

Physicians and Scientists for Global Responsibility

New Zealand Charitable Trust

Transgenic cotton – a toxic business

N.B. *Transgenic* refers to *genetic engineering* and *genetic modification* technology. The terms are synonymous.

“Hazardous pesticides, derived from chemicals developed for warfare and not suitable for food crops, have been used to cultivate cotton for more than fifty years.”

Hazards of Cotton in our Food Supply, Ruth Chant, Theoretical Physicist, 2013,¹

*Cotton is considered the world's dirtiest crop due to its heavy use of pesticides. Aldicarb, cotton's second best-selling insecticide and most acutely poisonous to humans and wildlife, is still used in 25 countries, including the US, where 16 states reported it in their groundwater. The dangers are recognized by the EPA and they have signalled its phase out in 2018.*²

Understandably, cotton is often described as a “toxic” business. In the two decades from the mid 1990s, following the introduction of commercial crops of genetically engineered cotton, introduced DNA traits have led to farmers using additional or different chemicals to those used on conventional crops, notably with herbicide resistance, which has led to an increase in the use of herbicides.⁴

Genetically engineered cotton – in the beginning

Scientists took the *Bacillus thuringiensis* (Bt) gene responsible for the production of the insecticidal protein from the bacterium and engineered it into the genome of plants. Bt cotton was first approved for commercial use in the US in 1995.⁵ When ingested by the larva of a target insect, the Bt protein is activated in the alkaline condition of the gut and punctures the mid-gut. Unable to eat, the insect dies.

Glyphosate-resistant cotton (MON1445) was commercially released by Monsanto Company in 1997.⁶ Glyphosate is a broad-spectrum herbicide. It blocks the activity of EPSPS⁷, an enzyme catalysing the pathway of various plant functions.

Gene stacking is a process of engineering a combination of two or more traits into a single plant; for example, a plant engineered with two or more genes that code for *Bacillus thuringiensis* proteins having different modes of action.

¹ Hazards of Cotton in our Food Supply, Ruth Chant on 15 June 2013,

<http://allianceofwomenscientists.com/articles/component/myblog/hazards-of-cotton-in-our-food-supply.html?Itemid=122>

² <https://www.nap.edu/read/4795/chapter/42>. <https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+1510>. E.J.F. (2007). The deadly chemicals in cotton. Environmental Justice Foundation in collaboration with Pesticide Action Network UK.

⁴ Freese, Bill. Herbicide Resistant Crops. Centre for Food Safety, Washington.

⁵ James, Clive (1996). "Global Review of the Field Testing and Commercialization of Transgenic Plants: 1986 to 1995" (PDF). The International Service for the Acquisition of Agri-biotech Applications. Retrieved 17 July 2010.

⁶ <http://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=6267>

⁷ Endogenous plant 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS)

The first 'stacked' cotton, approved in 1995, was produced by crossing Bollgard™ cotton that expresses the Bt toxin cry1Ab and Roundup Ready™ cotton that produces the EPSPS enzyme conferring resistance to the herbicide glyphosate.⁸ Cotton stacked with multiple genetic traits comprised 80 percent of cotton plantings in 2016.⁹

Cotton and chemicals

A 2007 study¹⁰ determined pesticide residues in soil and water collected from four cotton-producing areas of Mali, West Africa. Pesticides were detected in 77% of the soil samples and included p,p-DDT and its breakdown products, endosulfan I and II, endosulfan sulfate; and profenofos. While DDT and other pesticides are common in Africa using old stockpiles for supply, farmers in the study area said DDT had not been used in their fields during the past ten years.

Endosulfan II, the most commonly detected pesticide, constituted 65% of the detections with a maximum concentration of 37 ng/g. While residues detected in soil samples were below the researchers quantification limit in the newer cotton-producing region and one intermediate region, residues were detected at reportable levels in an older and one intermediate cotton producing areas.

Eight pesticides were detected in water samples: lindane, endosulfan I, endosulfan II, endosulfan sulfate, dieldrin, p,p-DDD, p,p-DDE, and atrazine. All had concentrations below established quantification limits except for atrazine. Despite these findings, pesticides in the water sources were of concern because those sources are used for human and animal consumption. Equally, plant uptake of pesticides poses health risks to domestic livestock that forage on crop stubble and to consumers of food products from these animals, who can commonly be affected by residues of chemicals on crops, and from clothing drenched in pesticides.

In another study¹¹ researchers established a method for simultaneous determination of pesticide and herbicide residues in cotton textiles by high performance liquid chromatography coupled with diode array detector (HPLC-DAD) and determined 2,4-dichlorophenoxy (2,4-D), 2-methyl-4-chlorophenoxy acetic acid (MCPA), dichlorprop, mecoprop, 2,4, 5-trichlorophenoxy (2, 4, 5-T), 2-methyl-4-chlorophenoxy butyric acid (MCPB), beta-endosulfan, methoxychlor and 2, 2-bis (p-chlorophenyl)-1, 1-dichloroethene (DDE).

Genetically engineered cotton – two decades on

Two decades on from the introduction of commercial plantings of genetically engineered cotton, cotton is cultivated primarily in the tropics and subtropics, and in arid, warm climate regions in moderate latitudes; India, China, the US, Pakistan, Uzbekistan and Brazil as well as West and East Africa. It is also cultivated in Europe in Greece, Bulgaria and Spain.

⁸ <http://www.isaaa.org/resources/publications/pocketk/42/>

⁹ <http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx>

¹⁰ Pesticide Residues in Soil and Water from Four Cotton Growing Areas of Mali, West Africa, Journal of Agricultural, Food and Environmental Sciences ISSN 1934-7235, Volume 1, Issue 1, 2007, Safiatou Berthe Dem et al, <http://www.scientificjournals.org/journals2007/articles/1062.htm>

¹¹ Simultaneous determination of nine organochlorine pesticide residues in textile by high performance liquid chromatography, Zhang X et al, Se Pu. 2007 May;25(3):380-3. <https://www.ncbi.nlm.nih.gov/pubmed/17679434>

Simon Ferrigno¹², an expert in organic cotton, says 12 countries growing transgenic cotton commercially account for most of the global production. However, Burkina Faso has recently stopped growing transgenic cotton.¹³

