Matthew and I affirm; resolved: On balance, the benefits of genetically modified foods outweigh the harms.

Observation One: As genetically modified, or GM, foods are a biotech innovation, future development should be considered along with the existing benefits and harms.

This is true for two reasons.

First, just as space exploration isn't harmful in the status quo because we can't realize its benefits, GM foods can't be discounted because it's underdeveloped now.

Second, the field of GM foods continues to change and evolve, so it doesn't make sense to analyze just the existing implications when they could be different overnight.

Observation Two: GM foods must be compared to conventional crops. There needs to be a comparative worlds analysis because only then is it clear what harms or benefits would exist anyway and which are actually due to GM foods.

The thesis of the Affirmative is that GM foods have increased efficiency in agriculture.

Published just two weeks ago, **Wilhelm Klümper confirms in a meta-analysis of 147 studies**

On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%. Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops. **Yield and profit gains are higher in developing countries than in developed countries.**

Contention One: Decreasing inputs.

By decreasing the amount of required tillage, a few inputs decrease. **Jennifer Thomson explains in her book *Seeds for the Future***

The question of no-till practices is an interesting one. Conservation tillage practices have been in place for many years. Prior to their use [Previously,] farmers would till, or plough, the soil to kill weeds present and encourage the growth of new weeds. Once these emerged they would [then] spray, usually with a type of herbicide which persisted for some time in the soil. Farmers would delay planting their seed until they estimated that enough of the herbicide had dispersed[,] in order for it not to harm the germinating plans. [but] During that period, precious top-soil might be lost due to wind and rain. **Ploughing [or tillage] causes runoff that pollutes** and erosion that silts, **rivers[,]**. It **kills** the earthworms and **microbes that naturally till and nourish the soil[,]**. It **[and] burns diesel fuel that pollutes the air.** Thus no-till or conservation tillage has great benefits to the environment and biodiversity. **With the advent of herbicide-tolerant GM crops, farmers can increase their use of conservation tillage** as once the weeds emerge they can spray without harming the crop itself. **This no-till agriculture leads to a decrease in** energy **[these] inputs**, lower soil erosion and soils that are much healthier with respect to structure and microbes, invertebrates and organic matter content.

The impact on soil erosion and pesticide usage is provided by **Charles Conner from the National Council of Farmer Cooperatives**

Herbicide tolerance has allowed growers to use fewer pesticides per acre in their weed management programs, enabling greater adoption of no-till practices. **As a result [of no-till practices], soil loss has been reduced by 69 percent while herbicide and insecticides applications** per acre **have been reduced 20** percent **and 65 percent respectively.** In 2006, that amounted to approximately 110 million pounds of pesticide use displaced due to biotechnology.

Jim Ritter adds

Tillage erosion impacts crop development and yield. Crop growth on shoulder slopes and knolls is slow and stunted due to poor soil structure and loss of organic matter and is more susceptible to stress under adverse conditions. Changes in soil structure and texture can increase the erodibility of the soil and expose the soil to further erosion by the forces of water and wind.

In extreme cases, tillage erosion includes the movement of subsurface soil. Subsoil that has been moved from upper-slope positions to lower-slope positions can bury the productive topsoil in the lower-slope areas, further impacting crop development and yield. **Research related to tillage-eroded fields has shown** soil loss of as much as 2 m of depth on upper-slope positions and **yield declines of up to 40% in corn.** Remediation for extreme cases involves the relocation of displaced soils to the upper-slope positions.

Another input that decreases is child labor, which otherwise contributes to poverty. **Thomson continues**

Because soybean production in Argentina is fully mechanized, the use of herbicide does not displace hand-weeding labourers. Whether the planting of herbicide-resistant in other developing countries will affect labour will depend on the type of agriculture practiced as well as on the type of crop. Weeding sometimes provides the labourers, mainly women, with their only source of income. However, the use of GM crops that reduce labour could significantly address specific social and economic crises facing rural communities as a result of the AIDS pandemic. **Shortage of farm labourers often means that children are increasingly involved in agriculture, impacting negatively on their education and quality of life.**

Contention Two: Increasing outputs.

Sub-point A: Nutrition.

