RICH APPETITES: HOW BIG PHILANTHROPY IS SHAPING THE FUTURE OF FOOD IN AFRICA

EPISODE 4: SCIENCE

A Companion Guide

AGRA WATCH

March 2023

This guide accompanies **Episode 4** of ***Rich Appetites: How Big Philanthropy is Shaping the Future of Food in Africa***, a short film series developed by AGRA Watch and the Alliance for Food Sovereignty in Africa (AFSA). The *Rich Appetites* series explains why exporting the US agribusiness model to Africa is a grave mistake, and promotes real, farmer-led solutions.

Learn more and watch all five films at www.richappetitesfilm.com

Companion Guide for Episode 4: Science
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AGRA Watch is a campaign of the Seattle-based Community Alliance for Global Justice that challenges the Bill and Melinda Gates Foundation's questionable agricultural programs in Africa, including its AGRA initiative, and promotes farmer-led alternatives.

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AGROECOLOGY AND SCIENCE

Debunking False Binaries and False Solutions

Critics of agroecology often position it as static and rooted in the past, in opposition to dynamic and "modern" science and technology — most notably, genetic engineering (GE). There are two key problems with this.

First, critics of agroecology define science, technology, and innovation in an extremely limited way, which allows corporations and labs to frame the debate on their terms. As the anthropologist and Green Revolution critic Paul Richards has noted, technology is best understood not as advanced machines, but as diverse ways of doing things that are "emergent in hands-on human action."[1] And science fundamentally involves diverse methods and practices of observation and hypothesis testing. Proponents of agroecology are not opposed to science, technology, and innovation, per se — in fact, they embrace them. It is particular kinds of science and technology, led by corporate actors in support of specific profit-oriented goals, that agroecological practitioners reject.

Second, even by the metrics favored by industrial agriculture — like crop yield — agroecological practices outperform many conventional and genetically-modified crop varieties. The scientific evidence heavily supports the ability of diversified farming approaches to feed people, heal the land, and adapt to climate change, and demonstrates that monoculture and industrial agriculture are not viable options for future food production. Far from being "stuck" in the past, agroecology is our only hope for the future.

MYTH 1: “Agroecology is unscientific and rooted in the past, locking farmers into traditional farming methods."

Agroecology centers *in situ* ecological innovation and offers farmers more choice, flexibility, and adaptability to changing circumstances. By contrast, industrial models of agriculture lock farmers into purchasing inputs and create cycles of indebtedness, benefiting large corporations at the expense of food producers

A common critique levied against agroecology is that it is focused on the past and seeks to keep local farmers in poverty. In contrast, critics claim that industrial agriculture and accompanying agricultural technologies boost development and improve livelihoods.

Although it certainly draws on cultural and ecological traditions, agroecology is a scientific approach to agriculture. People practicing agroecology consider the complex interactions between plants, animals, and the environment, with the goal of creating sustainable and resilient food systems. It is based on the principles of ecology, which is the scientific study of the relationships between living organisms and their environments. Agroecology recognizes that farming is not just about producing food, but also about managing ecosystems, conserving natural resources, and building social and economic resilience. It is therefore deeply rooted in the scientific understanding of ecological relationships among species, the physical environment and natural systems.[2] Agroecology recognizes that farmers themselves have a deep understanding of their local environments and the challenges they face, and that this knowledge must be fully integrated into any sustainable farming system.

While proponents of industrial agriculture position farmers as needing to “improve” by purchasing goods and services, agroecology recognizes farmers themselves as innovators, entrepreneurs, and knowledge producers. For example, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) argues that innovations to local problems must be developed in partnership with farmers and communities or they are unlikely to succeed.[3] The IAASTD was a project initiated by the World Bank and the United Nations that brought together more than 400 scientists from all continents and a broad spectrum of disciplines working together for four years to answer the question of how agricultural knowledge, science, and technology could best be used to reduce hunger and ensure sustainable livelihoods.[4]

The UN FAO's 13 Principles of Agroecology
Source: Agroecology Europe, The 13 Principles of Agroecology