Professor Joe Cummins and Dr Mae-Wan Ho have said¹⁴ transgenic cotton was readily accepted outside the Third World “for the simple reason that it is wrongly perceived to be a non-food crop.” Yet a substantial part of the cotton harvest is used in food processing. For example, cottonseed oil is a source of vitamin E (tocopherol) and used in pharmaceutical products. Cottonseed flour can be an ingredient in food supplements, bread, and sugar sweets. Cooked and toasted, cottonseed flour is a colouring agent for food products. It is said we eat more of the cotton crop than we wear.¹⁵

Almost certainly, some of the clothes you wear will be made from cotton or will contain cotton. Likewise, something you use is made from cotton: for example, tea towels, face flannels, cotton balls and cotton buds, and bedding.¹⁶ Statistics say enough cotton is harvested annually to provide everyone on Earth with 18 t-shirts.¹⁷ According to the British newspaper, *The Telegraph*, three quarters of the cotton clothes bought in Britain today are made from a transgenic crop.¹⁸

Cotton quality

Fragments of woven cotton fabric found by archaeologists in the Indus Valley show early farmers had domesticated wild cotton over 5000 years ago. Cotton was also used in Egypt in ancient times. It was later introduced by the Muslim caliphs in Spain and from there into Europe. Would today’s cotton fabric survive 5000 plus years?¹⁹

In 2002, William Dunavant Jr., CEO of US cotton merchants Dunavant Enterprises²⁰, told reporters at the annual Beltwide Cotton Conference at Atlanta that American cotton quality had not improved and blamed the engineered seed.¹ Tied with Dunavant’s statement was a fall in cotton quality. Short staple cotton fibre grown in Alabama, Arkansas, Carolinas, Georgia, Louisiana, Tennessee and Mississippi was increasingly difficult to market abroad. In contrast cotton from Uzbekistan commanded a premium price despite five years previously being the lowest among foreign fibre growth.

Two decades on consumers are asking questions. For example, *why are the cotton towels I buy today less absorbent than those I purchased two or more decades ago and why do they feel ‘sticky’ and just two years old and I put my foot through my supposedly good quality cotton sheets; in the ‘old days’ they would have lasted much longer.*

Few if any studies appear to have been made on genetically engineered cotton seed since its release for commercial crops, nor results released on the quality of cotton fabric and its durability.

¹² Freelance consultant and writer on cotton and sustainability, <http://www.sustainableorganicfarmsystems.co.uk/>

¹³ <http://www.reuters.com/article/us-burkina-monsanto-idUSKBN16F1N3>

¹⁴ <http://www.i-sis.org.uk/GMCTPF.php#SIS>

¹⁵ <https://oecotextiles.wordpress.com/2010/11/10/how-to-get-rid-of-chemicals-in-fabrics-hint-trick-question/>

¹⁶ <http://www.organicauthority.com/health/5-ways-youre-regularly-exposed-to-gmos-besides-food.html>

¹⁷ <https://www.forumforthefuture.org/greenfutures/articles/cottons-future-depends-industry-wide-change-says-simon-ferrigno>

¹⁸ <http://www.telegraph.co.uk/news/earth/earthnews/9590556/Most-cotton-we-wear-is-GM-today.html>

¹⁹ GM seeds lower cotton quality in US, 10 May 2003, <http://www.dawn.com/news/102399>

²⁰ Dunavant took over the company in 1961. [Dunavant Enterprises](http://www.dunavant.com/) is on the [Forbes 400](http://www.forbes.com/) list of largest private companies.

Genetically engineered cotton - cotton seed

Transgenic seed for growing commercial cotton crops is controlled by patent holders; the main holder being Monsanto Company based in St Louis, US. It is estimated that the ten largest transnational seed companies account for 67% of the global proprietary seed market; Monsanto, DuPont, Syngenta alone lay claim to 47%. With the proposed merger between Bayer and Monsanto ahead, the stranglehold could increase. See the blog for Traidcraft: <https://traidcraftindepth.org/2016/10/25/merger-mania-in-the-agricultural-seeds-and-chemicals-sector/>.

The bottom line is that patented gene technologies will concentrate corporate control, inhibit public sector research funding, raise the cost to the farmer, and continue to affect farmers' rights to exchange and save seed.²¹ To keep control, transnational seed companies are phasing out conventional varieties, leaving farmers little choice but to buy genetically engineered seeds, frequently at higher prices.²² In 2016, most raw cotton will have been grown from genetically engineered seed, but in India, they are developing Bt seeds that can be re-used while restricting the fees to biotechnology companies.²³

Transgenic cotton is either herbicide tolerant and/or has insecticidal traits.²⁴ It represents 94% of the cotton acreage grown in the US and in nine of eleven US cotton-growing states 95-98% of planted cotton seed is transgenic.²⁵ Australia plants 99.5% transgenic cotton, and of that 95% is stacked for insect resistance and herbicide tolerance.^{26 27} In India, 95% of all cotton seed is controlled by Monsanto.

Genetically engineered cotton and pesticide use

In the US, eight of the 10 most commonly-used pesticides applied on conventionally grown cotton were historically classified as moderately to highly hazardous by the World Health Organisation (WHO).²⁸ Data from the US Department of Agriculture (USDA) show herbicide use on cotton has risen from 2.1 kilograms per hectare in 1996 – corresponding with the time of the introduction of transgenic crops - to 3.0 kilograms/ha in 2010.²⁹

The USDA National Agricultural Statistics Service (NASS) is the federal government's official source of statistics about on-farm and post-harvest commercial fertilizer and pesticide use and pest management practices. For 2015, its website states³⁰:

²¹ <http://www.gmwatch.org/gm-firms/10558-the-worlds-top-ten-seed-companies-who-owns-nature>

²² <http://www.gmwatch.org/news/archive/2013/15093-gm-seed-monopoly-fewer-choices-higher-prices>. See also ETC Group report, "Who Owns Nature? Corporate Power and the Final Frontier in the Commodification of Life 2008.

²³ http://www.thehindu.com/news/national/punjab-varsity-develops-new-bt-cotton-varieties/article17437275.ece?utm_source=RSS_Feed&utm_medium=RSS&utm_campaign=RSS_Syndication

²⁴ *Bacillus thuringiensis* (Bt) is a soil-dwelling bacterium commonly used as a biological pesticide, and now introduced to genetically engineered crops using Bt genes to combat insect infestations.

