

AFRICA'S CHOICE

Africa's Green Revolution has Failed, Time to Change Course

TIMOTHY A. WISE
Senior Advisor, IATP



Timothy A. Wise is a senior advisor at the Institute for Agriculture and Trade Policy (IATP). He is the author of *Eating Tomorrow: Agribusiness, Family Farmers, and the Battle for the Future of Food*. He wrote this policy brief drawing from his working paper, “[Failing Africa’s Farmers](#),” and the related report, “[False Promises: The Alliance for a Green Revolution in Africa \(AGRA\)](#),” published by a coalition of German and African nongovernmental organizations and Rosa Luxemburg Stiftung (Germany and South Africa), which funded the research.

Since the 2007-8 food crisis, when spikes in prices for global commodity crops raised the specter of food shortages, Africa has seen a surge in funding to help local food producers grow more of the region’s food. African governments raised spending on agricultural development, supported by international donors who recognized, for the first time in decades, that developing countries needed to grow more of their own food and that their small-scale farmers could be a crucial part of that effort rather than a drag on economic development.² For several years, high international crop prices drew private investment into agriculture. Global philanthropies, newly endowed with billions of dollars in technology profits, led the charge. The Bill and Melinda Gates Foundation established a well-funded program on international development and partnered with the Rockefeller Foundation in 2006 to launch the Alliance for a Green Revolution in Africa (AGRA). AGRA eventually set the ambitious goals of doubling crop productivity and incomes for 30 million small-scale farming households while halving food insecurity in 20 African countries by 2020.³

That Green Revolution project is failing. My research has shown that as the Green Revolution project reaches its 2020 deadline, crop productivity has grown slowly, poverty remains high, and the number of hungry people in the 13 countries that have received priority funding has risen 30% since 2006. Few small-scale farmers have benefited. Some have been thrown into debt as they try to pay for the high costs of the commercial seeds and synthetic fertilizer that Green Revolution proponents sell them. This disappointing track record comes in spite of \$1 billion in funding for AGRA and \$1 billion *per year* in subsidies from African governments to encourage their farmers to buy these high-priced inputs.

African governments have a choice to make, a choice that will determine the continent’s food future. For the last 14 years, governments and donors have bet heavily, and almost exclusively, on the Green Revolution formula of commercial inputs, fossil-fuel-based fertilizers and agro-chemicals. That gamble has failed

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to generate agricultural productivity, even as the continent has seen a strong period of economic growth. Rural poverty remains high. Hunger is rampant, with the United Nations warning that Africa could see a 73% surge in undernourishment by 2030 if policies don't change.⁴

Africans can choose a different path, one offered by innovative small-scale farmers all over the continent. Many reject the Green Revolution as the failing policies of past, pointing to long-term damage to farming communities and the environment in India, target of the first Green Revolution fifty years ago. They have demonstrated that agroecology, with its innovative combination of ecological science and farmers' knowledge and practices, can restore degraded soils, make farms more resilient to climate change, improve food security and nutrition by growing and consuming a diversity of crops, all at a fraction of the cost — to farmers and to African governments — of the Green Revolution approach.⁵

To the Green Revolution, they say: Time's up. You've had your chance to show what difference you can make. As we face climate change and rising hunger from the COVID-19 pandemic, it is time to take a different path. The future is agroecology.

BACKGROUND

AGRA, initiated in 2006, heralded a new campaign to bring the kind of input-intensive agriculture to Africa that had failed to take hold on the continent when the first Green Revolution swept through much of Asia and Latin America in the 1960s and 1970s. Now, argued Green Revolution campaigners, science had developed the seed and other technologies to give Africa its own Green Revolution, one tailored to the specific ecological and climatic conditions across the continent. While the technologies may have evolved, the basic approach was the same: promoting the adoption of so-called high-yield seed varieties fed with inorganic fertilizer.⁶

With the Gates Foundation and donor governments providing nearly \$1 billion in contributions and disbursing \$524 million in grants, AGRA initially focused its work in 18 countries, soon reduced to 13.⁷ AGRA worked with governments to speed the development of high-yield commercial seeds designed for Africa's wide range of soils and climates and to facilitate the delivery to farmers of those seeds and the inorganic fertilizers that would make them grow.