Right now, malnutrition is a major problem that can be addressed. **Josh Schonwald in his book *The Taste of Tomorrow* outlines**

I promised that I'm not going to turn this into a food politics rant, but let me just point out one of the biggest reasons why my mind was changed – and why you should reconsider blithely following the advice from otherwise excellent guides of food choices, like Mark Bittman and Alice Waters and your synagogue pamphlet: According to the World Health Organization, **a quarter billion children worldwide**, mostly in the developing world, have diets **lack**ing in **vitamin A. Between 250,000 and 500,000 of these children go blind every year – with half of those dying within twelve months.** There is **a crop [called "golden rice"]**, developed in 1999, that **is fortified with vitamin A compounds.** If children unable to get vitamin A from other protein sources simply eat this crop, they will not go blind and die. It is named "golden rice" because of its yellowish hue, and every health organization in the world has declared it to be safe to eat. But golden rice was not bred through traditional means; it was bred in a lab. So golden rice is, by its opponents' definition, Frankenfood, and therefore it's been ferociously opposed. There is no "natural, traditional" alternative means of creating golden rice. You cannot use classical plant-breeding techniques because vitamin A compounds are only found naturally in the green parts of rice, not in the seed. In order to create a rice seed containing vitamin A compounds, you splice two daffodil genes and a bacterial gene into the rice genome.

Additionally, vaccination in the developing world can be addressed. **Madhavi Awale, professor of pharmacology and toxicology at Dantiwada Agricultural University highlights**

Transgenic plant vaccines are genetically engineered plant vaccines in which a selected gene is encoded for the desired antigen and modified which when taken orally elicits a strong immune response in the body. **Plant-cell produced vaccines** are inherently safe because they **pose no risk of microbiologic contamination** associated with animal-derived vaccines and eliminate the risk of pathogenicity, **[or] reversion to virulence and shedding.** Oral delivery stimulates mucosal immunity (the first line of defense) in the tissues lining the respiratory system and eliminates injection-related hazards. Plants structure may help in maintaining the antigenic property even after degradation in intestine. **Plenty of availability of plants makes the vaccine production of low cost apart from low cost in storage and transportation.** They act through different mechanism of action mainly stimulating the lymphoid structure in the intestine. This review highlights the development of transgenic plant vaccine, its action, and certain important diseases of animals, poultry and humans and status of plant vaccine developed against them.

Sub-point B: Yields.

Yields increase for three reasons, which are **outlined by the National Research Council.**

Although herbicide-tolerant and Bt crops are the most common types of transgenic crops, there is great interest in introducing other characteristics into plants to make them more productive in poor agronomic conditions. Nutrient-Poor Soil **Soil degradation** affects one-fourth of agricultural land worldwide (GEF, 2003) and **is one of the most important limitations on agricultural production in the developing world.** The African landscape is plagued by weathered soils and poor soil fertility (Holden, 2006). Although investment in improving soil fertility is needed, Kishore described how researchers at such companies as DuPont have used plants—for example, corn and arabidopsis— to produce transgenic plants with improved responsiveness to nitrogen. **[First,] Crops** that **have been genetically engineered to** more efficiently fix nitrogen, and thus **reduce the need for external inputs of fixed nitrogen, [which] could enable farmers to lower their production-related input costs while improving crop performance.** Heat and Drought Stress Water security is projected by the United Nations Population Fund as one of the top global issues in the 21st century (UNFPA, 2002). More than a half-billion people live in countries defined as water-stressed or water-scarce, and by 2025 that figure is expected to increase to 2.4-3.4 billion (UNFPA, 2002). **[Second,] Drought-resistant transgenic crops could be useful in alleviating the demand for water in agriculture.** Kishore described DuPont's work on corn varieties that maintain high yields under drought conditions and the development of drought-tolerant millet and sorghum, two staple crops; drought tolerance could have a large effect on agricultural productivity in Africa. It is unclear how well the technology will work under a multitude of field conditions—influenced by factors such as regional and geographic differences—and whether two or more types of stress (such as stress caused by heat and stress caused by drought) will have a compound effect on productivity. Salinity Salt tolerance was mentioned by workshop participants as useful in the developing world. **[Third,] Soils are often poor in quality because of salinity, and salt tolerance in crops** such as rice and other cereals and vegetables **would allow saline soils to be used more productively.** Mariam Sticklen, of Michigan State University, described her work on a barley gene that confers salt tolerance in transgenic oats. Efficiency of Resource Use Multiple lines of research are being conducted to find the genetic basis of a plant's ability to efficiently use resources, such as sunlight and nutrients. Kishore described research to improve the plants' ability to utilize whatever nutrition is available, starting with sunlight, carbon dioxide, and nutrients in soil. Beans and high-yield rice are two crops being examined for efficiency of resource use.