²⁵ Source USDA Economic Research Service, 1-7-11.

²⁶ <http://www.isaaa.org/resources/publications/briefs/43/executivesummary/>

²⁷ <http://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-biotechnology>

²⁸ <http://allianceofwomenscientists.com/articles/component/myblog/hazards-of-cotton-in-our-food-supply.html?Itemid=122>

²⁹ Jishnu, Latha. 2011. Cotton Saga Unravels. <http://www.downtoearth.org.in/content/cotton-saga-unravels>

³⁰ https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/2015_Cotton_Oats_Soybeans_Wheat_Highlights/Chem_UseHighlights_Cotton_2015.pdf

“The pesticide active ingredients used on cotton are classified ... as herbicides (targeting weeds), insecticides (targeting insects), fungicides (targeting fungal disease), and other chemicals (targeting all other pests and other materials, including extraneous crop foliage). Herbicides were used most extensively, applied to 92 percent of planted acres. Other chemicals such as desiccants were applied to 76 percent, insecticides and fungicides to fewer. Among herbicides, two different forms of glyphosate were the most widely applied active ingredients, followed by trifluralin.”

Glyphosate was first registered for use by the US Environmental Protection Agency (EPA) in 1974. It is the active ingredient in Monsanto’s proprietary herbicide, Roundup®, and an ingredient in proprietary brands marketed by Bayer, Dow, Zeneca and others.³¹ See also <http://www.psgr.org.nz/glyphosate>.

Transgenic crops resistant to glyphosate have aided the development of glyphosate-resistant ‘super’ weeds in broad areas of the US and consequently helped to raise the use of pesticides that can be even more toxic to combat them.

Extensive planting of Bt cotton has the potential to impact ecological environments; e.g. changes in the secondary pest populations of target insects could lead to new problems in cotton pest control if these currently minor pests become the major pest (Wu, 2007). Toxic effects of Bt cotton on lepidopteran insects can potentially affect the agro-ecosystem food chain and lead to an imbalance of the ecosystem. An occurrence of resistant target pests can lead to the ineffectiveness of Bt cotton (Wu and Guo, 2005).³²

Cotton crops and desiccation

For cotton to be ready for ‘stripper’ harvesting, the crop must first be dry enough for bolls to be easily snapped off of the plant. Drying is enhanced after use of desiccant harvest aid chemicals which aim to uniformly help plants drop leaves and open bolls; all to facilitate earlier stripper harvesting, higher yields and/or improved lint quality (Boman et al. 2009).

Desiccants - paraquat formulations such as Gramoxone Inteon®, Firestorm®, Parazone® and various tank-mixes with other products - dry down the plant by causing the cells to rupture. They are routinely applied when about 80% of the productive bolls are open or at two to three nodes above the cracked boll.

Industry advice is not to use “paraquat-based desiccants when seedling-stage small grains or other crops are near targeted cotton field. Paraquat drift can severely damage developing small grains grown for cover or harvest. Gramaxone Inteon®, Firestorm®, and Parazone® are similar products that have paraquat as the active ingredient.”

Other chemicals are also used. Nonionic surfactants (NIS) with paraquat and protoporphyrinogen oxidase (PPO) inhibitor defoliant/desiccants including Aim®, Blizzard®, ET®, and Resource®. Hormonal and herbicidal defoliants also play a part.

³¹ For trade names of herbicides containing glyphosate see <http://www.weedbusters.org.nz/weed-information/herbicides-trade-names/>. Monsanto’s patent on glyphosate outside the US expired in 1991, in the US, the patent on the salt form for glyphosate, isopropylamine salt, continued until 2000, and the first-generation transgenic Roundup Ready® soybean trait patent expires in 2015. Patents continue to be filed for glyphosate and glyphosate-related applications, latterly in respect of genetically engineered glyphosate-resistant crops.

³² A Review - Adoption of Bt Cotton: Threats and Challenges, Muhammad Faisal Bilal et al, Chilean J Agric Res vol 72 No 3 July - September 2012 <http://dx.doi.org/10.4067/S0718-58392012000300017>

'Raw' harvested cotton

Industry assesses the quality of raw cotton by colour, purity, fibre length (known as 'staple'), fineness, strength, and evenness. The staple length is 18 to 42 millimetres and there are four staple categories: short, medium, long and extra long.² The main factor for the textile industry is fibre length; the longer the fibre, the higher the quality.

Cotton and fabric production

Raw cotton fibre has a coating of natural waxes that makes it water repellent and thus unsuitable for use in many consumer products that need it to be absorbent; for example, towels and tea towels.

Handling starts with cotton fibre being turned into 'cakes'. Simplified, the processing steps include:

- Mechanical cleaning to remove all non-lint material, although it is never 100% effective;
- Scouring to turn natural waxes on the fibre into water-soluble soaps, to soften remaining plant matter, and remove pectins and other non-cellulosic materials;
- Rinsing with fresh water to remove the waxes and suspended materials to leave the cotton fibre absorbent and soften any small amounts of plant matter that remain;
- Purifying by applying a solution generally using hydrogen peroxide as the purifying agent to whiten the fibres by oxidizing colouring matter;
- Rinsing away the purifying solution with fresh water.

At this stage, all impurities and colouring bodies should be removed and the cotton fibres should be pure cellulose. However, the fibre can still be difficult to process due to a high level of fibre-on-fibre friction; hence a fibre finish lubricant is added, of which there are many types. Treated cotton is broken into tufts of fibre and the fibre is dried.

Processed cotton is re-baled and the moisture content measured. A standard bale of cotton weighs around 500 pounds (226 kilograms) and is called a 'universal density bale'. One bale is said to contain enough cotton to make 325 pairs of denim jeans.³³ See what can be made from a bale of cotton.³⁴

What happens to the left-over cotton crop

In 'Hazards of Cotton in our Food Supply' the Alliance of Women Scientists, write: "It is estimated that as much as 65% of hazardous conventional cotton production ends up in our food chain. This is due to the use of cotton by-products, generated by manufacturing non-food cotton products such as clothing, textiles, personal care products, and bedding. These by-products are commonly known as "gin trash" and consist of cotton seed, stalk, leaves, burrs, twigs, and dirt not used in cotton textile production. The gin trash is then sold to food companies to undergo further processing to create cottonseed oil, vitamins, additives, and fillers for processed foods, livestock feed, fertilizers, and soil compost mix. The waste from this process pollutes our water supply and adversely affects aquatic life."³⁵ See also 'Chemical Cotton'³⁶.