Far more important than AGRA in this endeavor were subsidies provided by African governments to their farmers to purchase these Green Revolution inputs. Of AGRA's 13 focus countries, only three — Mozambique, Niger and Uganda — do not have significant input subsidy programs. The resources expended by national governments on such programs, often heavily supported with donor funds, generally dwarf those invested by AGRA. Where AGRA grants \$40-50 million per year in its supported countries, aggregate government expenditures on input subsidies approach \$1 billion per year,⁸ more than twenty times AGRA's funding.

These Green Revolution policies have always been controversial with Africa's farmer organizations. Many warned that it was seeking to impose Western technologies inappropriate for the continent's soils, farmers and food systems. Some decried the lack of consultation with African farmers on the nature of the interventions.⁹ Others pointed out the serious flaws in the first Green Revolution: water supplies depleted and contaminated with chemical runoff; farmers indebted due to high input costs while yields declined after their initial increases; and the loss of crop and diet diversity as Green Revolution crops took over the countryside. African farm groups like the Alliance for Food Sovereignty in Africa (AFSA) also warned of the loss of food sovereignty, the ability of communities and nations to freely choose how they wanted to feed themselves, as large commercial firms could come to dominate local markets backed by new government policies designed to ensure market access.

These early warnings take on new weight in light of new research by historians on the myths and realities of the first Green Revolution.¹⁰ Their accounts, grounded in empirical data, much of it from India, suggest that crop yields for wheat and rice did not increase significantly faster after Green Revolution innovations than they were already rising. Agriculture was not stagnant, and the new technologies did not appreciably increase yield growth. Some historians suggest that even in the short term the new technology package may have had only a negligible impact on hunger in India. There is also evidence that high-yield seed genetics were not the most important input responsible for the yield increases Indian farmers observed, nor was inorganic fertilizer. The most important input was irrigation, according to recent studies, as the Indian government and donors supported the widespread installation of tube wells. In any case, the long-term environmental toll on India's farmers and landscapes has been severe. Even long-time advocates of the Green Revolution

approach acknowledge the damage caused by the technologies and practices it promoted.¹¹

Neither AGRA nor the Gates Foundation has published an evaluation of the impacts of its programs on the number of smallholder households reached nor the improvements in their yields and household incomes.¹² Periodic reports simply highlight intermediate objectives — number of new seed varieties released, tons of seed produced in-country by domestic seed companies, number of farmers trained in new agronomic practices and number of crop breeders trained.¹³ This lack of accountability represents a serious oversight for a program that has consumed so much in the way of resources and driven the region's agricultural development policies with its narrative of technology-driven agricultural development.¹⁴

Our research team at Tufts University set out to fill that accountability gap using the best data and information to which we had access. AGRA declined our request to provide data from their own internal monitoring and evaluation of progress. In the absence of more specific data from AGRA, we used national-level data on productivity, poverty and food security as strong indicators of the impacts of Green Revolution policies. AGRA claimed it would double incomes and productivity for 30 million smallholder households, nine million directly and 21 million indirectly. Depending on the estimates used, the total represents a clear majority of smallholder households in AGRA countries.¹⁵ Thus, national-level data seems an appropriate indicator of AGRA's progress.¹⁶

Limited number of beneficiary farmers

From the available data, it is difficult to determine how many farmers are benefiting from AGRA and who those farmers are. AGRA's own reports suggest very limited reach in terms of "direct beneficiaries." Annual country reports refer to farmers "committed," without defining what that means. AGRA's most recent progress report, for the period 2007-16, is indicative of the reporting gap. Most detail focuses on seed varieties developed and commercialized or tons of fertilizer sold. Farmers are listed mainly as benefiting from training in ISFM techniques — Integrated Soil Fertility Management — AGRA's term for its technology package. The report lists "5.3 million farmers with knowledge of ISFM" and "1.86 million farmers using ISFM." But there is no accounting for what technologies they are actually using and what benefit is accruing to those farmers.¹⁷

For a billion-dollar program with the goal of reaching nine million farmers directly and another 21 million indirectly, a report of fewer than two million farmers "using ISFM" is a poor outcome.