Contrary to criticisms of agroecology as static, it is responsive to changing environmental and social conditions, and embraces innovation. For example, a partnership between the non-profit Bio Gardening Innovations (BIOGI) and local farmers in Western Kenya demonstrates how innovative practices, combined with local farmer knowledge, can lead to revitalized farming systems.[5] The staple crop in the region is maize, traditionally harvested twice a year and grown using agrochemicals. As a growing population encroached on the land, farmers resorted to increasingly aggressive farming techniques to maintain yields. This led to soil exhaustion, decreased quality of each yield, dependence on third parties to provide chemical fertilizers and pesticides, and the high risks that come with monocropping. BIOGI worked with farmers to grow food forests, combining farmers' knowledge of the land with innovative permaculture methods. Food forests involve layers of plants and wildlife that live harmoniously with little human intervention, producing crops and trees useful to the farmers as both food and cash crops. It also involved making fertilizer from fallen leaves and animal droppings, which restored soil fertility and increased the economic independence of farmers, who were no longer reliant on expensive inputs. The collaboration has enabled farmers to confront food insecurity and restore and protect biodiversity. As the success of the practice grows, more farmers are joining through farmer-to-farmer education and farmer-led experimentation.

Agroecology actually provides more control to farmers than does industrial agriculture, by reducing their reliance on expensive external inputs such as synthetic fertilizers and pesticides. Accordingly, many small-scale and Indigenous farmers themselves are demanding a greater focus on agroecological farming practices rather than industrial agriculture. For example, at the 2015 International Forum on Agriculture, diverse social movements and organizations representing small-scale food producers gathered and produced a final declaration stating that they considered "agroecology as a key element in the construction of food sovereignty."[6] Far from being locked in to the past, many farmers see agroecology as crucial to a future of empowerment and food sovereignty — "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems."[7]

Source: Timothy A. Wise, Agroecology as Innovation (2019), Food Tank

What's in a name? Agroecology and other terms for ecological agriculture

In this film series, we expressly advocate for agroecology, rather than sustainable, organic, or regenerative agriculture. Although these approaches share some similarities in moving toward more environmentally-friendly forms of food production, there are major differences that set agroecology apart as a better model.

Sustainable agriculture is a catch-all term for practices that consider long-term viability. The UN's 1987 report Our Common Future (also sometimes referred to as the Brundtland Report) defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."[8] According to the report, sustainability must address three Es: ecology, economy, and social equity. However, sustainability as a term has been applied so widely and to such contradictory practices that it has become meaningless. There are no rigorous guidelines governing what is or is not sustainable agriculture, which allows organizations and companies to greenwash their activities—in other words, they claim to be "sustainable" and environmentally conscious, while continuing to engage in harmful practices.

Organic agriculture is a farming approach that seeks to reduce the use of synthetic chemical fertilizers and pesticides. In the US, it typically refers to farms that meet a minimum set of ecological standards, as certified by an independent third party. In this context, some producers who may use low-input practices or "organic" methods cannot get certified due to cost and access issues. Organic agriculture also retains market imperatives and is silent on issues of labor rights or equity (although some attempts have been made to incorporate these into global definitions). As such, many organic producers and companies are massive farms or subsidiaries of huge corporations, with rampant labor violations. Additionally, the imperative of serving large markets means that many organic producers are forced to purchase "alternative" inputs, rather than relying on more time-intensive biophysical processes (like composting or crop rotation).[9]

Like sustainable agriculture, **regenerative agriculture** is very poorly defined and open to sometimes contradictory interpretations. Even among practitioners, it is used to refer to different processes or objectives, from sequestering carbon to maintaining soil health to emphasizing human health.[10] This lack of a clear or cohesive definition makes it easily co-opted by organizations and companies in greenwashing their work. Furthermore, like organic agriculture, the regenerative agriculture movement is largely silent on issues of social equity, including the impacts of racism on the food system.[11]