³³ <http://www.cottonsjourney.com/storyofcotton/page6.asp>

³⁴ <http://www.cotton.org/pubs/cottoncounts/what-can-you-make.cfm>

³⁵ <http://allianceofwomenscientists.com/articles/component/myblog/hazards-of-cotton-in-our-food-supply.html?Itemid=122>

³⁶ Chemical cotton, 4 February 2014, Melody Meyer, Vice President of Policy and Industry Relations, United Natural Foods Incorporated (UNFI) <http://rodaleinstitute.org/chemical-cotton/>

Cellulose from left over cotton fibres is added to foods to thicken and stabilize products and as a filler to extend serving sizes without increasing calories. It is used in cheese, cream, milk powder, flavoured milks, ice cream, sherbet, whey products, processed fruits, cooked vegetables, canned beans, pre-cooked pastas, pre-cooked rice products, vinegars, mustard, soups, cider, salads, yeast, seasonings, sweeteners, soybean products, bakery items, breakfast cereals, including rolled oats, sports drinks, and dietetic foods as a non-caloric filler. Some brands of pizza cheese consist of cellulose coated cheese granules combined with silicon to aid in melting.³⁷

Cotton and cottonseed oil extraction

The processing of cotton seed to produce oil takes several steps, here simplified.

- The hulls of de-linted seeds are removed. The hulls are used in manufacturing plastic products, and in the production of synthetic rubber and petroleum refining, and added to the mud used in drilling oil wells. The kernel is the inside 'meat' of the seed and rich in oil.
- Kernel meat is pressed into flakes cooked at 170⁰ F (76.67 °C) to reduce moisture, pressed at 10 to 12 tons per square inch (6.5 per square cm), forcing out 96% of the oil. Another method is to flake cooked meats to the thickness of paper and expose them to high-pressure steam to rupture the oil cells, making it accessible for the solvent extraction process.
- Prepared meats are 'washed' with hexane, an organic solvent that dissolves out and removes up to 98% of the oil.
- Crude cottonseed oil is further refined for food use, using heat, sodium hydroxide and a centrifuge which transforms the dark colour into a transparent, yellow oil. The oil may then be treated with bleaching clay to produce transparent, amber-coloured oil. Further processing may involve deodorizing or treatment to keep the oil clear and eliminate unwanted flavours.

"Unrefined cottonseed oil is highly toxic and a skin irritant. Refined cottonseed oil is considered edible. However, compared to other oils, such as olive oil and sunflower oil, it is high in saturated fats. Cottonseed oil, if partially hydrogenated, as found in margarines or solid shortenings, contains high amounts of trans-fats, which are considered dangerous for health. Although omega 3 fatty acids are said to be essential for good heart health, cottonseed oil is high in omega 6 fatty acids which may increase the risk of heart disease. From this perspective, health conscious consumers may wish to avoid cottonseed oil."

Hazards of Cotton in our Food Supply, Ruth Chant, Theoretical Physicist, 2013¹

Dried kernel meat is ground into cottonseed meal as feed for livestock and to be spread as fertilizer.

Oils have been used for centuries to control insect pests and cottonseed oil is claimed the most insecticidal of vegetable oils.³⁸ Cottonseed oil goes into explosives, cosmetics, soap and many other products. NB Gossypol is the natural active ingredient, but may be weakened in many bred, hybrid or transgenic cottons as natural pest resistance may not be selected or bred for.

³⁷ <http://rodaleinstitute.org/chemical-cotton/>

³⁸ <http://extension.colostate.edu/topic-areas/insects/insect-control-horticultural-oils-5-569/>

Cotton-related foods

To reduce reliance on pesticides, Bt cotton was introduced globally without considering the implications of using GE cotton crops as a food and feed source.”

Hazards of Cotton in our Food Supply, Ruth Chant on 15 June 2013¹

Cottonseed oil is extracted for use in processed foods, despite there being chemicals banned for use on food crops which have been used on cotton. It is routinely blended with other vegetable oils. It is used in frying and baking, in snack foods, doughnuts, pancake and waffle mixes, savoury crackers, bread and cereal, and in canned sardines. It is a common ingredient in mayonnaise, salad dressing, pasta sauce, margarine and vegetable shortening. Cottonseed oil is significantly less expensive than olive oil, even than canola oil.^{42 43}

Cottonseed oil is a source of vitamin E (tocopherol) and used in pharmaceutical products. Cottonseed flour can be an ingredient in food supplements, bread, and sugar sweets. Cooked and toasted, cottonseed flour is a colouring agent for food products. It is said we eat more of the cotton crop than we wear.⁴⁴

The effects of pesticides used on cotton crops

Polyoxyethyleneamine is the surfactant in a Roundup formulation commercialized in Brazil. Researchers studying the glyphosate product found:

“The results showed that glyphosate-Roundup did not induce maternal toxicity but induced adverse reproductive effects on male offspring rats: a decrease in sperm number per epididymis tail and in daily sperm production during adulthood, an increase in the percentage of abnormal sperms and a dose-related decrease in the serum testosterone level at puberty, and signs of individual spermatid degeneration during both periods. There was only a vaginal canal-opening delay in the exposed female offspring. These findings suggest that in utero and lactational exposure to glyphosate-Roundup may induce significant adverse effects on the reproductive system of male Wistar rats at puberty and during adulthood.”⁴⁵

Using blood samples, a 2011 study evaluated the correlation between maternal and foetal exposure and determined exposure levels of the glyphosate and its metabolite aminomethyl phosphoric acid (AMPA), gluphosinate and its metabolite 3-methylphosphinopropionic acid (3-MPPA0), and Cry1Ab protein (a bacillus thuringiensis toxin) in Eastern Townships of Quebec, Canada. Samples came from thirty pregnant women and thirty-nine non-pregnant women. Serum glyphosate and gluphosinate were detected in the non-pregnant women, but not in the pregnant women. Serum 3-MPPA and CryAb1 toxin were detected in the non-pregnant women, and in the pregnant women and their foetuses.⁴⁶