Evidence would suggest that the main beneficiaries are likely not the poorest or most food-insecure farmers but rather a growing number of medium-scale farmers who have access to more land and are already integrated into commercial networks. Only a fraction of such farmers come up from the ranks of smallholders; many are new investors in farming from urban elites. One study showed that a tiny fraction of smallholders is likely to become commercial farmers.¹⁸

Limited productivity improvements

Table 1 shows the percentage growth in production, harvested area and yield aggregated for the 13 AGRA countries over a 14-year period. Because three-year averages smooth some of the annual fluctuations common in agriculture due to weather and other variations, we use averages from 2004-6 as a pre-AGRA baseline, compared with the most recent available data, 2016-18 averages, to gauge progress. We treat the period under review as a 12-year span of time from a pre-AGRA baseline in 2006 to one that goes through 2018. We include production, area and yield because all are relevant to any evaluation of agricultural intensification, which is intended to increase production on existing lands by increasing productivity.

Over the 12-year period in which AGRA operated, from 2004-6 to 2016-18, maize production in the 13 countries increased 87%, but that production gain was due more to a 45% increase in area harvested than it was to yield increases, which improved only 29%. We highlight the yield column because that is the metric AGRA and related Green Revolution programs promised to double by 2020. (To be on track to achieve a 100% increase in yield by 2020 the growth through 2018 would need to be 85-90%.)

There is no sign of impressive productivity growth in any major food crops sufficient to meet AGRA's goal of doubling yields. Rice, a staple in only a minority of AGRA countries, showed large production increases, but as with maize this owed less to productivity improvements, which grew only 41%, than to bringing new land into rice production. Overall, cereals production grew 55%, but yields grew just 27%.

TABLE 1: AGRA: LIMITED SIGNS OF GREEN REVOLUTION

% Growth, selected crops, 13 AGRA Countries
2004-6 to 2016-18

	Production (MT/year)	Area (hectares)	Yield (MT/hectare)
Maize	87	45	29
Rice (paddy)	163	87	41
Wheat*	93	28	51
Millet	-24	-5	-21
Sorghum	17	13	3
All Cereals	55	22	27
Cassava	42	51	-6
Roots/tubers (all)	42	51	-7
Pulses (all)	80	19	51
Groundnuts	17	52	-23
Soybean**	58	35	18

Sources: FAOSTAT for 13 Alliance for a Green Revolution in Africa countries: Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Twanda, Tanzania, Uganda, Zambia

*excluding Burkina Faso and Ghana

**excluding Ghana, Mozambique and Niger

Weak productivity growth in maize is stunning given the support the crop has received from AGRA and input subsidies. Several of Africa's top maize producers have shown surprisingly weak productivity improvement:¹⁹

- Nigeria, the largest maize producer among AGRA countries, saw just a 7% increase in yields under AGRA, less than 0.5% per year, compared to 2.5% annual yield growth before AGRA.²⁰ Production increased significantly primarily because of an 81% increase in land planted to maize.
- Kenya, the fourth largest maize producer, saw yields actually decline under AGRA, after posting 1.7% average annual yield growth in the nine-year period before AGRA's arrival.
- Tanzania, the third largest maize producer, also showed tepid yield growth of just 15%, barely more than 1.0% per year.
- Zambia, AGRA's sixth largest maize producer, posted just a 27% increase in maize yields, an annual average of 2%; yield growth before AGRA was much higher, 4.2% per year.