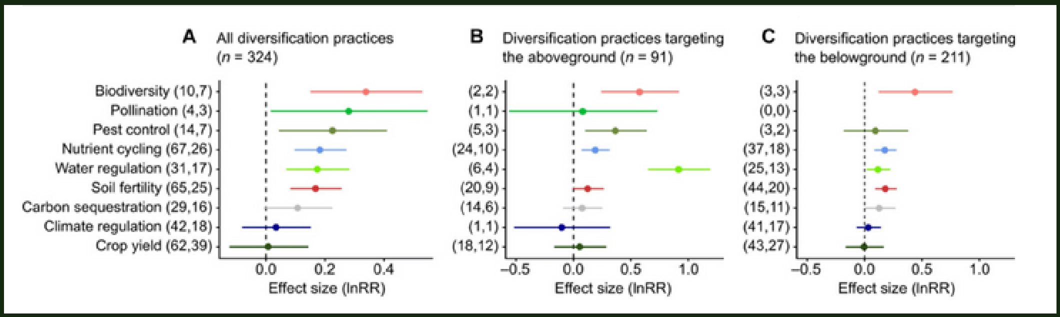
Agroecology is a recent name for a set of practices and overall approaches that have been used by farmers around the world for generations. It is based on observing and mirroring ecological processes in producing food, including practices that improve or maintain soil health, use water efficiently, and deter unwanted pests. It has been codified by organizations like the UN Food and Agriculture Organization as including 13 ecological, social, and political principles. It is therefore more cohesive, unified, and prescriptive than other terms, and it requires fundamental changes to outlooks, political systems, and social processes, unlike other movements that seek to make capitalist forms of agriculture simply "greener." At the same time, there are ongoing efforts to co-opt it, by reducing it to a set of discrete components (rather than a holistic approach).

MYTH 2: “Agroecology and small-scale agriculture can't feed the world.”

Agroecology actually has a much better chance of feeding the world than does industrial agriculture.

As demonstrated in Companion Guide 1, tackling hunger and malnutrition is not simply about increasing food production; food must be readily available not only to those who can purchase it but also to the poor.[12] Several recent studies suggest that dramatic increases in food access in developing countries can be achieved most quickly and most affordably by applying the principles of agroecology, including local ownership and autonomy over what is produced, sold, and consumed.[13]

In terms of overall food production capacity, a number of studies have shown that implementing agroecological farming practices can lead to large increases in crop yields. A comprehensive 2011 report, presented before the UN Human Rights Council and based on an extensive review of recent scientific literature, showed that agroecologically-guided restructuring of agro-ecosystems can double food production in entire regions within ten years, while mitigating climate change and alleviating rural poverty.[14] Similarly, a review of 286 agroecological projects across 57 low-income countries found an average yield increase of 79 percent.[15]



An extensive review of studies from around the world finds that agricultural diversification practices increase biodiversity and other ecological metrics, without reducing crop yields
Source: Giovanni Tamburini, Agricultural diversification promotes multiple ecosystem services without compromising yield (2020)

Agroecology can also increase food security by producing a wider range of crops, thus providing more diverse and nutritious diets. In 2018, the FAO projected that a "business as usual" scenario is likely to lead to significant undernourishment by 2050, even if gross agricultural output increases by 50 percent.[16] By contrast, agroecological approaches consistently lead to improved diet diversity and household food security.[17] For example, a community-level intervention where Nepalese women groups learned about agroecological practices led to a significant improvement in children's diet quality, with the strongest effect observed during seasons when food access is typically the most difficult. Children of families that received the intervention were more likely to consume an additional food group, achieve minimum dietary scores, and consume animal proteins.[18]