A study released in 2012 looked at the combined effects of pesticides for toxicology in transgenic crops. The researchers studied “Cry1Ab and Cry1Ac Bt toxins (10 ppb to 100 ppm) on the human embryonic

⁴² http://www.ehow.com/list_5914372_list-foods-cottonseed-oils.html

⁴³ http://www.gmo-compass.org/eng/grocery_shopping/crops/161.genetically_modified_cotton.html

⁴⁴ <https://oecotextiles.wordpress.com/2010/11/10/how-to-get-rid-of-chemicals-in-fabrics-hint-trick-question/>

⁴⁵ Arch Toxicol. 2007 Sep;81(9):665-73. Epub 2007 Jul 19, Pre- and postnatal toxicity of the commercial glyphosate formulation in Wistar rats. Dallegrave et al PMID: 17634926 DOI: 10.1007/s00204-006-0170-5, <https://www.ncbi.nlm.nih.gov/pubmed/17634926>

⁴⁶ Reprod Toxicol. 2011 May;31(4):528-33. doi: 10.1016/j.reprotox.2011.02.004. Maternal and foetal exposure to pesticides associated to genetically modified foods in Eastern Townships of Quebec, Canada. Aris and Leblanc, <https://www.ncbi.nlm.nih.gov/pubmed/21338670>

kidney cell line 293, as well as their combined actions with Roundup, within 24 h, on three biomarkers of cell death: measurements of mitochondrial succinate dehydrogenase, adenylate kinase release by membrane alterations and caspase 3/7 inductions. Cry1Ab caused cell death from 100 ppm. For Cry1Ac, under such conditions, no effects were detected.

The Roundup tested alone from 1 to 20 000 ppm is necrotic and apoptotic from 50 ppm, far below agricultural dilutions (50% lethal concentration 57.5 ppm). The only measured significant combined effect was that Cry1Ab and Cry1Ac reduced caspases 3/7 activations induced by Roundup; this could delay the activation of apoptosis. There was the same tendency for the other markers. "In these results, we argue that modified Bt toxins are not inert on non-target human cells, and that they can present combined side-effects with other residues of pesticides specific to GM plants."⁴⁷

A pilot study, conducted by Moms Across America and Sustainable Pulse, tested for glyphosate levels in breast milk. The concentrations of glyphosate found in the samples were 76 ug/l to 166 ug/l, 760 to 1600 times higher than the European Drinking Water Directive allows for individual pesticides. However, they are less than the 700 ug/l maximum contaminant level for glyphosate in the US decided upon by the country's Environmental Protection Agency based on the premise glyphosate is not bio-accumulative.⁴⁸

Urine samples and drinking water samples from across the US were measured and the results compared with a study conducted by Friends of the Earth in 2013. Urine samples were collected from volunteers in Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Germany, Hungary, Latvia, Macedonia, Malta, Poland, Spain, Switzerland, The Netherlands, and the UK; 80/182 samples tested found to contain glyphosate. The study volunteers were all city-dwellers and included vegetarian and non-vegetarian diets. No two samples were tested from the same household and were analysed by Dr Hoppe at Medical Laboratory Bremen, Germany. The urine samples of American citizens were at least ten times more contaminated with glyphosate than Europeans.⁴⁹

Senior Monsanto scientist, Dan Goldstein, recently stated, "If ingested, glyphosate is excreted rapidly, does not accumulate in body fat or tissues, and does not undergo metabolism in humans. Rather, it is excreted unchanged in the urine."⁵⁰

Cotton - other uses

The Cotton Australia website⁵¹ states:

"Cotton is known for its versatility, performance and natural comfort. It is used to make all kinds of clothes and home wares as well as for industrial purposes like tarpaulins, tents, hotel sheets and army uniforms. Cotton fibre can be woven or knitted into fabrics such as velvet, corduroy, chambray, velour, jersey and flannel. In addition to textile products like underwear, socks and t-shirts, cotton is also used in fishnets, coffee filters, book binding and archival paper... Linters are the very short fibres that remain on the cottonseed after ginning. They are used to produce goods such as bandages, swabs, bank notes, cotton buds and x-rays."

⁴⁷ Cytotoxicity on human cells of Cry1Ab and Cry1Ac Bt insecticidal toxins alone or with a glyphosate-based herbicide, Mesnage et al, 15 February 2012, DOI: 10.1002/jat.2712 <http://onlinelibrary.wiley.com/doi/10.1002/jat.2712/abstract>

⁴⁸ http://www.momsacrossamerica.com/glyphosate_testing_results

⁴⁹ The full FoE study is on http://www.foeeurope.org/sites/default/files/glyphosate_studyresults_june12.pdf.

⁵⁰ <http://www.glyphosate.news/2016-03-09-glyphosate-found-at-high-levels-in-mothers-breast-milk.html>

⁵¹ <http://cottonaustralia.com.au/australian-cotton/basics/uses-of-cotton>. <http://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-cotton-properties-and-products>

This website also claims, “Global cotton seed production can potentially provide protein requirements for half a billion people and many billions of other animals.”

The National Cotton Council of America says: “US textile mills presently consume approximately 7.6 million bales of cotton a year. Eventually, about 57% of it is converted into apparel, more than a third into home furnishings and the remainder into industrial products.”⁵²

Genetically engineered cotton - 2016

Is transgenic cotton meeting farmers’ expectations? Has quality improved with engineered DNA? Can we find answers to the questions consumers raised on page 3.

Genetically engineered crops are being challenged worldwide, countries increasingly standing up to Monsanto and biotechnology transnationals. In April 2016, the *New York Times* reported *China Post* and *Southern Times Africa* say transgenic crop areas globally had declined for the first time in 20 years.

