Untested, Unproven and Unnecessary:" The Controversies of Marketing Genetically Modified Crops as Technology for the Poor

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INTRODUCTION

Proponents of genetically modified (GM) crops have argued that genetically modified organisms (GMOs) have enhanced food quality, reduced the costs of food production, increased crop yields, decreased pesticide use, and improved food security, stressing the importance of these technologies for the poor in developing contexts. However, others have argued that this technology is "untested, unproven and unnecessary," [1] and controversies surrounding licensure and regulatory practices, high technology costs and patent disputes, and limited farm data suggest a varied track record. This review argued that the shaping of a pro-poor narrative around GMOs has been rooted more in optimism than fact, and despite its hopeful promise, GM technologies have an empirical record of being shaped more by commercial interests, oversold and underperforming as a technology for the poor.

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History of GM Technology

Genetically modified organisms are defined as "organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination" by the World Health Organization [2], differing from evolutionary selective breeding in the active manipulation of genetic materials. Tracing DNA modification back to the mid-1940s, scientists began experimenting with transferring genetic materials between species [3]. The commercialization of GMO technology began in 1990s in China with the marketing of GMO tobacco, and swiftly entered the US marketplace with the Flavr Savr tomato in 1994. Since the 1990s, multiple transgenic crops like modified Canola oil, soybeans, cotton, and a variety of herbicide-resistant crops have been engineered, and many more are awaiting introduction to consumers [4].

Marketing GMOs as a "pro-poor" Technology

GMOs have been marketed as a way to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture," consistent with Goal 2 ("Zero Hunger") of the United Nations Sustainable Development Goals [5]. However, Shattuck argues that the production of grain has never been higher, indicating staple food production has far eclipsed demographic growth [6]. This view is shared by the Food and Agriculture Organisation of the UN, which asserts that "concerning the future, for the world as a whole there is enough, or more than enough, food production potential to meet the growth of effective demand" [7]. Despite strides made during the Green Revolution, which doubled the production of food, problems of hunger, poverty and malnutrition remain unsolved, and rates of global poverty and hunger are increasing. According to biotechnology companies, GM technologies could increase food production, helping to address hunger toward the fulfilment of this ambitious goal.

However, even when food is made available, the cost may prevent some from accessing it, necessitating "redistributing purchasing power and resources" [8]. Kisan Mehta points out, "it is the high cost of food that keeps food from the hungry mouth [9]. As the population continues to grow, more people will continue to suffer from crippling poverty, lacking the purchasing power to buy enough food to feed and sustain their families, particularly in rural areas [10]. While it is often argued that GM foods may provide a novel way for the increased production of food, it is less clear how GMOs could improve distribution, lower food costs, and ensure the sustainability of farming practices.

Regardless, biotechnology has frequently been framed as a "pro-poor" technology despite limitations and controversies. As Robert B. Zoellick, former United States' Representative for International Trade, notes, biotechnology companies have frequently furthered the narrative that GM agriculture is a way to "... help nourish the hungry international population, to offer exceptional opportunities to improve health and nourishment, to protect the environment reducing land erosion and the use of pesticides, a technology that can greatly benefit farmers and consumers in the world"

[11]. The feverish hype of this new technology resulted in conflicting messages that stressed the need for its “careful [and] responsible” trialing, while simultaneously advocating for the “enthusiastic and rapid, development” [12] in the service of the poor.

Aggressive marketing campaigns by large GM firms like BASF, Dow AgroSciences, Bayer, DuPont, Syngenta and Monsanto, largely to sell agricultural products like patented GM seeds and herbicides to farmers, often appealed to consumers’ pathos, citing imagined potentialities of saving starving people worldwide [13]. In Monsanto’s European Marketing campaign in 1998, they stated, “ as we stand on the edge of a new millennium, we dream of a tomorrow without hunger. Worrying about starving future generations won’t feed them. Food biotechnology will” [14].

These assertions rest on two key assumptions: 1) that hunger is a result of insufficient food supply, with need outpacing the growing population or current food production abilities, and 2) that biotechnology, specifically GM engineering, provides the best way to address food insecurity by increasing harvest yields [15]. Further assumptions were that this technology would help usher in a new era of commercial farming in developing contexts, transitioning subsistence farming models toward market-oriented agriculture that would better serve the interests of the poor due to its increased efficiency and productivity [16]. As we will argue, these assumptions have become the core of GM companies’ marketing strategies despite limited evidence.

