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GMO Crops Super-Weed Time Bomb Explodes

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By Institute of Science in Society

Superweeds infest a corn field

"The scene is set at harvest time in Arkansas October 2009. Grim-faced farmers and scientists speak from fields infested with giant pigweed plants that can withstand as much glyphosate herbicide as you can afford to douse on them. One farmer spent US$0.5 million in three months trying to clear the monster weeds in vain; they stop combine harvesters and break hand tools. Already, an estimated one million acres of soybean and cotton crops in Arkansas have become infested."

GM Crops Facing Meltdown in the USA

Major crops genetically modified for just two traits – herbicide tolerance and insect resistance – are ravaged by super weeds and secondary pests in the heartland of GMOs as farmers fight a losing battle with more of the same; a fundamental shift to organic farming practices may be the only salvation Dr. Mae-Wan Ho

Two traits account for practically all the genetically modified (GM) crops grown in the world today: herbicide-tolerance (HT) due to glyphosate-insensitive form of the gene coding for the enzyme targeted by the herbicide, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), derived from soil bacterium *Agrobacterium tumefaciens*, and insect-resistance due to one or more toxin genes derived from the soil bacterium Bt (*Bacillus thuringiensis*). Commercial planting began around 1997 in the United States, the heartland of GM crops, and increased rapidly over the years. By now, GM crops have taken over 85-91 percent of the area planted with the three major crops, soybean, corn and cotton in the US [1]] (see Table 1), which occupy nearly 171 million acres.

Table 1. GM crops grown in 2009 in the USA

Percent of Total Area Crop	ALL GM	HT	Bt	Stacked
Soybean	91	91	0	0
Corn	85	68	63	46
Cotton	88	71	65	48

The ecological time-bomb that came with the GM crops has been ticking away, and is about to explode.

HT crops encouraged the use of herbicides, resulting in herbicide-resistant weeds that demand yet more herbicides. But the increasing use of deadly herbicide and herbicide mixtures has failed to stall the advance of the palmer super weed in HT crops. At the same time, secondary pests such as the tarnished plant bug, against which Bt toxin is powerless, became the single most damaging insect for US cotton.

Monster plants that can't be killed

It is the *Day of the Triffids – not* the genetically modified plants themselves as alluded to in John Wyndham's novel – but "super weeds that can't be killed" [2], created by the planting of genetically modified HT crops, as seen on ABC TV news.

The scene is set at harvest time in Arkansas October 2009. Grim-faced farmers and scientists speak from fields infested with giant pigweed plants that can withstand as much glyphosate herbicide as you can afford to douse on them. One farmer spent US$0.5 million in three months trying to clear the monster weeds in vain; they stop combine harvesters and break hand tools. Already, an estimated one million acres of soybean and cotton crops in Arkansas have become infested.

The palmer amaranth or palmer pigweed is the most dreaded weed. It can grow 7-8 feet tall, withstand withering heat and prolonged droughts, produce thousands of seeds and has a root system that drains nutrients away from crops. If left unchecked, it would take over a field in a year.

Meanwhile in North Carolina Perquimans County, farmer and extension worker Paul Smith has just found the offending weed in his field [3], and he too, will have to hire a migrant crew to remove the weed by hand.

The resistant weed is expected to move into neighbouring counties. It has already developed resistance to at least three other types of herbicides.

Herbicide-resistance in weeds is nothing new. Ten weed species in North Carolina and 189 weed species nationally have developed resistance to some herbicide.

A new herbicide is unlikely to come out, said Alan York, retired professor of agriculture from North Carolina State University and national weed expert

Glyphosate-resistant weeds from widespread planting of HT crops

Glyphosate is the most widely used herbicide in the US and the world at large. It was patented and sold by Monsanto since the 1970s under the trade name and proprietary formulation, Roundup. Its popularity shot up with the introduction of HT crops. Data from the US Department of Agriculture indicate that the use of glyphosate on major crops went up by more than 15 fold between 1994 and 2005 [4]. The EPA estimated in 2000-2001 that 100 million pounds of glyphosate are used on lawns and farms every year [5], and over the last 13 years, it has been applied to more than a billion acres [6].

It did not take long for glyphosate-resistant weeds to appear, just as weeds resistant to every herbicide used in the past had appeared. The Weed Science Society of America reported nine weed species in the United States with confirmed resistance to glyphosate [6]; among them are strains of common ragweed (*Ambrosia artemisiifolia*), common

waterhemp (*Amaranthus rudis*), giant ragweed (*Ambrosia trifida*), hairy fleabane (*Conyza bonariensis*), horseweed (*Conyza canadensis*), Italian ryegrass (*Lolium multiflorum*), johnsongrass (*Sorghum halepense*), rigid ryegrass (*Lolium rigidum*), and palmer pigweed (Amaranthus palmeri).