This means that among AGRA's top six maize producers, only Ethiopia and Mali showed significant yield growth that surpassed pre-AGRA yield growth rates. The Green Revolution technology package often just doesn't pay for farmers. The African Center for Biodiversity estimated that in Malawi seeds and fertilizers cost three times the value farmers could gain from the small maize yield increase, assuming the farmer can afford to sell all the added production.²¹ Many can't; their families need to eat. For many smallholders, the Green Revolution package is just too expensive. That is why input subsidies have been critical to achieving what limited adoption has been achieved, but it is striking that even with all those subsidies, yield improvements in maize have been so poor.

Failure to intensify production

These data suggest that Green Revolution programs have not produced a productivity boom through intensification but rather an *extensification* onto new lands. The promotion of extensification is a serious contradiction for Green Revolution proponents. The explicit goal of "sustainable intensification" is to minimize pressure on land and water resources while limiting further greenhouse gas emissions. To the extent Green Revolution programs are encouraging extensification, they are at odds with national and donor government commitments to mitigate climate change. Depending on individual countries' land endowments, extensification can be a serious problem. Rwanda, for example, is densely populated and does not have vast tracts of uncultivated arable land.

Decline or stagnation in nutritious food crops

One of the negative consequences of the Green Revolution focus on maize and other commodity crops is the declining importance of nutritious and climate-resilient crops like millet and sorghum, which have been key components in healthy diets. These are rarely supported by African governments or AGRA; meanwhile, input subsidies and supports for maize and other favored crops provide incentives for farmers to decrease the cultivation of their own crop varieties. As Table 1 shows, millet production fell 24% in the AGRA period, with a 5% drop in area planted and a 21% decline in yields. Sorghum, an ancient grain that is a staple of many African foods, has also languished under the Green Revolution. Production grew just 17% as yields stagnated (3%) and area harvested increased only 13%.

Before AGRA nearly twice as much land was planted in both millet and sorghum than was planted in maize. Now, maize dwarfs both due to the many incentives to produce the crop despite the demonstrated climate-resilience of these crop varieties. In this sense, Green Revolution programs are undermining farmers' ability to adapt to climate change.

Other critical food security crops suffered as well. Cassava, a key staple in Nigeria, Mozambique, Uganda, Tanzania and many other AGRA countries, saw a 6% decline in yields. Overall, roots and tubers, which include nutritious crops such as sweet potatoes, experienced a 7% decline in yields. Groundnuts, another critical staple source of protein in many countries, saw an alarming 23% drop in yields.

Measuring productivity gains comprehensively

To better assess the overall impact of Green Revolution programs on the productivity of staple crops as a whole, not just the favored crops such as maize, we used national-level data to estimate the yield growth during the AGRA years for a basket of important staple crops. We included maize, millet sorghum, and the broad category of "roots and tubers," which includes cassava, sweet potato and other key staples. For countries in which another grain is a key staple (e.g., teff in Ethiopia, rice in Nigeria and Tanzania), we used "cereals, total" with "roots and tubers." We created one index by weighting the yield growth for each crop based on area harvested (in 2017), a good measure of the prevalence of the crop. The resulting "Staple Yield Index" gives a more comprehensive picture of overall productivity growth for a range of key food crops over 12 years of Green Revolution programming.

No country is on track to reach the goal of doubling productivity. Only Ethiopia and Malawi show staple crop yield growth as high as 50% for the AGRA period. Three countries — Burkina Faso, Kenya and Nigeria — show declines in productivity for this basket of staple crops.

Rwanda, which AGRA touts as one of its greatest success stories, registers staple yield growth of just 24%, less than 2% per year. This is because Rwanda's relative success in raising maize yields (+66%) is offset by stagnant yields for sorghum (0%), which before AGRA was a more important staple than maize. Yields also declined for rice. Perhaps most significant, yields for "roots and tubers" increased only 6% over the 12-year AGRA period. The Staple Crop Index shows that Rwanda's apparent success in maize has come at the expense of more comprehensive food crop productivity.