Monsanto, as the pioneer of GM crop commercialization, embedded pro-poor rhetoric into its marketing strategy and company vision, appealing to investors. According to Glover, biotechnology was seen as “an essential tool for addressing critically important future challenges in hunger, environmental sustainability, and international development as vital goals for humanity as a whole” [17] in an attempt to “depict GM crops — and Monsanto as their chief provider — a provider of indispensable products and services in future markets for agricultural technology” [17]. Glover notes that “poverty was merely invoked as a ‘moral platform’ on which a series of assertions about the value of the technology could be made” [18] and the narrative of GM technologies being pro-poor served to unite the industry around a unified moral mission [19-21]. Similar marketing campaigns in pharmaceuticals [22] and biotechnology [23, 24] proved successful and served as a model for shaping biotechnology as a pro-poor innovation [25].

Many sources cite the origination of this imaginative pro-poor narrative framing stemming from a need to defray the objections from anti-GMO lobbyists, soften consumer criticisms directed at transgenic technologies, or as a public relations device as an exercise in ‘greenwashing’ [26-28]. In addition, pro-poor narratives could have also originated from an uncertain business model as Monsanto and other companies like it entered the biotechnology space to justify its costly expenditures on biotechnological developments [18], and may have actually helped shape Monsanto’s and other corporations ‘developing country goals’ which aimed to make “a contribution to transferring modern farming technology to under-privileged small-scale farmers” [29].

Many have taken issue with this framing, not least because "selective and misleading interpretation of farmers' experiences has distorted public debate and impeded the development of sound, evidence-based policy" [30]. In a joint letter to Channel Four Television and The Times Newspaper, representatives from organizations in the Global South wrote that "We consider the use of the South's rural poverty to justify the monopoly control and global use of GM food production by the North's transnational corporations, not only an obstructive lie, but a way of derailing the solutions to our Southern rural poverty" [31]. Gordon Conway, President of the Rockefeller Foundation, echoed this sentiment, noting "the public relations use have gone too far. The industry's advertisements and the media in general seem to forget that it is a research product that needs considerable further development" [32]. Despite opposition, this simplistic narrative — that GM technology is 'pro-poor' — has become entrenched in discussions of GM crops.

Biotechnology has not only been heralded as a revolutionary technological solution to poverty and hunger by companies like Monsanto, but has been supported by prestigious international medical and scientific institutions and politicians alike. For example, politician and GM-enthusiast Dick Taverne famously argued that anti-GMO NGOs had "exacted a heavy price [resulting in] the needless loss of millions of lives in the developing world," describing the technology as an "astonishing success" [30]. A report from the Research Directorate of the European Union indicated that "biotechnology, and in particular GMOs, are not per se more risky than e.g. conventional plant breeding technologies," and GMO technologies have gained widespread approval for use in developing contexts [33]. Influential organizations like the World Bank's Consultative Group on International Agricultural Research (CGIAR) have been fervent supporters of biotechnology research, indicating that it could serve as a means to augment global food production and serve as a vital tool to revitalize small farmers' agricultural yields and growing strategies to boost productivity [34-36]. To quote the Asian Development Bank, Biotechnology may offer cost-effective solutions to vitamin and mineral deficiencies … [and could] increase smallholders' incomes, reduce poverty, increase food access, reduce malnutrition, and improve the livelihoods of the poor [37].

Arguments in support of GMOs often centre on the cost-saving effect of planting GM crops, improvements in human health, the protection of the environment, and increased productivity and efficiency resulting in higher yields. Further arguments focus on how GM crops can increase smallholder farmer incomes, augment food access, and improve the lives and livelihoods of the impoverished.

Pro-poor Benefits of GM Technology

What truth is there to these assertions? GM crops frequently require less pesticides [38] and have been engineered to be resistant to certain diseases, making them better for the environment due to fewer chemicals utilized during growth and harvesting resulting in less greenhouse gas emissions. Environmental impacts of farming were reduced by 19% when farmers grew GM crops compared to wildtype varieties, and GM crops were shown to have reduced the use of pesticides and chemicals by 37%, being more sustainable and eco-friendlier [39]. GM crops like Bt-cotton that produce toxins that are harmful to pests but safe for human consumption, tailored genetically to reduce harvest loss, potentially useful in the fight against hunger and poverty.