The cotton sector of Burkina Faso, in northwest Africa, earns 5-8% of its gross domestic product and about 60% of export earnings. It provides work for 1,845,000 persons through cotton production and a further 1.15 million persons through value added processing.⁵³ Bt cotton promised a great deal until officials noticed declines in both staple length and ginning ratios during the first years of commercial release. Monsanto suggested these initial declines were due to exceptional water stress and other climate variants, but the variations in the cotton crops persisted.⁵⁴ Frustrated with Monsanto’s inability to identify and correct these declines in quality, Bt cotton is to be phased out and a return made to conventional Burkinabe cultivars.⁵⁵

The Bt cotton seed price of US\$60 per hectare was much more expensive than the conventional cottonseed price of \$2.00.⁵⁶

When India’s government reduced cotton royalty by 70.0% and cotton seed prices by 14.0%, Monsanto threatened to leave India. There is a movement of farmers returning indigenous seed.⁵⁷

In 2015, the adoption of insect resistant Bt cotton varieties in Pakistan increased to 93%.⁵⁸ The Pakistan Economic Survey 2015-16 shows it failed to meet the growth target of 5.5% due to a ‘major setback’ in agriculture. Central to the crisis was a 27.8% decline in cotton production. Cotton is the mainstay of Pakistan’s agriculture and textile industry. Farmers say poor quality of seed was to blame. The government insists on approving transgenic cotton seeds.⁵⁹

⁵² <https://www.cotton.org/pubs/cottoncounts/fieldtofabric/uses.cfm>

⁵³ GMO Cotton in Burkina Faso, October 2009, H Lanting, Lanting AgriConsult, The Netherlands

⁵⁴ Brian Dowd-Urbe, *Engineered outcomes: The state and agricultural reform in Burkina Faso*, University of California PhD thesis 2011.

⁵⁵ Briefing: Burkina Faso’s Reversal on Genetically Modified Cotton and the Implications for Africa, Brian Dowd-Urbe and Matthew A Schnurr, pub Oxford University Press on behalf of Royal African Society, doi: 10.1093/afraf/adv063

⁵⁶ Brian Dowd-Urbe and James Bingen, ‘Debating the merits of biotech crop adoption in sub-Saharan Africa: distributional impacts, climatic variability and pest dynamics’, *Progress in Development Studies* 11, 1 (2011) pp 63-8

⁵⁷ Cotton Association of India, 2016-17 No. 5 3rd May, 2016, Dr K R Kranthi, Director of Central Institute for Cotton Research (CICR), Nagpur. http://www.cicr.org.in/pdf/Kranthi_art/Breaking_News.pdf

⁵⁸ https://www.isaaa.org/resources/publications/biotech_country_facts_and_trends/download/Facts%20and%20Trends%20-%20Pakistan.pdf

⁵⁹ <http://www.dawn.com/news/1266798>

Uganda, Kenya, and Ghana are said to be needing to make decisions about whether or not to adopt Bt cotton. Four decades ago, high quality, high value cotton was available in Nigeria; that quality has now gone.⁶⁰

Bt cotton has not been the answer to the problems of Makhathini farmers having proved to be unsustainable. Transgenic technologies had some initial success, but Bt cotton failed the small farmers. From this, it was made clear that Bt cotton and many other transgenic crops will fail the majority of farmers throughout Africa.^{61 62}

In China, Monsanto's Bt cotton accounts for two third of transgenic cotton grown and farmers are "finding themselves entangled in Bt-resistant superbugs, emerging secondary pests, diminishing natural enemies, destabilized insect ecology, and the need to keep spraying chemical pesticides to deal with the increasingly uncontrollable situation," says Lo Sze Ping, programme manager for Greenpeace China. "The Chinese government has a role in helping the international community to ensure that corporations such as Monsanto are held liable for the damage they are causing by having developed and released GE crops."⁶³

See the Greenpeace report on http://www.greenpeace.org/international/PageFiles/26271/btcotton_china.pdf

Indian livestock have fallen sick or died after grazing on Bt cotton stubble.⁶⁴ In 2011, Pakistani farmers reported Bt cottonseed cakes were harming cattle: appetite loss, drop in milk production, premature deliveries, infertility and death from unknown causes. They also reported the animals' milk products - yogurt, butter, and ghee - tasted bitter. They noticed skin-related itching on their animals.

If Bt cottonseed is harmful to animals, it is potentially probable that food products from these animals could have adverse effects on human consumers. Statistically, we absorb over 60% of what our skin comes into contact with.⁶⁵ The Bt in transgenic crops is designed to be more toxic than the natural spray and is thousands of times more concentrated.

The Institute of Responsible Technology says farm workers throughout India are getting the same allergic reactions from handling Bt cotton⁶⁶ as those who reacted to Bt spray.⁶⁷ Mice⁶⁸ and rats⁶⁹ fed Bt corn also showed immune responses.

⁶⁰ GM Cotton's Future in Africa on Shaky Ground, 5 February 2016, Third World Network Biosafety Information Service. <https://biosafety-info.net/article.php?aid=1218>

⁶¹ <https://www.grain.org/article/entries/492-bt-cotton-in-south-africa-the-case-of-the-makhathini-farmers>

⁶² See 'Cotton Made in Africa' on <http://www.cottonmadeinafrica.org/en/about-us/african-cotton>

⁶³ www.greenpeace.org/international/en/news/features/adverse-impacts-of-ge-bt-cotto

⁶⁴ <http://www.cban.ca/Resources/Topics/GE-Crops-and-Foods-On-the-Market/Cotton/Genetically-Modified-Cotton-CBAN-Factsheet>

⁶⁵ <http://organic4greenlivings.com/gmo-cotton-the-ugly-facts/>

⁶⁶ Nagui H. Fares, Adel K. El-Sayed, "Fine Structural Changes in the Ileum of Mice Fed on Endotoxin Treated Potatoes and Transgenic Potatoes," *Natural Toxins* 6, no. 6 (1998): 219–233.