Glyphosate-resistant palmer super weed

Glyphosate-resistant palmer pigweed first turned up in late 2004 in Macon County, Georgia, and has since spread to other parts of Georgia as well as to South Carolina, North Carolina, Arkansas, Tennessee, Kentucky and Missouri [7]. An estimated 100 000 acres in Georgia are severely infested with pigweed and 29 counties have now confirmed pigweed resistance to glyhosate, according to weed specialist Stanley Culpepper at the University of Georgia. In 2007, 10 000 acres of glyphosate-resistant pigweed infested land were abandoned in Macon County.

Monsanto's technical development manager Rick Cole was reported saying that the problems were "manageable". He advised farmers to alternate crops and use different makes of herbicides. Monsanto sales representatives are encouraging farmers to mix glyphosate and older herbicides such as 2,4-D, banned in Sweden, Denmark and Norway on account of links to cancer and reproductive and neurological damages. It is a component of Agent Orange used in Vietnam in the 1960s.

Farmers in Georgia are reported to be going back to conventional non-GM crops.

Weed scientists at the University of Georgia estimate that an average of just two palmer amaranth plants in every 6 m length of cotton row can reduce yield by at least 23 percent [8]. A single weed plant can produce 450 000 seeds. Many fields in Arkansas, Tennessee, New Mexico, Mississippi and most recently, Alabama are also infested.

Paraquat is recommended for use in conservation tillage programmes, mixed with up to three other herbicides, each with a different mode of action. Scientists at the University of Tennessee have seen palmer weeds resistant not only to glyphosate but also to the sulfonylurea herbicide trifloxysulfuron-sodium

Glyphosate resistance with the greatest of ease

Critics have been predicting glyphosate-resistant weeds before HT crops were introduced, simply through cross-pollination between HT crops and wild weedy relatives. But they had neglected the 'fluid genome' mechanisms that can alter genomes and genes in response to environmental stimuli, enabling most weed plants to become herbicide resistant independently of cross-pollination. I drew attention to these mechanisms in my book Genetic Engineering Dream or Nightmare, *the Brave New World of Bad Science and Big Business* [9] first published in 1997/1998.

Researchers led by Todd Gaines at Colorado State University, Fort Collins in the United States investigated glyphosate-resistant palmer pigweed populations from Georgia. They found that the gene coding for the enzyme EPSPS responsible for metabolising glyphosate herbicide was amplified (multiplied) 5 to 160-fold in glyphosate-resistant plants compared with glyphosate-susceptible plants [10]. The level of gene expression was positively correlated with gene copy number. Fluorescent staining for the gene showed that the amplified gene copies were present on every chromosome.

Gene amplification is one of the most common physiological responses of cells and organisms to 'selective' agents in their environment, known at least since 1980s [9].

Glyphosate resistance has been confirmed in 16 weed species as of 2009 [10]. The mechanisms identified so far include reduced glyphosate uptake, and/or mutations in the EPSPS gene that make it less susceptible to inhibition by the herbicide. Glyphosate-resistant palmer pigweed is the first case of resistance based on gene amplification. It confirms the ease with which resistance to obnoxious agents can evolve [9], and the futility of this 'chemical warfare' against nature.

Tarnished plant bug the single most damaging pest for cotton

The tarnished plant bug infested 4.8 million acres of US cotton in 2008 [11] making it the single most damaging pest for cotton. Another insect, the fleahopper ranked 5th, and infested 2.3 million acres.

The Cotton Belt of the United States, extending from the San Joaquin Valley of California to Southeastern Virginia, has

largely seen off the boll weevil and tobacco budworm since the introduction of Bt cotton, which now accounts for 65 percent of the area planted with cotton (Table 1 [1]). But, as in India and elsewhere [12, 13] (Farmer Suicides and Bt Cotton Nightmare Unfolding in India, Mealy Bug Plagues Bt Cotton in India and Pakistan, *SiS* 45), secondary pests are posing serious problems, especially the tarnished plant bug.

The tarnished plant bug (TPB), *Lygus lineolaris*, has been a cotton pest for as long as records were kept. Before 1995, it was controlled with insecticides targeting other insect pests such as tobacco budworm and boll weevil. According to researchers at the Mississippi State University Delta Research and Extension Center [14], since the widespread adoption of Bt-cotton and eradication of the boll weevil, less insecticide have been used; and as a result, the tarnished plant bug has become the primary insect pest of cotton.