Additionally, biofortification, or the addition of useful micronutrients and vitamins to foods, is also seen as an advantage of this technology, reducing malnutrition. This can be seen in the attempts to fortify rice with Β-carotene, a precursor to Vitamin A (Golden Rice) [40]. Furthermore, engineering crops to have longer shelf lives and better taste or selecting for traits like elimination of browning or delayed ripening are advantageous from a marketing perspective, allow for flexibility in the food chain. Examples of these can be seen in the manufacturing of the Flavr Savr tomato. Engineering plants with traits to resist environmental stress like drought or frost, like DNA Plant Technology's tomato spliced with "anti-freeze" genes from arctic fish, can increase yield [41, 42]. New innovations that have increased the efficiency of GM technologies, like CRISPR-Cas9, have also helped to reduce the cost and increase the timeliness of transgenic innovations [43, 44].

In addition to increasing agricultural productivity, GM technologies can permit faster plant growth, increasing yields by up to 22% [39], and reduce agricultural land use, leading to more harvesting opportunities. According to the World Bank, increasing productivity is a "critical entry-point in designing effective poverty reduction strategies [and is responsible for], 40 to 70 percent of poverty reduction [45]" demonstrating how this product could serve as a vital pro-poor tool. Recently, a study conducted by Realizing Increased Photosynthetic Efficiency (RIPE) led to a 40% upsurge in crop production due to a genetic modification that increased photosynthetic efficiency [46].

Lastly, GM farming can increase farmer incomes and benefit local economies. In an investigation by Carpenter (2010), surveying 49 peer-reviewed journal articles, GM crops were associated with higher economic performance resulting from lower input costs for fertilizers and pesticides, higher production, and lower fuel and labour costs [47]. This assertion was supported by the findings of a report authored by the International Food Policy Research Institute (IFPRI), which determined that GM crops resulted in "positive economic effect" on farms in sub-Saharan Africa, indicating that this technology has the potential to "lift many small, resource-poor farmers and their families in developing countries out of poverty" [48]. In this way, technological solutions to development problems affecting the poor — of which biotechnology and GMO research represent examples — have come into vogue in the development sector, and public-private partnerships like those between companies like Monsanto and governments are frequently envisioned as playing a major role in shaping GM technology as a solution to global poverty.

A Mixed Empirical Record Of The "Pro-Poor" Impact Of Gm Technology

Despite the claims that GMOs are pro-poor, the empirical record of their uptake is limited and has shown mixed results. Not all are as convinced that biotechnology is key to addressing the most pressing challenges in agricultural development, with the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) asserting that these technologies could only play a "minor role" in alleviating hunger [49, 50]. Consumers, development activists, policymakers and environmentalists alike continue to oppose this technology, citing its lack of field testing and risks [51].

Data demonstrating the impact of GMOs in developing contexts, where it is intended to be used, is ironically mixed. Many GM products were "developed for commercial farmers in the global North" [13] with limited testing in developing contexts, leading to concerns about their transferability and relevance. Studies at the farm-level have varied widely in the success of their implementation [52, 53]. In addition to methodological limitations [10], few studies on the long-term economic impact of GM crops have been conducted and crops like Bt cotton and rice dominate the scant literature. Despite some observations of positive income and yields during 'first generation' studies, sites surveyed varied widely in their success based on geography and GM crop planted, suggesting that contextual factors may have more to do with the success of GMO crops than the technologies themselves [39, 10]. Only recently have concerns been raised about resistant plants and pests, increasing the need for more toxic chemical pesticides [54, 55, 13].

Additionally, most GMOs are still prohibited from human consumption, and largely are used as animal feed or in industry, never reaching the poor that they claim to help. In the United States, corn, cotton and soybeans are the three most frequently grown GMO crops. While cotton is primarily an industrial crop, 98% and 88% of soybean and corn are used as animal feed respectively, with only around 10% going toward human consumption [37] leading some like Kisan Mehta, in her article Feeding the Poor, to pronounce that this rhetoric "is a bogey that is used by everybody from big business and government to multilateral agencies" [9].

