Trevewas and Livermore clearly take the view that the loss of autonomy for poorer farmers associated with purchasing patented GM seeds is justified by a number of claimed benefits.

However, in practice, GM farming is in crisis as resistant weeds have become widespread in response to the use of glyphosate-resistant GM crops and secondary and resistant pests are causing increasing difficulties for farmers growing insect-resistant GM crops.

Despite decades of investment and research, other products have not been delivered or have failed to reach the market place, due to poor performance and technical difficulties.

GM farming in the United States has not out-performed non-GM farming in Europe (Heinemann et al. 2013, Hilbeck et al. 2013). In the US, yields are falling behind and are more variable, pesticide use is higher, the number of farms is decreasing and there is greater monopoly control over inputs.

The implication that US farmers grow GM through choice because it is superior is questionable as seed catalogues show that the diversity of seeds on the market in the US has reduced significantly as a result of takeovers in the industry, with many

varieties only available in combination with GM traits. In addition, the capacity to innovate on farm has reduced significantly.

Although Trevewas and Livermore describe GM as a “cutting edge technology”, conventional breeding, in some cases enhanced by new technologies such as market assisted selection (MAS), has in fact delivered more crop improvements much faster and more cheaply, despite a significant diversion of resources away from conventional breeding towards GM research (Goodman, 2002; Knight, 2003; Jiang, 2013).

Organic and resource-conserving agriculture can improve farmers’ livelihoods, without creating dependency on patented GM seeds and associated chemicals (Bennett & Franzel, 2013).

However, research investment in these areas is relatively limited. Over-optimism about what GM can deliver has led to significant opportunity costs as other areas of research have been neglected.

The authors describe glyphosate, which is blanket sprayed on the market-leading GM crops which are tolerant to glyphosate, as “innocuous to human health” and “environmentally benign”.

This claim is not consistent with evidence in the scientific literature which suggests a number of mechanisms through which glyphosate and its common commercial formulation RoundUp may damage human health (see, for example: Koller et al. 2012; Mañas et al. 2009; Paganelli et al. 2010; Romano et al. 2010; Samsel & Seneff 2013; Thongprakaisang et al. 2013).

Glyphosate accumulates in glyphosate-resistant GM soybeans (Bøhn et al. 2013). Regarding environmental impacts, there are particular concerns about impacts on amphibians (Relyea & Jones 2009; Wagner et al. 2013).

Disturbingly, Trevewas and Livermore downplay the negative effects on wildlife of habitat loss due to blanket spraying, including impacts on iconic species such as the Monarch butterfly.

Whilst it is clear that other factors (e.g. deforestation) play a role in the Monarch’s decline it is surprising to see the role of the expansion of GM herbicide-resistant crops dismissed when it is widely acknowledged in the literature (Brower et al. 2012).

In addition to the negative impacts of blanket spraying GM crops with glyphosate, further milkweed habitat has been lost due to the large areas of grassland and rangeland that have been converted to biofuel crops, especially GM maize.

Studies have confirmed the link between milkweed habitat loss and glyphosate-treated fields (Harzler 2010, Pleasants and Oberhauser 2013) and the negative impact on the butterflies has been modelled, providing a convincing link between the decimation of habitat and loss of fecundity (Zalucki & Lammers 2010).

Messan and Smith (2011) conclude that herbicide has a large effect and that a reduction of herbicidal spraying is needed to stabilize the monarch butterfly population.

Trevewas and Livermore fail to acknowledge the seriousness of the problem of herbicide tolerant weeds ('superweeds') and the harm to farmers, or the problems associated with proposed responses.

The spread of glyphosate-resistant weeds in the United States is causing severe weed management problems, with nearly half of US farms affected (Fraser 2013).

The dramatic increase in glyphosate use that caused this would not have been possible without glyphosate-resistant GM crops.

The proposed response includes new GM crops tolerant to more toxic herbicides such as 2,4-D and dicamba, which will inevitably exacerbate the environmental problems associated with blanket spraying and create a new cycle of resistant weeds (Mortensen et al. 2012).

Trevewas and Livermore also claim that widespread resistance has not developed to the Bt toxins expressed by insect-resistant GM crops.

However, reduced efficacy of Bt crops caused by field-evolved resistance has been reported now for some populations of 5 of 13 major pest species examined, compared with resistant populations of only one pest species in 2005 (Tabashnik et al. 2013; Van den Berg et al. 2013; Jin et al. 2013).

Whilst they concede that Bt crops were never intended to give complete protection against pests, Trevewas and Livermore ignore the impact on farmers of a number of documented increases in secondary pests, which can increase significantly in numbers when targeted pests decrease (e.g. Zhao et al. 2011; Tay et al. 2013).

As a response to these problems, Trevewas and Livermore highlight research on the use of double-stranded RNA to switch off the expression of specific genes, as a new means of pest-control.

However, the use of RNA interference can give rise to unintended off-target effects and its efficacy and safety is far from being established (Heinemann et al. 2013; Lundgren et al. 2013).

There is no scientific consensus on the safety of GM crops (ENSSER 2013) and there are limitations to all rat feeding studies conducted on both sides of the debate (Meyer & Hilbeck 2013).

There is also evidence of commercial bias in the literature (Diels et al. 2011). Even if there were no such scientific disagreements, consumers have a right to choose to avoid GM crops for health, environmental or other reasons, such as objections to the patenting of seeds.

If consumer choice is to be maintained, the introduction of GM farming to a country or region adds the costs of segregation to the food supply chain, increasing costs across the board.

Failure to plant what consumers demand or to effectively segregate supplies means that US farmers have lost markets due to GM farming as exports elsewhere have been reduced (EuropaBio and BIO, 2012).

Whilst the industry argues that the answer is to weaken regulation, the alternative route of not planting GM food crops at all still remains open to most developing countries.

For example, India and China, despite growing GM cotton, are still rightly hesitant over planting crops such as GM brinjal (aubergine) or GM rice. Food security and trade issues are a big part of the debate, as countries seek to avoid dependency on imported GM seeds and associated chemicals.

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21st November 2014

Comments