Additional insect control costs are coming from increasing foliar sprays, higher technology fees and pest resistance, said Jeff Gore, research entomologist at the Delta Research and Extension Center, speaking at the 2010 Beltwide Cotton Conferences in New Orleans [15]

In 1995 planting an acre of cotton cost $12.75 to $24; in 2005, planting Bollgard, Roundup Ready cotton with a 'Cadillac' seed treatment would have cost about $52 an acre. Now in 2010, with Bollgard II and Roundup Ready Flex, farmers will be spending $85 or more an acre.

"In Mississippi, we have growers who are spending well over $100 for foliar insect control. You add that onto technology fees and seed treatments, you understand why our cotton acreage is decreasing." Gore said.

To compound the problem, TPB has become resistant to several classes of insecticides, particularly in the Delta regions of the Mid-South states [14].

While TPB is a pest of cotton throughout the growing season, it is particularly damaging during the flowering period, when the pest reproduces copiously, so both adult and immature stages of TPB feed on cotton during the flowering period. Most feeding occurs on reproductive structures. The pests insert their mouthparts into squares and small bolls. It is not uncommon for TPB to cause near-total crop loss in the absence of effective control in some areas of the Delta.

Mid-South growers consulted Gore about planting a non-Bt variety, especially with the higher costs of Bt technology [15]. "We have a few growers planting small acreages of non-Bt cotton, and they're probably going to see benefits from that.

"But if we start shifting back to non-Bt cotton, I promise you, the tobacco budworm will come back, and we don't want to be making foliar applications for resistant tobacco budworms, in addition to treating tarnished plant bugs. The amount of money we would have to spend in that situation would be astronomical."

TPB has been the No. 1 pest in the Mid-South for the past four to five years, and is driving a lot of cotton growers out of the Mississippi Delta, no longer able to afford the cost of sprays.

Gore revealed that spider mites are also gaining a reputation as 'budget busters' in the South, along with aphids and stink bugs.

Like TPB, spider mites are becoming resistant to the insecticides used to control them. "Over the past 15 years, we've essentially doubled our application rates with Bidrin and tripled our application rates with acephate. So we're not only spraying more often, we're applying higher rates that cost more." Gore said.

He pointed out that a side-effect of relying on neoniccotinoids for plant bug control is some resistance has developed in cotton aphids. "We're starting to hear lots of complaints from consultants across the Mid-South."

More of the same is futile

It is disappointing though predictable that the only official academic advice given to farmers is more of the same conventional practices that created the problems in the first place, spraying more and spraying mixtures of different kinds of pesticides, including those banned for being too toxic. Industry, meanwhile, is ready to sell varieties with more stacked GM traits; up to eight at double the seed price [16].

Disappointing too is the persistent effort by some governments and government scientists to promote the failed GM technology, which as I made clear, was already obsolete since the early 1980s [9]. A *Sciencexpress* paper (indicating quick publication, probably without peer review) entitled "Food security: the challenge of feeding 9 billion people" [17] co-authored by UK chief scientist Prof. John Beddington among others, while somewhat dismissive of current GM crops, nevertheless holds out promises we've heard for more than 30 years. "The next decade will see the development of combinations of desirable traits and the introduction of new traits such as drought tolerance. By mid-century much more radical options involving highly polygenic traits may be feasible." It went on to promise "cloned animals with engineered innate immunity to diseases" and more.

Glyphosate and Roundup, still advertised as 'less toxic to us than table salt' in a pamphlet from the Biotechnology Institute promoting HT crops as 'Weed Warrior' [18], is in fact highly toxic as new findings indicate [19, 20] (Death By Multiple Poisoning, Glyphosate and Roundup, *SiS* 42; Ban Glyphosate Herbicides *Now*, *SiS* 43). Thirteen years of GM crops in the USA has increased overall pesticide use by 318 million pounds [21] (GM Crops Increase Herbicide Use in the United States, *SiS* 45). The extra disease burden on the nation from that alone is considerable.

India has learned bitter Lessons from Bt Cotton [22] in a saga of worsening farm suicides and, in common with the USA, an ecological disaster in secondary and new cotton pests, resistant pests, new diseases, and above all, soils so depleted in nutrients and beneficial microorganisms that they would cease to support the growth of any crop in a decade. Their only salvation is a return to organic agriculture, which has already proven far more sustainable and profitable than Bt cotton [12]. This may apply also to the USA.

A fundamental shift in farming practices needed *now*

The organic market has been booming in the United States despite the economic downturn. According to a new report from the US Department of Agriculture, retail sales of organic food went up to $21.1 billion in 2008 from $3.6 billion in 1997 [23] (see Fig. 1). The market is so active that organic farms have struggled at times to produce sufficient supply to keep up with the rapid growth in consumer demand, leading to periodic shortages of organic products.

