**A Meta-Analysis of Studies Addressing the Impact of GM Foods on Human and Animal Health and the Environment**

**Dragan Miljkovic – Project #1, August 24, 2019**

The herbicide glyphosate was introduced in 1974 and its use is accelerating with the advent of herbicide-tolerant genetically engineered (GE) crops. Glyphosate has been sold under the commercial/brand name of Round Up for decades in the US. Moreover, almost 100 percent of soybeans and corn produced in the US and most of these crops produced globally are Round Up ready, i.e., genetically modified varieties fully resistant to indiscriminately large applications of this pesticide. These varieties have been tested and approved by both the FDA and the USDA, as evidenced by many published research papers, i.e. they are deemed safe for humans, animals and the environment. However, evidence is mounting that glyphosate interferes with many metabolic processes in plants and animals and glyphosate residues have been detected in both. Glyphosate disrupts the endocrine system and the balance of gut bacteria, it damages DNA and is a driver of mutations that lead to cancer (e.g., Bohn et al., 2014; Swanson et al., 2014). Contradictory scientific findings often come from private industry labs and independent public research entities worldwide.

In response to the findings of most recent scientific studies, the World Health Organization’s International Agency for Research on Cancer recently concluded that glyphosate is “probably carcinogenic to humans.” In response to changing glyphosate-based herbicides (GBH) use patterns and advances in scientific understanding of their potential hazards, a group of very prominent scientists from the USA, Canada and the UK (Myers et al., 2016) have produced a Statement of Concern drawing on emerging science relevant to the safety of GBHs. Their Statement of Concern considers current published literature describing GBH uses, mechanisms of action, toxicity in laboratory animals, and epidemiological studies. It also examines the derivation of current human safety standards. They conclude that: (1) GBHs are the most heavily applied herbicide in the world and usage continues to rise; (2) Worldwide, GBHs often contaminate drinking water sources, precipitation, and air, especially in agricultural regions; (3) The half-life of glyphosate in water and soil is longer than previously recognized; (4) Glyphosate and its metabolites are widely present in the global soybean supply; (5) Human exposures to GBHs are rising; (6) Glyphosate is now authoritatively classified as a probable human carcinogen; (7) Regulatory estimates of tolerable daily intakes for glyphosate in the United States and European Union are based on outdated science.

The primary contribution of this research is to help discern why science on this subject has been inconclusive and was not able to establish itself as the primary driver in formulating science-based policies regarding the adoption of the GMO foods. Moreover, the increases in agricultural productivity due to switching to GM crops and other food products often serve as the primary justification for their non-discriminate adoption to feed growing global population (e.g., Godfray et al., 2010; Godfray and Charles, 2015; James, 2015). The merit of such claims on productivity will be empirically examined. Finally, the linkages between global economic institutions and processes and their role in spreading the GM will be analyzed.

The objective of this research is threefold:

OBJECTIVE 1: To identify the determinants of the outcomes of scientific research to date regarding potentially adverse impacts of GMO foods on human and animal health and the environment.

OBJECTIVE 2: To examine the role of changes in U.S. intellectual property laws on GM Round Up ready crops production nationally and globally.

OBJECTIVE 3: To examine the impact of the highly concentrated GM food production in the US. on global trade and consumption patterns.

Objective 1 – Note on Methods: Appropriate literature databases such as Medline will be examined by using web scraping methods based on identified scientific key words and terms using either R or Python. Then we will conduct the systematic review of the scientific literature identified in previous procedure. Finally, meta-analysis of the scientific literature to date will enable us to establish, in statistical terms, the relative importance of a range of factors leading to often contradictory scientific findings and, in turn, resulting policy recommendations.

Objective 2 - This research takes a different tack and inquires whether institutions such as the patent system create opportunities for firms with monopoly power to maintain their monopoly power. The results apply to other situations such as brand identification, spatial location, and capacity expansion, which share the characteristic that early, or pre-emptive, actions may lower the returns to potential competitors.

Objective 3 – This objective is closely linked with Objective 2. It looks into how monopoly or near-monopoly structure existing in parts of biotech sector pertinent to Round Up ready crops nationally used the WTO provisions for market access to impact the global market structure in this industry.

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