'Superweeds' or 'survivors'? Framing the problem of glyphosate resistant weeds and genetically engineered crops

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ABSTRACT

In this paper, we explore how efforts to frame the socio-environmental problem of glyphosate resistant weeds— superweeds—at particular scales shape calls for certain governance strategies and regulatory responses. We use a political agronomy approach and the politics of scale literature to understand the linkages and relationships between socio-political and economic forces and the problem of glyphosate resistant weeds. We draw on in-depth interview data with representatives from farm groups, consumer and environmental advocacy organizations, agriculture and biotech companies, government regulatory agencies, and agricultural extension agents, together with a content analysis of websites of GE supporters and opponents. Together these data are used to explore how the problem of superweeds is being framed by proponents and opponents of GE crops, and among agricultural scientists, advocacy organizations and business. We conclude that when environmental problems associated with pesticide resistance are 'scaled up' to incorporate more systemic agricultural issues and are linked with broader socio-economic and political issues that impact a larger public, there are greater possibilities for pushing for government intervention and regulation to address environmental burdens and externalities.

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1. Introduction

The problem of 'superweeds'— weeds that have developed resistance to the herbicide glyphosate— has emerged as a critical new front in debates concerning the sustainability and governance of genetically engineered (GE)[1] crops and commodity agriculture. Commonly known by its trade name Roundup, glyphosate was commercialized by Monsanto in 1974 and became the primary weed management tactic among farmers with the release of glyphosate-resistant, GE (Roundup Ready) soybeans, corn, and cotton in 1996.[2] Glyphosate resistant weeds now affect hundreds of millions of acres of farmland in the US as well as in other countries that have adopted GE crops, such as Argentina and Brazil. By 2014, glyphosate resistance had cost US farmers around $1 billion in lost crops (Koba, 2014). Proponents of GE crops had been able to maintain support by arguing that GE crops are good for the environment because they promote soil conservation and good for the farmers that grow them. Both arguments are now being challenged with the spread of glyphosate resistant weeds. In addition, following the classification of glyphosate as 'probably carcinogenic' to humans in 2015 by the International Agency for Research on Cancer (IARC), the use of this herbicide has become increasingly controversial and has led to environmental and consumer health campaigns (Bonny, 2016).

In response to glyphosate resistance, farmers are applying more herbicides including those that are more toxic than glyphosate, and using less environmentally benign on-farm practices, such as tillage (Benbrook, 2012). Biotech companies, such as Dow AgroSciences and Monsanto, are commercializing new crops engineered to tolerate 2,4-D and dicamba, older

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[1] GE plants are those where recombinant DNA (rDNA) technology has been used to insert a gene from any species that has a desirable trait, such as resistance to a specific virus, or herbicide or insect tolerance. This desired trait is then expressed in the genetically engineered plant.

[2] Roundup and glyphosate are often used synonymously since glyphosate is the active ingredient in Roundup. However, it is important to note that Roundup also includes adjuvants, which are chemicals added to improve the performance of the active ingredient, in this case, glyphosate. Adjuvants are not regulated by the EPA and concerns have been raised about their role in increasing Roundup's toxicity (see Bonn, 2005; Cox and Surgan, 2006). This debate may become more pertinent as industry efforts to develop adjuvants to address glyphosate resistance increase (see Johnson et al., 2015).

herbicides that are considered more toxic to human health and the environment than glyphosate. Glyphosate resistance then poses significant social and environmental concerns regarding the health, wellbeing and sustainability of our agrifood system and natural environment.

Social scientists have begun to examine the social significance of these issues, although much of the research has focused on farmer perceptions and attitudes about herbicide resistance in GE agriculture (Binimelis et al., 2009, Dentzman et al., 2016; Fischer et al., 2015; Erwin and Jussaume, 2014; Bonny, 2016). Our paper contributes to this emerging literature by employing a political agronomy approach (Sumberg et al., 2014) to examine the relationships between socio-political and economic forces and the problem of glyphosate resistant weeds. In this paper, we address the following questions: What social, political and economic forces led to the problem of glyphosate resistant weeds? How is the solution to this problem of resistant weeds being framed and by whom? How do particular "framings and narratives" (Sumberg et al., 2014: 2) shape governance options for new agricultural biotechnologies?

To answer these questions, we draw on data from in-depth interviews with 29 key informants from environmental advocacy organizations, agricultural scientists and extension agents, farm organizations, and agricultural and biotech companies. In addition, we conducted a content analysis of websites of the key organizations involved in the GE debate in the US. Together these data are used to examine how the problem of superweeds is being framed by proponents and opponents of GE crops, and by agricultural scientists, advocacy and business organizations. We explore how efforts to frame the socio-environmental problem of glyphosate resistant weeds at particular scales lead to particular governance strategies and regulatory responses. We argue that both proponents and opponents of GE crops use discourses of neoliberalism and scale as a way to assign responsibility and frame the problem of glyphosate resistance in a manner that either rationalizes or rejects regulatory intervention.