Ultimately, GE crops empirically have led to higher yields.

Because it is so vital to long-term food security, this has a three-fold impact.

First, a lack of food security results in conflict. **Emmy Simmons from the Wilson Center argues**

Analysis of the causes of conflict and war has been an area of growing academic interest. Both theoretical work and empirical analyses substantiate the many ways in which food insecurity can trigger, fuel, or sustain conflict. Unanticipated food price rises frequently provide a spark for unrest. **Conflict among groups competing to control the natural resources needed for food production can catalyze conflict.** Social, political, or economic inequities that affect people's food security can exacerbate grievances and build momentum toward conflict. Incentives to join or support conflicts and rebellions stem from a number of causes, of which the protection of food security is just one. **Food insecurity may also help to sustain conflict. If post-conflict recovery proves difficult and food insecurity remains high, incentives for reigniting conflict may be strengthened.**

Second, food security stabilizes water scarcity. **MIT explains**

Food security is invariably interconnected with water security because water is needed to produce the **food** that feeds the billions of people on our planet. **Currently, the agricultural sector uses 75 percent of global water** [1]. In a world in which access to abundant, clean, freshwater is becoming more difficult, **the amount of agricultural water use threatens future global water security.** Our ability to produce staple crops, which comprise the majority of the agricultural sector and constitute a large part of people's diets, will become a growing concern as water supplies dwindle. Maize (commonly known as corn), rice, and wheat are especially important because they are the most produced crops worldwide. In 2012, there were 875 million tons of corn, 718 million tons of rice, and 674 million tons of wheat grown globally [2]. Figures 1 and 2 below show the area harvested and production of all cereals globally [2]. These figures highlight the importance of these three staple crops, and why they should be the primary focus in the development of biotechnology for drought resistance and water efficiency.

If more crops are produced with equal amounts of water, then there won't be as big a strain on scarce water resources.

Water scarcity results in conflict. **David Michel corroborates**

Historically, warring states often made use of existing water resources to threaten the opposing country by poisoning wells or controlling access to water supplies that were not necessarily scarce. By contrast, **recent conflicts over water have increasingly been triggered by genuine shortage** more so than by accessibility. This is a worrying sign. No longer merely a tool of political or military advantage, **the control of water supplies increasingly constitutes the spark or object of civil strife or open conflict.**

Water scarcity also exacerbates poverty. **The University of East Anglia furthers**

They found that during the dry period, **children without access to clean water were about 2.5 times more likely to be absent from school** than children where water was provided.

Education is one of the most important factors that **enables children to** fulfill their potential later in life and **reduce poverty.** Better education is also associated with substantial health gains – especially for child health in future generations and in reducing child mortality. However, even when schooling is available, absenteeism rates can be high. Clearly reducing student absenteeism is vital to improve educational attainment and alleviate poverty.

Third, GM production can meet future demand. **Mike Obel furthers**

Perhaps the greatest factor spurring the use of GM crops is the dire need for food in the world, a situation that is worsening literally by the day. **By 2050 the world's population is expected to reach 9 billion**, nearly 30 percent higher than today. To feed that population, more food will have to be grown over the next 50 years than has been grown in the last 10,000 years combined, according to Henrylito Tacio, East Asia contributing editor for PeopleAndThePlanet.com. In certain countries, like Kenya, Tanzania and Uganda, where starvation is endemic, GM crops can make a huge difference right now, according to the Center for Strategic & International Studies. "Donor countries, as part of their broader food security and development aid, can support countries' efforts to pursue GM technology by providing scientific and technical assistance to scientists and regulators," CSIS said in a statement. **Meeting the planet's growing food needs without genetically modifying the seeds will be virtually impossible, considering the challenges to traditional crops** from global warming, drought, water shortages, and new strains of diseases and pests. Indeed, the use of pesticides to protect conventional crops are a double-edged sword because they often destroy many of the plants that they are meant to save.