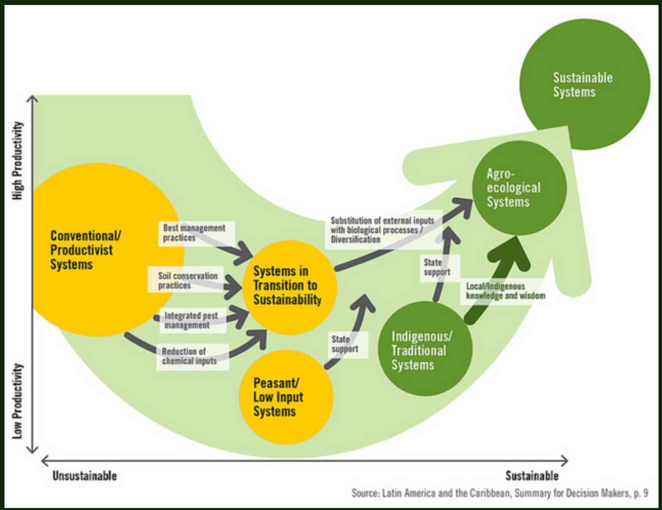
Critics of agroecology often suggest that to keep up productivity, small-scale agriculture will require even more land to be brought under cultivation, contrasting this with industrial agriculture's "intensive" use of land. But industrial agriculture's intensive model of agriculture, which relies on the use of fossil fuels and chemical inputs, has led to biodiversity loss, land degradation, loss of soil fertility, and chemical contamination of soil and water, with major consequences on human, animal, and planetary health.[19] Because of declining soil fertility and the exhaustion of resources, industrialized farms' productivity actually diminishes over time, requiring more chemicals and often more land clearance.[20] By contrast, agroecology restores, replenishes, and increases soil fertility, as well as ensuring broader environmental quality and positive spillover effects. This, combined with experimentation and adaptation to local particularities, allows agroecological farmers to produce continually high yields of diverse crops, even on very small plots of land.[21]

Agroecological methods are essential in ensuring food security for future generations. A number of studies suggest that industrial agriculture cannot ensure sustainable food systems in the long term because of its negative impacts. Agroecology, on the other hand, would counter many of the harmful impacts of industrial agriculture. Rebuilding soil fertility to pre-industrial levels would capture 30 to 40 percent of current excess CO_2 in the atmosphere. Selling most food through local markets would lead to a 10 to 12 percent reduction in current global emissions. And halting land clearance and deforestation for large agribusinesses would further reduce emissions by 15 to 18 percent.

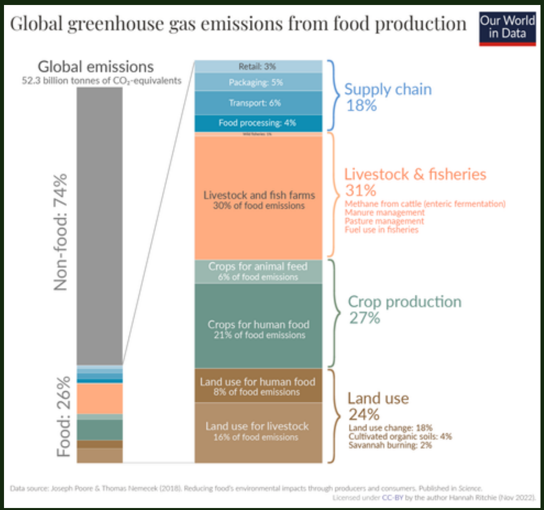
FAO Director-General José Graziano da Silva, on the potential of agroecology (2014):

"While past efforts focused on boosting agricultural output to produce more food, today's challenges – including climate change – demand a new approach. We need to shift to more sustainable food systems – food systems that produce more, with less environmental cost. In many countries agriculture has been seen as an enemy of the environment, but there is increasing recognition that a regenerative, productive farming sector can provide environmental benefits while creating rural employment and sustaining livelihoods.

Agroecology offers the possibility of win-win solutions. By building synergies, agroecology can increase food production and food and nutrition security while restoring the ecosystem services and biodiversity that are essential for sustainable agricultural production. I firmly believe that agroecology can play an important role in building resilience and adapting to climate change."[24]



Source: IAASTD (2009)



Source: Our World in Data

MYTH 3: “Genetically modified crops are essential in addressing climate change and food insecurity.”

The Gates Foundation has spent billions of dollars and funded thousands of projects on chemical inputs and gene technologies at universities and research institutes around the world.[25] Yet the evidence behind gene technologies – like genetic engineering and new breeding techniques – is weak at best, and largely stems from experimental conditions in the US.[26]

What we refer to as gene technologies includes a range of approaches that share a commitment to understanding, visualizing, editing, and manipulating the genetic code of plants and animals:

- **Genetic Engineering (GE)** refers to the modification and manipulation of an organism's genes using biotechnology. It is a set of technologies used to change the genetic makeup, or DNA, of cells, including the transfer of genes within and across species boundaries to produce "improved" or novel organisms.
- **Genetically Modified Organisms (GMOs)** are the products of genetic engineering, and they range from yeasts and bacteria to **genetically modified (GM) crops** like soybeans, corn, and cotton. In most cases, genetic modification of crops is aimed at introducing a new trait to the plant which does not occur naturally in the species, such as pest resistance.
- **New Breeding Techniques (NBTs)** are methods that aim to increase and accelerate the development of new traits in plant breeding. NBTs make specific changes within plant DNA in order to change its traits, and these modifications can vary in scale from altering a single base, to inserting or removing one or more genes. These new techniques often involve RNA interference, also known as "gene silencing," which switches off the expression of specific genes, or genome editing, which modifies DNA at specific locations within the plant's genes so that new traits and properties are produced. Perhaps the most widely-known example of NBTs is **CRISPR-Cas9** genome editing. In this form of genome editing, an enzyme (Cas9) facilitates the ability of the CRISPR family of DNA sequences to cut the DNA of a target organism, after which the natural DNA repair processes take over. The products of NBTs may or may not be classified as GMOs, depending on the specific techniques used and a given country's regulatory frameworks and definitions.

There are a number of arguments put forward in support of GMOs. Let's debunk these one by one.

GMOs Do Not Significantly Increase Crop Yields

Proponents of genetic engineering argue that GMOs can reduce world hunger by boosting yields, increasing the overall amount of food produced. Based on this assumption, the Gates Foundation has awarded numerous grants to projects that aim to genetically engineer both staple crops and livestock species to have higher productivity.[27]

While livestock research is more nascent, the results of decades of experimentation and commercialization of GM crops do not suggest that these deliver consistently higher yields. In the US, where GM crops have been widely planted for decades, their impact on crop yield is negligible. Some analyses of the data demonstrate no improvement[28], while other analyses suggest a small but non-significant improvement in yield.[29] Overall, a report published by the National

Academies of Sciences, Engineering, and Medicine concludes that the nation-wide data on maize, cotton, and soybean in the United States do not show a significant impact of genetic-engineering technology on the rate of yield increase.[30] By contrast, significant, replicable evidence suggests that agroecology is able to increase crop yield, decrease household hunger, and improve diet diversity.[31]

Moreover, as we discuss in Companion Guide 1, higher yields do not necessarily reduce hunger, due to unfair and unequal systems of distribution and access. And an exclusive emphasis on yield (rather than also on crop diversity and/or nutritional profiles) has undermined wider health goals and has contributed to soil exhaustion and degradation, through industrial agricultural models that rely on monocropping.

Source: Sabrina Masinjila and Anne Maina, Monsanto's GMO drought-tolerant maize failed in US, now pushed on Africa (2019), for GM Watch

GMOs Do Not Build Climate Resilience or Drought Resistance

Another key argument put forward for the focus on GM crops is that climate change will require developing drought-resistant crops.[32] However, it is not clear that GM crops can actually produce greater yields under severe drought conditions. A US Department of Agriculture report has found that while drought-tolerant corn varieties planted in the US (the vast majority of which are GMOs) may sometimes be worth the higher cost to farmers, under "extreme or exceptional drought, there could be little expected benefit to adoption since both DT and non-DT corn are likely to suffer crop failure."[33] These dubious results have been used to drum up support for genetic engineering initiatives in Africa, such as the Water-Efficient Maize for Africa (WEMA) project. WEMA was a public-private partnership coordinated by the African Agricultural Technology Foundation and funded by the Gates Foundation, which sought to develop drought-tolerant and insect-resistant maize.[34] Monsanto donated the gene used in its MON 87460 variety to the project, admitting based on their data that the gene provided only a 6 percent reduction in yield loss in times of moderate drought — but this could be reduced to zero under severe drought conditions.[35] It is likely that any yield advantages of WEMA varieties, like DroughtTEGO, during mild or moderate drought conditions may disappear during severe droughts — which are increasing in duration and frequency due to climate change (as has been the case with US GMO drought-tolerant varieties). Because the crop varieties used in WEMA were already heavily reliant on other techniques such as conventional breeding, it is not clear how much additional drought tolerance comes from genetic engineering.