Table 2: AGRA: Productivity & Undernourishment

	% Change 2004/6-2016/18	
	Staple Yields Index	Number Undernourished
AGRA Total	18	31
Burkina Faso	-10	15
Ethiopia	73	-29
Ghana	39	-20
Kenya	-7	43
Malawi	50	-3
Mali	19	-14
Mozambique	30	6
Niger	36	71
Nigeria	-8	181
Rwanda	24	13
Tanzania	22	29
Uganda	0	155
Zambia	20	29

Source: FAO; author's calculation of change in number undernourished between 3 year averages 2004/6-2016/18

Staple Yield Index: weighted yield increases for maize, millet, sorghum roots/tubers. For AGRA total, Ethiopia, Nigeria, and Tanzania - cereals plus roots/tubers

No evidence of doubling incomes or halving food insecurity

AGRA offers little evidence that beneficiary farmers' incomes are increasing, never mind whether they are doubling. There is no comprehensive measure of farmer or rural incomes, and data on rural poverty is spotty from country to country. The best available measure of farmer welfare is U.N. Food and Agriculture Organization (FAO) data on food insecurity. It indicates whether those yield increases are improving the lives of the poor.

Table 2 shows the staple yield index and percentage change in the number of undernourished for AGRA countries. The results are alarming. The total number of undernourished in AGRA's 13 countries has increased from 100.5 million to 131.3 million, a 30% increase, from before AGRA to 2018. Only Ethiopia, Ghana and Mali report a significant decline in the absolute number of chronically hungry residents. Nigeria and Uganda account for a large share of the increase in undernourishment, with the number more than doubling in each country over the 12-year period. Several AGRA countries posted improvements in the share of their populations suffering undernourishment,

indicating progress in reducing the rate if not the number of hungry. But in four countries — Kenya, Niger, Nigeria and Uganda — the share as well as the number increased.²²

AGRA'S BALANCE SHEET

Failure to yield, little benefit for small-scale farmers

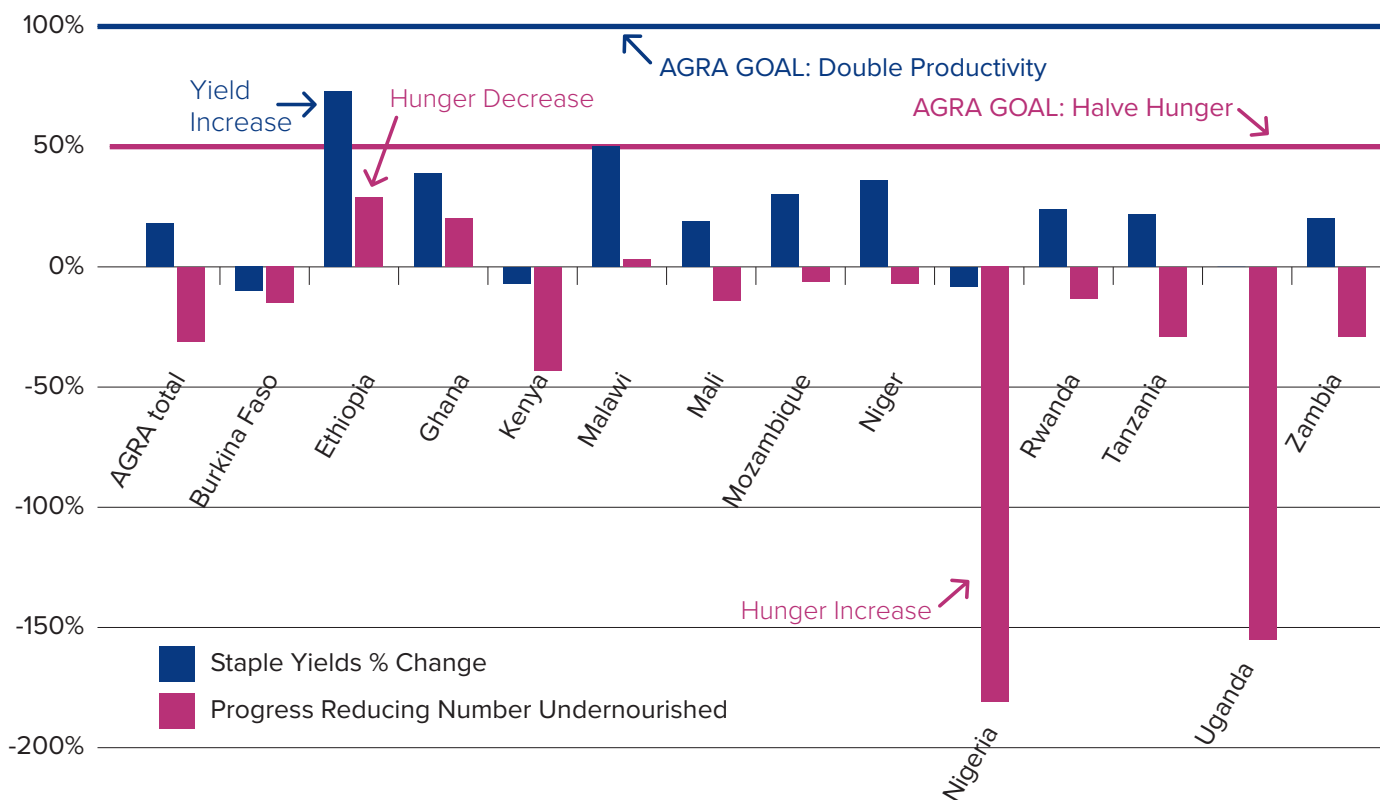
On balance, as AGRA reaches its 2020 deadline for doubling the productivity and incomes of 30 million smallholder farm households while cutting hunger in half, the evidence shows that AGRA and the Green Revolution campaign of which it is a part are failing Africa's smallholder farmers.

