centre, University of Cape Town; 1998.
4. Kabra K. Some neglected aspects of the economics of tobacco. In: Abedien I, *et al.* (eds). *Proceedings of the Conference on the Economics of Tobacco Control: Towards an optimal policy mix.* Cape Town: Applied Fiscal Research Centre, University of Cape Town; 1998.
5. Lal D, Scruton R. *War on tobacco: At what cost?* New Delhi: Liberty Institute; 2000:17.
6. World Health Organization (WHO). Tobacco company strategies to undermine tobacco control activities at the WHO. Report of the Committee of Experts on Tobacco Industry Documents, July 2000.
7. Government of India (GOI), Department of Health, Ministry of Health and Family Welfare. Report of the Expert Committee on the Economics of Tobacco Use. New Delhi: GOI; 2001.
8. Central Statistical Organization (CSO). *National Accounts Statistics.* New Delhi: CSO; 2002:23.
9. EPW Research Foundation. *National Accounts Statistics of India, 1950–1951 to 1995–1996.* New Delhi: EPW Research Foundation, Mumbai; 1998.
10. National Family Health Survey 1998–1999. International Institute for Population Sciences (IIPS) and ORC Macro, 2001. *National Family Health Survey (NFHS-2), India, 1998–99.* Mumbai: IIPS; 2000.
11. Ray CS, Gupta PC, Beyer JD. *Research on tobacco in India (including betel quid and tobacco). Economics of tobacco control paper No. 9. HNP discussion paper*. Washington: World Bank; 2003.
12. Rath GK, Chaudhary K. *Estimation of cost of management of tobacco-related cancers.* Report of an ICMR Task Force Study (1990–1996). New Delhi: Institute of Rotary Cancer Hospital, All India Institute of Medical Sciences; 1999.

5.2 Ecological and environmental effects of tobacco use

13. Novotny T, Zhao F. Consumption and production waste: Another externality of tobacco use. *Tobacco Control* 1999;**8:**75–80.
14. Environmental Protection Agency (EPA), 2004. Available from URL: www.usepa.gov (accessed on 12 September 2004).
15. Personal comunication. Paulo De Riotta, Department of Environmental Studies, University of Reading, UK.
16. World Bank. *Causes and consequences of tropical deforestation. World Bank Report*. Washington DC: Environmentally Sustainable Development Division; 1997.
17. Geist HJ. Global assessment of deforestation related to tobacco farming. *Tobacco Control* 1999;**8:**8–28.
18. Geist HJ. Tobacco: A driving force of environmental change in the Miombo Woodland Zone of Southern Africa. Paper presented at African Environments: Past and Present. Department of Geography, 11 August 1998. Oxford University Press; 1999.
19. Economist Intelligence Unit (EIU). *Tobacco and food crops production in the Third World.* London: EIU; 1983.
20. Taylor P. *Smoke ring: The politics of tobacco.* The Bodley Head; 1984.
21. Chapman S. Tobacco and deforestation in the developing world. *Tobacco Control* 1994;**3:**91–3.
22. Moyo S, O'Keefe P, Sill M. *The Southern African environment: Profiles of the SADC countries.* London: ETC Foundation/Earthscan Publishers Ltd; 1993.
23. Plantation House. *The Tobacco Newsletter* 1999;[3(1)] www.coffinails.com (accessed on 8 September 2004).
24. Central Tobacco Research Institute. Available from URL: www.indiantobacco.com/rd.htm (accessed on 28 October 2004).
25. Weiji Wu, *et al.* Assessment of tobacco-specific nitrosamines in the tobacco and mainstream smoke of *bidi* cigarettes. *Carcinogenesis* 2004;**25:**283–7.
26. Spratt ED, Chowdhury SL. *Improved cropping systems for rainfed agriculture in India, field crops research, Vol. 1.* New Delhi: Elsevier Science BV; 1978:103–26.
27. Shankar TL, Rao U. *Rural energy consumption survey in Godavari delta.* Hyderabad: Institute of Public Enterprise, Osmania University; 1985.
28. Personal communication. Lal JB. Estimating deforestation rates due to tobacco cultivation, presentation made at National workshop on wood fuel trade in India, organised by IIFM, Bhopal, M.P. February 17–18, 1999.
29. FAO. *Issues in the global tobacco economy. Selected case studies: Raw materials, tropical and horticultural product service.* Rome: Commodities and Trade Division, FAO, UN; 2003.
30. Shiva V, Sharatchandra HC, Bandyopadhyay J. *Social, economic and ecological impact of social forestry in Kolar*. Bangalore: Indian Institute of Management; 1981.
31. Goodland JA, Watson C, Ledec G. *Environmental management in tropical agriculture*. Boulder, Colorado: Westview Press; 1984.
32. Gunatilake Hearth. Institutional aspects of soil conservation in tobacco lands and factors influencing tobacco farmer's soil conservation—decisions in the

Hanguranketha-Walpane area, Sri Lanka, 1990 (Thesis). University of Norway, White, Roger, *et al*. (1995) Land use changes in upper Mahaweli catchment Sri Lanka Forester—remote sensing, Colombo: Colombo Press.
33. Olenga S. Biodiversity losses due to tobacco cultivation–a case study of deciduous forest ecosystems in Tanzania. *Oxford Forestry Review* 11:4.34–4.39.
34. Gopalachari NC, Mahgaraddy MC. Effects of season and soil type on the yield and quality of flue cured tobacco.*Indian Journal of Agricultural Sciences* 197;**41:**365–73.
35. California Department of Pesticide Regulation. Methyl bromide. California Department of Pesticide Regulation; 1994.
36. EPA. *Methyl bromide use*. Washington: EPA; 1997.
37. ANON. UN Environment Programme. The impact of ozone layer depletion; 1992 (www.unep.org).
38. Chapin G, Wasserstrom R. Pesticide use and malaria resurgence in Central America and India. *Social Science and Medicine* 1983;**17:**273–87.
39. Barry M. The influence of the US tobacco industry on the health, economy and environment of developing countries. *New England Journal of Medicine* 1991;**324**.
40. Castilho C. New markets for bad products. *The World Paper* 1997;**11:**11–18.
41. Panchamukhi PR. Agricultural diversification as a tool of tobacco control. Paper presented at the WHO International Conference on Global Tobacco Control, 7–9 January 2000, New Delhi.
42. World Health Organization (WHO), International Agency for Cancer Research. Available from URL: www.iarc.fr (accessed on 12 September 2004).
43. Agency for Toxic Substances and Disease Registry (ATSDR). Available from URL: www.atsdr.cdc.gov (accessed on 14 September 2004).
44. WHO Pesticide Action Network. Available from URL: www.who.int (accessed on 16 September 2004).
45. Fekadu Kassiea *et al.* Genotoxic effects of methyl isothiocyanate. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis* 2001;**490:**1–9.
46. Sreedhar U, Rao N, Sitaramiah. Pesticide residues in tobacco. *The Hindu* 22 July 2004.
47. Anon. Worst forms of child labor, global march against child labor. Available from URL: http://www.global march. org/worstformsreport/world/worst-form.html.