Furthermore, drought tolerance is determined by many genes, as well as external environmental factors. Yet genetic engineering can only manipulate a few genes at a time; this is why, to date, the most widely-adopted and commercially successful GM crops are those that are more straightforward, such as Bt crops into which DNA from the *Bacillus thuringiensis* (Bt) soil bacterium have been inserted to confer pest resistance. Genetic engineering is unlikely to accomplish the goal of drought resistance given the complexity of the circumstances surrounding it.

Finally, droughts vary in severity and timing, and it is therefore unlikely that any single approach or gene used to make a GM crop will be useful in all types of drought. As noted above, GM drought-tolerant varieties do not outperform conventionally-grown drought-tolerant varieties or non-GMO hybrids during severe droughts, and may fail entirely. While organic corn has demonstrated a 31 percent higher yield than conventional in years of drought, GM drought-tolerant corn only outperformed conventional corn by 6.7 percent to 13.3 percent.[36]

GMOs Do Not Benefit Small Farmers

In addition to concerns over viability, there are more fundamental criticisms of access and control over genetic engineering technology. GM crops are unlikely to benefit small-scale farmers, because they are designed to be used in large-scale industrial farming systems, by farmers who have access to credit and markets.[37] We can look to the example of Makhatini cotton in South Africa for an illustration of this. In 1997, Monsanto developed a project in Makhatini, Northern KwaZulu Natal, to introduce GM cotton to small-scale farmers.[38] They gave farmers support to grow their crops and made credit available to farmers in the area. Within two years, almost 90 percent of small-scale farmers were growing GM cotton. However, GM seeds are expensive and require farmers to apply specific pesticides and fertilizers. Participating farmers had to take out loans to begin production, but were unable to pay back their debt. By 2009-2010, nearly all farmers had abandoned GM cotton, and R22 million in outstanding debt remained. We see similar patterns in other attempts to introduce GM crops to small-scale farmers – switching to cash crops does not improve household livelihoods, and farmers cannot get good prices as they have little bargaining power, leaving them in debt and unable to sustain GM crops.[39]

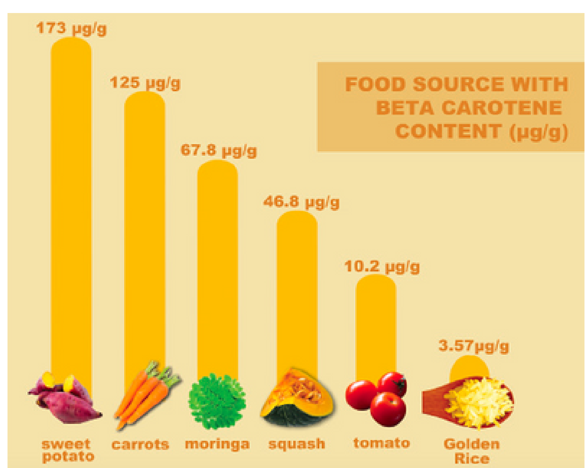
New technologies can be part of the solution, but they must fit within a well-thought-out development and delivery program that ensures people can make their own decisions, manage their own systems, and access the resources they need.[40] The widespread promotion of gene technologies can result in multinational companies gaining further control over the food chain by patenting techniques, genes, and products.[41] Like commercialized, privatized, and patented seeds more generally (as discussed in Companion Guide 2), GMOs tip the scale in favor of corporations, threatening the livelihoods of farmers in Africa for whom the majority of crops are grown with no intergovernmental or donor support from farmer-saved seed and farmer-developed varieties – many of which are equally, if not better, adapted to changing climatic conditions.

GMOs Do Not Solve Food Insecurity or Malnutrition

In addition to claims about boosting overall yields, GMOs are often promoted as a "silver bullet" in addressing nutrient deficiencies and malnutrition. Proponents and funders like the Gates Foundation suggest that a key strategy in fighting malnutrition is for staples, like cassava and rice, to be bred to have higher doses of micronutrients.[42] There are two main ways that gene technologies are used to play a role in this process of biofortification:

- Scientists can use genome sequencing to identify cultivars with higher naturally-occurring levels of micronutrients, which can then be cross-bred using conventional breeding techniques.[43]
- Scientists can use genetic engineering to introduce vitamins or minerals across crop species. The most famous and controversial example of this is Golden Rice, discussed below.