⁶⁷ <http://news.webindia123.com> Ashish Gupta et. al., "Impact of Bt Cotton on Farmers' Health (in Barwani and Dhar District of Madhya Pradesh)," Investigation Report, Oct–Dec 2005; and M. Green, et al., "Public health implications of the microbial pesticide *Bacillus thuringiensis*: An epidemiological study, Oregon, 1985-86," *Amer. J. Public Health* 80, no. 7(1990): 848–852; and M.A. Noble, P.D. Riben, and G. J. Cook, Microbiological and epidemiological surveillance program to monitor the health effects of Foray 48B BTK spray (Vancouver, B.C.: Ministry of Forests, Province of British Columbi, Sep. 30, 1992)

⁶⁸ Alberto Finamore, et al, "Intestinal and Peripheral Immune Response to MON810 Maize Ingestion in Weaning and Old Mice," *J. Agric. Food Chem.*, 2008, 56 (23), pp 11533–11539, November 14, 2008

⁶⁹ Joël Spiroux de Vendômois, François Roullier, Dominique Cellier and Gilles-Eric Séralini. 2009, A Comparison of the Effects of Three GM Corn Varieties on Mammalian Health . *International Journal of Biological Sciences* 2009; 5(7):706-726; and Seralini GE, Cellier D, Spiroux de Vendomois J. 2007, New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity. *Arch Environ Contam Toxicol.* 2007;52:596-602

Human health and safety

Glyphosate - the most commonly used herbicide on transgenic crops - has been detected in hygiene and medical products. In a study, 85% of samples tested positive for glyphosate and 62% for AMPA (aminomethylphosphonic acid), a metabolite of glyphosate. With cotton and sterile cotton gauze the figure was 100%. In raw cotton, AMPA dominated; 39 ppb, with 13 ppb of glyphosate. The gauze had no AMPA, but contained glyphosate at 17 ppb. Samples included tampons and sanitary pads.⁷⁰ Unlike with food products, manufacturers are not required to disclose materials used because feminine hygiene products are considered "medical devices."⁷¹

Cotton products are applied to open wounds and highly sensitive areas, and tampons against internal membranes. When using cotton or gauze to heal wounds or for personal hygiene, the products are assumed to be sterilized. In fact they can be contaminated with carcinogenic and toxic substances.^{72 73} When chemicals are in contact with skin, they are absorbed straight into the bloodstream going directly to internal organs. Once they find their way into the body, they tend to accumulate over time.

While the end product should be thoroughly cleaned, cotton textile processing relies heavily on chemicals, traces of which, including silicone waxes, petroleum compounds, heavy metals, flame and soil retardants, ammonia and formaldehyde, can remain in fabrics even after washing.⁷⁴ These can cause health problems and with bioaccumulation being a natural process, some toxic chemicals can accrue in the body, and may adversely affect the immune system.⁷⁵

Dr Medardo Ávila-Vázquez, a paediatrician at the Faculty of Medical Sciences, National University of Córdoba, Argentina, is co-ordinator of the Physicians of Crop-Sprayed Towns, a University Network for Environment and Health. The group campaigns against agrochemical spraying and provides medical treatment to villages suffering from illnesses as a result of agrochemical exposure. They particularly noticed that children are some of the worst affected.⁷⁶ Dr Ávila-Vázquez has said, "The results of this research are very serious. When you use cotton or gauze to heal wounds or for personal hygiene, you do this thinking that the products are sterilized, but in fact you are using products contaminated with a carcinogenic substance."⁷⁷ Speaking of pesticides, he has said they "... are scientifically known to produce small head growth in children. It's science; a done deal. In a study carried out in the Brittany region of France from 2002 through 2006, there was a direct association between the presence of Atrazine in the mother's urine and the malformation called microcephaly (small head)."⁷⁸

In 2010, the late Argentine researcher, Andres Carrasco, published "Glyphosate-Based Herbicides (GBH) Produce Teratogenic Effects on Vertebrates by Impairing Retinoic Acid Signalling."⁷⁹ Carrasco found administering glyphosate to chicken embryos produced "microcephaly".

⁷⁰ <http://ecowatch.com/2015/10/26/cotton-glyphosate-cancer/>; <http://articles.mercola.com/sites/articles/archive/2013/05/22/feminine-hygiene-products.aspx> and <http://www.ecowatch.com/85-of-tampons-contain-monsantos-cancer-causing-glyphosate-1882112780.html>

⁷¹ Andrea Donsky, founder of Naturally Savvy and co-author of *Label Lessons: Your Guide to a Healthy Shopping Cart*,

⁷² http://www.i-sis.org.uk/Devastating_Impacts_of_Glyphosate_Argentina.php

⁷³ <http://www.infobae.com/2015/10/20/1763672-hallaron-glifosato-algodon-gasas-hisopos-toallitas-y-tampones-la-plata>

⁷⁴ <http://allianceofwomenscientists.com/articles/component/myblog/hazards-of-cotton-in-our-food-supply.html?Itemid=122>

⁷⁵ 'Aminomethylphosphonic Acid Accumulation in Plant Species Treated with Glyphosate,' Reddy et al, Southern Weed Science Research Unit, Agricultural Research Service, USDA, <https://www.ars.usda.gov/ARSUserFiles/64022000/Publications/Reddy/Reddyetal.08JAFCS6-2125-2130.pdf>

⁷⁶ http://www.i-sis.org.uk/Devastating_Impacts_of_Glyphosate_Argentina.php

⁷⁷ <http://www.infobae.com/2015/10/20/1763672-hallaron-glifosato-algodon-gasas-hisopos-toallitas-y-tampones-la-plata>

⁷⁸ *Environ Health Perspect.* 2011 Jul;119(7):1034-41. doi: 10.1289/ehp.1002775. Epub 2011 Mar 2.

⁷⁹ http://www.gmwatch.org/images/pdf/Carrasco_research_paper.pdf

Pesticide and herbicide imply they only kill unwanted organisms. In fact, they are biocides, i.e. they kill life. Glyphosate and Atrazine are designed to kill plants. Endosulfan, chlorpyrifos, dimethoate, cypermethrin, imidacloprid, etc. are meant to kill insects, the latter being the most widely used. They can all have deleterious effects on human health and the environment. Numerous scientific papers have shown how exposure to toxic agrochemicals significantly increases the rate of birth defects, miscarriages, cancer, and hormonal disorders in people subjected to repeated sprayings.⁸⁰

Monsanto and regulators maintain direct human exposure to novel transgenes and their products will be limited because, for example, cottonseed oil contains little protein and DNA. Yet in Sub-Saharan Africa cottonseed cake has been used extensively in ruminant feeding.⁸¹ Potentially, effects could come via ingested farm animals that consume cottonseed cakes, a common protein supplement for ruminants.

In 'Hazards of Genetically Engineered Cotton', the US Organic Consumers Association say: "The potential toxicities of the synthetic genes, their ability to recombine and stability have yet to be documented. Already, all the (*Bt*) transgene products, Cry1Ac, Cry2Ab, CP4 EPSPS, as well as the marker gene product, UidA, show stretches of amino-acid sequence identities to known allergens, and are hence suspected allergens; at least, until proven otherwise by further studies."⁸²

The fact that personal care products like lotions, deodorants and cosmetics often contain toxic ingredients is becoming more common knowledge. Some companies have removed questionable ingredients.⁸³ Consumers are choosing to opt for natural alternatives.