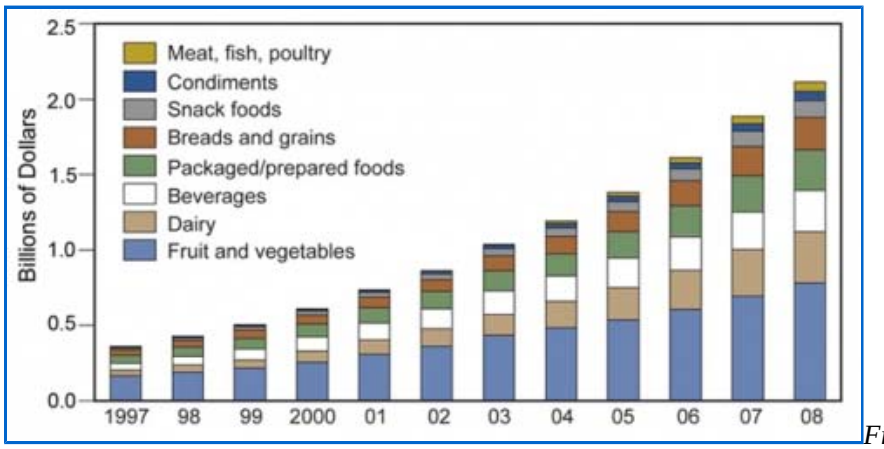

Figure 1 Growth in US organic market 1997 to 2008

Certified organic acres more than doubled from 1.3 million acres in 1997 to a little over 4 million acres in 2005 (0.5 percent of all agricultural land in the US). In the same period, the number of organic farms increased from 5 021 to 8 493, and the average size of certified organic farms went from 268 acres to 477 acres.

So why are US farmers failing to taking advantage of the rapidly expanding market? It is thought [23] that potential organic farmers may opt to continue with conventional production methods because of "social pressures from other farmers nearby who have negative views of organic farming", or because of an inability to weather the effects of reduced yields and profits during the transition period. This is not surprising on account of the persistent negative propaganda carried out by GM proponents, including government regulatory agencies, against organic agriculture. (See for example the recent attempt by UK Food Standards Agency to prove organic food is no more nutritious than conventional food, which backfired [24] (UK Food Standards Agency Study Proves Organic Food Is Better, *SiS* 44). The usual claims are that organic agriculture yields less and require more energy than conventional agriculture, and organic produce no more nutritious or healthy, but less hygienic than conventional produce. These false claims are *all* thoroughly refuted in ISIS report Food Futures Now: *Organic *Sustainable *Fossil Fuel Free [25], with evidence from

the published scientific literature, as well as other studies.

Most relevant for US farmers is a study by Kathleen Delate of Iowa State University and Cynthia A. Cambardella of the US Department of Agriculture assessing the performance of farms during the three-year transition it takes to switch from conventional to certified organic production [26]. The experiment lasting four years (three years transition and first year organic) showed that although yields dropped initially, they equalized in the third year, and by the fourth year, the organic yields were ahead of the conventional for both soybean and corn.

Our report [25] also documents the enormous potential for reducing greenhouse emissions – even to the extent of freeing us entirely from fossil fuels – through organic agriculture and localised food (and renewable energy) systems. It is a unique combination of the latest scientific analyses, case studies of farmer-led research, and especially farmers' own experiences and innovations that often confound academic scientists wedded to outmoded and obsolete theories, of which GM technology is one glaring example.

At about the same time our report was released, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) was also published. IAASTD was the result of three-year deliberation by 400 participating scientists and non-government representatives from 110 countries around the world [27]. It came to the conclusion that small scale organic agriculture is the way ahead for coping with hunger, social inequities and environmental disasters [28] ("GM-Free Organic Agriculture to Feed the World[", *SiS* 38).

A fundamental shift in farming practice is needed right now, before the agricultural meltdown complete.

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- Food Legislation (44)
- Food News (28)
- Free Range Animals (9)
- Gardening (6)
- Genetically Engineered Food (49)
- Health Foods (28)
- Humor (3)
- Labor (2)
- Land Rights (21)
- Litigation (2)
- Monopolies (16)
- NAIS (13)
- Neoliberalism (9)
- organic (27)
- Peasants, Farmers, Ranchers (45)
- pollution (6)
- Premises ID (5)
- Recycle (1)
- Scientific Studies (21)
- Sustainable Practices (16)
- Uncategorized (1)
- usda (8)
- Water Rights (3)

Since June 12, 2009

- 64,959 hits