Figure 1 shows the two most revealing measures of productivity and welfare. The blue bars represent the Staple Yield Index, with the blue line at 100%, AGRA's goal of doubling productivity. The red bars indicate the progress in reducing the number of undernourished people,

with percentage reductions in undernourishment — improvement — above the x-axis and increases in undernourishment below it. Only one country, Ethiopia, shows anything resembling the combination of yield growth and hunger reduction Green Revolution proponents promised, with a 73% increase in productivity and a 29% decrease in the number of hungry. Note, however, that neither of these is on track to meet AGRA's goal of doubling productivity (100% increase) and halving the number of hungry (which would be a 50% decrease). Ghana is the only other AGRA country that shows decent productivity growth with some decrease in hunger. Malawi achieved relatively strong yield growth but only a small reduction in undernourishment.

For AGRA countries as a group, the picture is grim through 2018: small yield increases for staple crops (+18%) and rising levels of hunger (+30%). Nine of AGRA's 13 countries show rising hunger levels. In Rwanda, a supposed

Figure 1: AGRA: Limited Productivity Growth, Rising Hunger Percent Change 2004/6-2016/18



Source: FAOSTAT crops data; FAO.

Notes: % changes are between 2004-06 3 yr average and 2016-18 3 year average; author's calculation.

Staple Crop Productivity Index: sum of yield increases weighted by relative areas of maize, millet, sorghum, and roots/tubers.

For AGRA total, Ethiopia, Nigeria, and Tanzania index is for cereals plus roots/tubers.

Green Revolution success story, the number of hungry increased 13% on mediocre productivity increases of 24%.

Alternatives to the Green Revolution

Since AGRA's founding in 2006, science and policy have advanced significantly, bringing to light the limitations of the input-intensive Green Revolution model of agricultural development and the viability of alternative approaches. This new literature was summarized and analyzed well in the report, "From Uniformity to Diversity," by the International Panel of Experts on Sustainable Food Systems, founded by former U.N. Special Rapporteur on the Right to Food Olivier De Schutter.²³ As the expert report makes clear, a range of sustainable agricultural practices that move away from chemical-intensive monoculture cropping can grow all the food the world needs to feed a growing population. They warn of "lock-ins" that are preventing the changes called for by a wide range of experts, from the IPCC to the FAO. They identify seven key lock-ins, including "path dependency," the tendency of economic systems to follow prescribed development paths which are then difficult to change.