The US Food and Drug Administration classifies most feminine hygiene products, including tampons and pads, as 'medical devices'. In New Zealand, the term medical device is defined in Section 3A of the Medicines Act: any device, instrument, apparatus, appliance, or other article that is intended to be used primarily on human beings for a therapeutic purpose and does not achieve its principal intended action by pharmacological, metabolic or immunological means.⁸⁴

With a product labelled 'medical device' a company does not have to disclose the ingredients contained therein. Most tampons are made from cotton, rayon, or other pulp fibre and these materials may contain toxic disinfection by-products from the chlorine bleaching process. The toxins can include dioxins and furans, and pesticides from non-organic or transgenic cotton.

Alternative options include organic cotton gauze, organic cotton feminine products, and non-disposable silicone replacement for tampons, and organic cotton balls.⁸⁵

⁸⁰ Devastating Impacts of Glyphosate Use with GMO Seeds in Argentina, Science in Society, http://www.i-sis.org.uk/Devastating_Impacts_of_Glyphosate_Argentina.php

⁸¹ <http://www.fao.org/wairdocs/ILRI/x5480E/x5480e03.htm>

⁸² https://www.organicconsumers.org/old_articles/clothes/hazards012405.php

⁸³ <http://articles.mercola.com/sites/articles/archive/2015/05/13/tampons.aspx>

⁸⁴ <http://www.medsafe.govt.nz/regulatory/Guideline/G RTPNZ/overview-of-therapeutic-product-regulation.pdf>

⁸⁵ The Official Alternative Doctor www.alternative-doctor.com

Genetically engineered cotton vs conventional cotton

Studies comparing transgenic varieties of cotton with parent plants found fibre uniformity, length, strength, and elongation showed no significant differences due to transgenic technology.⁸⁶

Cooke et al. (2001) compared commercial yields and quality reports of cotton varieties from 12 to 15 Mississippi Delta Farms in 1997-2000.⁸⁷ They measured entomological and economic impact of Bt cotton compared with conventional cotton and found no significant differences in staple length and grade between transgenic and conventional varieties observed on all the study areas over that period.

Creech (2001)⁸⁸ showed that conventional varieties exhibited slight advantages in mean length and uniformity and transgenic varieties were slightly better (lower) in micronaire. (Cotton Inc. defines micronaire as a measure of the air permeability of compressed cotton fibres used as an indication of fibre fineness and maturity.)⁸⁹ Tests on conventional varieties showed approximately 4% higher strength.

Are there advantages to transgenic cotton?

The case remains questionable. There are insufficient studies to tell. Public opinion may hold the key.

Summary

Conventional cotton, grown by conventional agricultural methods, is renewable, biodegradable, potentially friendly to the environment, and sustainable.

Has transgenic cotton improved things? That question is in the unanswerable box simply because no one is looking at the issue hard enough. As to why towels are less absorbent and sticky and why the good quality sheets are not robust, again there is no definitive answer. Again, it seems no one is looking to find answers.

There is no doubt the quality of organically grown cotton is equal to or better than conventionally grown cotton. It undergoes less processing and is not treated with harsh chemicals that aid wear and tear. Organic cotton is often more durable than conventional cotton and does not cause allergic reactions or irritation when it comes into contact with sensitive skin.⁹² Organically grown cotton may well survive 5000 plus years to be found by archaeologists in a future dig.

If cotton is to remain an important part of the global economy, its production and distribution must become more efficient, says Simon Ferrigno, author of *An Insider's Guide to Cotton & Sustainability*. Transgenic cotton production is driven by profit goals with too little attention to the consumer and the environment. Organic production is driven by consumer demand, by consumer choice.

⁸⁶ Ethridge, M. D. and E. F. Hequet. (2000): Fiber Properties and Textile Performance of Transgenic Cotton versus Parent Varieties. Proc. Beltwide Cotton Conf. National Cotton Council. 1:488-494. See also <http://www.cottoninc.com/fiber/quality/fiber-management/conferences/2003-conference/transgeniccotton.pdf>

⁸⁷ Cooke et al, 2001, 'The economics of Bt cotton in the Mississippi delta: 1997-2000. p. 175-177.

⁸⁸ Creech, J.B. 2001. 2000 Mississippi Cotton Variety Trials Preliminary Data. Mississippi Agricultural and Forestry Experiment Station Cotton Improvement, Stoneville, Mississippi, USA

⁸⁹ Feb 24, 2015

⁹² <http://www.howstuffcompares.com/doc/o/organic-cotton-vs-conventional-cotton.htm>

Certified organic foods and ingredients, and non-food products prohibit the use of transgenes at all stages of production. That is one way to protect health and ensure a safe, pure supply.

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Other sources of information

Fibre content labelling – New Zealand

<http://www.comcom.govt.nz/fair-trading/consumer-information-standards/fibre-content-labelling/>

Clothing Dermatitis and Clothing-Related Skin ... - Labor & Industries

<http://www.lni.wa.gov/safety/research/dermatitis/files/clothing.pdf>

Effect of Perfume on Cotton Fabrics | How Clothing Reacts to Perfume

<http://www.realmenrealstyle.com/perfume-effect-cotton-fabrics/>

Top 10 Skin Allergy Triggers - Everyday Health

<http://www.everydayhealth.com/allergy-photos/top-10-skin-allergy-triggers.a>

In vitro percutaneous absorption of model compounds glyphosate ...

<http://www.ncbi.nlm.nih.gov/pubmed/8883475>

... glyphosate and malathion from cotton fabric into and through human skin. ... These chemicals must get from fabric into and through skin to cause toxic effects.

On the Physicians and Scientists for Global Responsibility New Zealand website:

PAN Monologue

<http://www.psgr.org.nz/glyphosate/finish/10-glyphosate/36-glyphosate-pan-mongraph>

Glyphosate

<http://www.psgr.org.nz/glyphosate>

Glyphosate – calling for a ban

<http://www.psgr.org.nz/glyphosate/viewdownload/10-glyphosate/25-glyphosate-calling-for-a-ban>