Furthermore, country-specific limitations on types of GM products that can be commercialized and limited geographical distribution further restrict these products from entering consumer markets and, in turn, benefit the poor. Presently, South Africa, Burkina Faso, and Sudan are the only three Sub-Saharan African countries to approve and grow GM crops, and even these countries limit which crops are permitted. Sudan and Burkina Faso have only approved genetically modified cotton, while South Africa has legalized the commercialization of GM maize, cotton and soybeans [37].

Even in countries that are sympathetic toward GM products, limited scientific testing capabilities, long processes of government approvals, varied political willingness to advocate for GMO technologies, and nebulous regulatory practices, have slowed or blocked the uptake of GM technologies entirely. Recently, after over 17 years of testing, Kenya has only just initiated its first trials for pest-resistant cotton, [56, 57] but many LMIC countries are still far off from approving trials or commercialization of GMO crops. Biotech crops have been slow to be scaled up internationally. Few countries have permitted their use: only 29 countries worldwide approved GM crop cultivation in 2015. Of those, 20 were developing [58]. Additionally, the percentage of farmable land cultivated with GM crops remains low [59]. Although GM cultivation continues to grow in popularity worldwide particularly in developing contexts, biotech farming still only accounts for 10% of all arable land [60].

Moreover, the major types of GM crops are frequently for commercial export, "cash crops" rather than staples or sustenance crops. The dominant GM crops on the global marketplace are maize, soy, cotton and canola, GM monoculture crops that are prioritized for their export potential. Unlike sorghum, sweet potatoes, millets, sorghum, yams, and legumes, the staples of the global poor, GM crops presently on the market are less frequently used for domestic consumption. Furthermore, a shift toward perishable commodities that reap higher economic returns, but are less easily stored, presents a major concern for the poor [61]. As Maarten J. Chrispeels points out, this fact betrays a bias toward commercially exploitable crops, indicating that "this technology primarily benefits the multinational corporations that sell the seeds, and that these corporations are more interested in their own bottom line (always referred to as 'corporate greed') than in 'feeding the poor" [62].

GM crops — primarily cash crops — may destabilize local growing patterns or local varieties, resulting in a harmful trade-off between locally tested staple crops in widespread use and undertested GMO replacements. Farm economies are often central to rural ecosystems: favoring exogenous produce could destabilize local economies, devastating impoverished communities [63]. Manju Sharma, Director of India's Department of Biotechnology, recently indicated that India would begin using GM potatoes to fight malnutrition. By favoring exogenous GMOs, endogenous produce (and, in turn, farmers) may suffer. To this end, Vandana Shiva and Afsar Jafri stated that this is not just a decision to promote GM potatoes. It is a decision not to promote amaranth and pulses (important [indigenous] sources of protein in the Indian diet) [61].

Furthermore, the traits that are selected for during GM development are usually limited to insect resistance and herbicide tolerance [6]. While these indeed are important traits, these models can entrap farmers by requiring them to utilize commercially patented products — like expensive herbicides — that must be used in tandem with these crops. Ironically, these are often sold by the same GM companies marketing the GM seeds with these traits. In this way, markets govern which crops are invested in by GM firms, gearing this technology toward commercial productivity, compatibility to herbicides, and export potential, which erodes the argument that GM technology is indeed for the poor [64].

Critics are also quick to point out technological and hurdles and consumer opposition (Brooks 2008) which have left some transgenic technologies like Golden Rice, heralded by the GM industry in the 1990s as a "miracle cure" for hunger, far from commercialization [18]. Highly publicized backlash from NGOs like Green Peace and other anti-GMO lobbyists has resulted in low public support, largely borne out of safety, health and socioeconomic concerns [15]. Vandana Shiva has been a vocal critic of GMOs like Golden Rice, a genetically modified rice heavily marketed to developing countries as being a cure for malnutrition. Shiva argues that it, like many GMOs, greatly exaggerated its impact:
"Vitamin A rice is a hoax, and will bring further dispute to plant genetic engineering where public relations exercises seem to have replaced science in promotion of untested, unproven and unnecessary technology... This is a recipe for creating hunger and malnutrition, not solving it" [1].