Since the 1980s, researchers have worked to genetically engineer Golden Rice—varieties of rice that could include high levels of beta-carotene in the endosperm (not just the hull). To do this, they used biosynthesis genes from daffodil and the soil bacterium *Erwinia uredovora*; later cultivars also used genetic material from maize.[44] Golden Rice promised to reduce Vitamin A deficiency (VAD), which causes hundreds of thousands of childhood deaths each year. In the 2010s, the Gates Foundation awarded a grant of $10.3 million to support Golden Rice development at the International Rice Research Institute in the Philippines.[45]



Source: Farida Akhter and Afsar Jafri, Golden rice in the Philippines: hurried approval raises questions (2021), GRAIN

However, Golden Rice has consistently come up against regulatory challenges. Although its supporters blame delays in approval on anti-GMO activists, critics suggest that the technology itself was simply underdeveloped, requiring decades to even be ready for the market.[46] And while Golden Rice was approved for sale in the Philippines in 2021, with farmers planting it in 2022, it is not positioned to make a meaningful impact on VAD, for several key reasons [47]:

- Beta-carotene uptake requires high levels of fat in the diet, and feeding trials of Golden Rice only measured uptake in children who were healthy and eating balanced diets (unlike the vast majority of children experiencing VAD).
- Golden Rice varieties, developed in labs, do not actually grow successfully in the areas and ecological zones in which the majority of children with VAD live.
- In the Philippines, the incidence of VAD had already fallen dramatically prior to the arrival of Golden Rice, due to governmental childhood nutrition programs.

As the Golden Rice case demonstrates, more holistic solutions can actually deliver more effective results in terms of meeting nutritional needs.

Overall, even when it succeeds in meeting narrowly-defined goals, genetic engineering is overly reductionist. It focuses on specific qualities and traits of a handful of species, in isolation from the rest of the social and environmental landscape. In terms of environmental impacts, all of the available evidence suggests that this kind of monocultural system is ecologically harmful and extremely vulnerable to disruption. And in terms of human health, there is insufficient evidence to draw definitive conclusions about the safety of GMOs.[48] By contrast, agroecology promotes health among both humans and environments, through crop diversification and holistic, ecosystem-level approaches.

So why do we see such an unbalanced investment towards technologies such as genetic engineering, rather than holistic and agroecological approaches?

First, agricultural science policies are explicitly and increasingly oriented towards growth and national competitiveness; unlike agroecology, genetic engineering is more directly linked with GDP growth.[49] Second, the private sector has become an increasingly important actor in agricultural research.[50] The private sector focuses on innovations that can generate high revenues and secure competitiveness through patents or other forms of intellectual property regimes. As such, genetic engineering has received the backing of strong industrial lobby platforms. This is an orientation which Bill Gates also favors, as evidenced by the types of innovations that the Gates Foundation supports. Private sector incentives for agroecological research are limited, as private companies are unable to capture all the benefits resulting from agroecological innovations (as many of these are long-term public goods). Meanwhile, many Green lobbies have adopted positions that are anti-GE, rather than pro-agroecology. And those scientific organizations that back agroecological research on agroecology have less clout than the mainstream scientific organizations that support genetic engineering.

The nature of R&D and the orientation of researchers themselves also favors GE over agroecology.[51] Agroecology requires context-dependent, systems-level research, as compared to laboratory-based, molecular-level research. Therefore, agroecological research does not fit well with laboratory-based institutions and protocols, and it is not aligned with the incentives that push scientists and scientific publications to focus on direct, localized, and short-term impacts. Many researchers also believe that modern agricultural systems only require small adaptations, and are biased towards solutions that fit with the most probable (rather than the most desirable) future of food systems.[52] GE crops do not require any structural changes to the current industrial and monoculture farming system, whereas agroecology challenges the fundamentals of the current system. Agroecology suggests that innovations should not be developed by private sector corporations to maximize profit, but by farmers themselves to maximize their well-being and sustain their livelihoods.

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