Proponents of GE crops *naturalize* the problem of glyphosate resistance, arguing that weed resistance occurs regularly in nature and is part of the agricultural production system, which needs to be distinguished from the advent of GE crops. They also *scale down* responsibility for glyphosate resistance, focusing on individual farmer behavior as primarily responsible for the problem (Harrison, 2006; Kurtz, 2003; van Lieshout et al., 2014). In contrast, critics of GE crops are attempting to frame glyphosate resistance as a structural and systemic problem where weed resistance is a product of the input-intensive, monocultural agricultural system. While they recognize that farmers readily embraced glyphosate and came to rely exclusively on the chemical at the expense of a diversity of weed management practices, they argue that in the context of commodity agriculture and the transgene-facilitated herbicide treadmill (McAfee, 2003), farmers had few alternatives. In their efforts to scale up the problem and frame it as systemic, critics of GE crops attempt to gain traction for greater political oversight and regulation of GE crops and agricultural chemicals.

In the next section, we describe the methods used to gather and analyze our data. This is followed by a background discussion to situate the emergence and expansion of glyphosate resistant weeds in the US, and the regulatory framework that exists to manage GE crops in the US. Following that, we describe the theoretical framework that guides our analysis of interview and content analysis data. Drawing on our data, we illustrate how scaled discourses are used both by GE proponents and opponents to frame the problem of glyphosate resistant weeds, and to justify the appropriate responses to the problem. In the final sections, we discuss conclusions and implications.

2. Methods

We used a purposive sampling technique to identify organizational websites disseminating information about GE and the growing issue of herbicide resistance and that included both critics and supporters of GE crops. In a general web engine search we used keywords "GMOs,[3]" "superweeds," and "GMOs and herbicide resistance" to identify organizational websites that were prominent search engine results. Websites' content on the initial pages of the search engine results were explored and the website sample was narrowed based on the following criteria: 1) the organizational mission statement and the website content included sections dedicated to the GE debate; 2) the organizational website took a specific stance on GE practices in crop production (in favor or critical of GE technology); 3) the organizations have been actively involved in the present GE debate with content related to current statewide and/or federal policies such as moratoriums on the planting of GE crops or labeling of foods produced through GE; and 4) the websites contained content specifically related to herbicide resistance and GE crops. A total of eight websites were selected for content analysis with an equal number of websites critical of and in favor of GE crops to provide a well-rounded analysis. The following websites that took a critical stance on GE crops and herbicide resistance were selected for analysis: 1) Center for Food Safety (http://www.centerforfoodsafety.org/#); 2) Environmental Working Group (http://www.ewg.org/); 3) Food and Water Watch (http://www.foodandwaterwatch.org/); 4) Just Label it Blog (http://www.justlabelit.org/). Websites analyzed that took a positive approach to GE crops were: 1) GMO Answers (https://gmoanswers.com/); 2) Coalition for Safe Affordable Food (http://coalitionforsafeaffordablefood.org/); 3) Genetic Literacy Project (https://www.geneticliteracyproject.org/); 4) Facts About GMOs.org (https://factsaboutgmos.org/).

Websites were explored by looking through posted web pages, articles and press releases related to GM foods, the environment and/or specifically herbicide resistance. Analysis of website content was conducted in November 2014, March 2015, and September 2015, and data collected from websites spanned from 2011 to 2015. Each website was read through first to determine common topics discussed. Within these websites, the three most prominent topics were related to glyphosate and herbicide resistance, followed by a broad focus on biotechnology and its effect on the environment, and the least frequently mentioned topic was GM foods. Data were coded in terms of how the organization explained the causes of the problem of glyphosate resistant weeds, who or what was responsible, and how they framed solutions to this problem.

In addition, we conducted semi-structured interviews between July 2013 and September 2015 with 29 key informants with expertise regarding GE crops and herbicide resistance. These included individuals, such as agricultural extension agents, as well as representatives from organizations including farm groups, consumer and environmental advocacy organizations, agriculture (both organic and conventional) and biotech companies, and government regulatory agencies (see Appendix 1). The initial interview participants were sampled purposively because of their expertise and knowledge regarding GE crops, weeds, herbicide resistance, human health and environmental concerns related to herbicides and GE regulations. The remaining participants were then selected through snowball sampling. For example, we interviewed three

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[3] In the public debate around labeling of GE foods the term 'genetically modified organisms' (GMO) has come to dominate the public discourse rather than genetic engineering.