Despite claims that GMO technologies carry limited risks, these technologies require immense investment in gene editing, which can be a lengthy and costly process, increasing farmer debt. Critics like Shiva have condemned the failed (over) promises of this technology, arguing that technological solutions to poverty are costly and ineffective, resulting in "soaring seed prices in India [that] have resulted in many farmers being mired in debt" [1]. Data would suggest that 75% of debt for rural farmers is associated with input costs — such as seeds and associated herbicides — that tie rural debt to corporate profit [61]. GMO technologies could introduce an additional burden, augmenting debt, which then is passed on to the consumer, making food increasingly expensive and inaccessible to the poor.

Moreover, concerns over rising "technology fees," connected to breeder's rights, might expose farmers to strict Intellectual Property (IP) regulations as GM businesses demand governments strengthen IP, impacting farmers' incomes and exposing them to lawsuits under Article 34 of the World Trade Organisation's Agreement IP protection prohibiting them from growing (even unknowingly) GM-patented seeds [65, 66]. While some multinational companies have expressed interest in technology transfer, with some donating technologies to developing countries, most of these technologies are tightly patented and therefore inaccessible to poor farmers without a fee, breeding dependency [67].

This dependency on large corporations has given rise to the term biocolonialism, which can be described as "the risk for [farmers] to depend on other people or entities' choices, as well as the risk to incur in a new phase of colonialism characterized by the mercantilist attitude of biotech firms" [11]. This aspect of biocolonialism extends to all aspects of GM farming: as Melinda Smale notes, "poorer farmers have less access to various forms of capital, including physical capital (land resources, equipment), financial capital (cash and credit) and human capital (education, literacy, experience)" [10] which could greatly increase their susceptibility to aggressive GM marketing campaigns from Western companies that could entrap them with expensive seed and herbicide costs, or lead to harvest mismanagement [68]. As stated by Hugh Fearnley-Whittingstall in his article "GM crops? Not in my backfield" published in The Guardian:

The only conceivably acceptable pro-GM argument, that it might help us feed the starving in the poorer parts of the world, turns out to be the most cynical and reckless of all. Far from offering hope and independence to the Third World farmers and growers, GM represents the new economic enslavement of the Third World neo-colonialism by proxy [9].

GM firms have also failed largely to consult local knowledge of farming, favoring the promotion of high-tech solutions over low-input, tried indigenous techniques. Rural farming practices differ drastically from commercial ones, often centering of the practice of saving and exchanging seeds, preserving harvest biodiversity, and prioritizing risk aversion over productivity [69]. More than 500 million smallholder farms represent the major source of the world's food production [70]. Smallholder farmers' lives and livelihoods depend on sustainable, resilient agriculture, valuing consistent results over maximizing food production.

Additionally, adopting GM seeds — and commercial farming practices — could lessen crop diversity, resulting in crop monocultures which require "standardization, chemical and capital intensification of production, and deregulation of the input sector, especially seeds, leading to rising costs of production" [61]. In sustainable models of farming, "farmers are at the centre of plant breeding, rather than passive recipients of new seeds" [11]. Using unsustainable models could introduce risk: GM monotypes could fail to propagate, confer insecticidal or viral resistance to wild-type plants, decrease soil fertility, or kill beneficial pests, irreparably altering local farming practices. Rural farmers often depend on farming for sustenance, and overreliance on GM crops can be devastating, increasing vulnerability to environmental stressors and decreasing sustainability, leading to higher costs for consumers.

CONCLUSIONS

Overall, this paper takes a critical view of the promotion of GMOs as being pro-poor. After considering the evidence, we are most aligned with Persley's argument: that "Biotechnology is only one tool, but a potentially important one, in the struggle to reduce poverty, improve food security, reduce malnutrition, and improve the livelihoods of the rural and the urban poor," [71] but most certainly cannot be lauded as a "miracle cure" for food insecurity. While these technologies do have the potential for significant impact on the lives and livelihoods of the poor, the potential for monocultures and reduced crop biodiversity, biocolonialism, export-oriented commercial farming practices that suppress indigenous knowledge, and the potential for entrapping farmers in debt by requiring them to purchase costly GMO seeds or pesticides or miring them in complex patent disputes, highlight how this technology has been shaped by corporate interests. While GM technologies may eventually serve to increase farmer incomes, improve productivity of harvest yields, and reduce environmental impact, myriad regulatory concerns, technological restraints, and the limited spread of this technology have thus far significantly hindered it from benefiting the poor [72, 73].

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