AGRA seems to be feeding Africa's worrisome trend toward locking in path dependency on input-intensive agriculture, much to the detriment of smallholder farmers. A recent article in the journal *Food Policy* surveyed the results from seven countries with input-subsidy programs and found little evidence of sustained — or sustainable — success. "The empirical record is increasingly clear that improved seed and fertilizer are not sufficient to achieve profitable, productive, and sustainable farming systems in most parts of Africa," wrote the authors in the conclusion.²⁴

The vast majority of smallholders on the continent are not yet heavily reliant on such inputs, nor are they locked into production for value chains that require the large-scale production of uniform commodities. Unlike industrial-scale farmers in developed countries, their path has not yet been determined; there remain opportunities to chart paths different from the high-input agriculture model promoted by AGRA.

Agroecology is one of the systems giving farmers the kinds of innovation they need, farming with nature to promote the soil-building practices that Green Revolution practices often undermine. Building on farmers' knowledge of local conditions and food cultures, multiple food crops are grown in the same field. Compost, manure and biofertilizers — not fossil-fuel-based fertilizer — are

used to nourish fields. Biological pest control decreases pesticide use. Researchers work with farmers to improve the productivity of their seeds rather than replacing them with commercial varieties farmers need to buy every year and douse with fertilizer to make them grow.²⁵ AFSA has documented the effectiveness of agroecology, now widely promoted among its member organizations as a key step toward food sovereignty.²⁶

Such initiatives also achieve productivity increases more impressive than those achieved by Green Revolution programs. One University of Essex study surveyed nearly 300 large ecological agriculture projects across more than 50 poor countries and documented an average 79% increase in productivity with decreasing costs and rising incomes.²⁷ Such results far surpass those of the Green Revolution.

CONCLUSION: TIME TO CHANGE COURSE

Since AGRA's founding, scientists and world leaders have gained growing awareness of the limitations of input-intensive agricultural systems, particularly to mitigate and adapt to climate change. A 2009 interagency report by a large number of scientists showed that industrial agriculture was ill-suited to the climate, soils and needs in developing countries, arguing forcefully that "business as usual is no longer an option."²⁸ The U.N. Intergovernmental Panel on Climate Change in 2019 documented the contributions of industrialized agriculture to climate change, calling for profound changes to both mitigate and help farmers adapt to climate disruptions.²⁹ An expert panel from the FAO published a detailed analysis in 2019 of the contributions ecological agriculture could make to food security and long-term sustainability.³⁰ As former FAO Director General Jose Graziano da Silva had earlier indicated, "We need to promote a transformative change in the way that we produce and consume food. We need to put forward sustainable food systems that offer healthy and nutritious food, and also preserve the environment. Agroecology can offer several contributions to this process."³¹

The Gates Foundation, AGRA and African governments have had 14 years to show results from their Green Revolution for Africa. The evidence indicates it is failing to raise productivity, incomes and food security. In fact, it is taking Africa down a dangerous path toward greater dependence on external inputs and worsening crop and diet diversity. These are the failed policies of the past

failing again now in Africa. It is time for international donors and African governments to change course, to shift their agricultural development funding toward the kinds of low-input sustainable farming that many small-scale farmers in Africa are pioneering under the banner of agroecology. With substantial support, like that provided to Green Revolution programs, agroecology can be Africa's food future.

The study “False Promises: The Alliance for a Green Revolution in Africa (AGRA)” can be downloaded here: www.rosalux.de/en/agra. It is published by: Biba (Kenya), Bread for the World (Germany), FIAN Germany, Forum on the Environment and Development (Germany), INKOTA (Germany), IRPAD (Mali), PELUM Zambia, Rosa Luxemburg Stiftung (Germany and South Africa), Tabio (Tanzania) and TOAM (Tanzania). Timothy A. Wise's working paper, published by Tufts University's Global Development and Environment Institute, is available at: https://sites.tufts.edu/gdae/files/2020/07/20-01_Wise_FailureToYield.pdf

ENDNOTES

1. This policy brief is based on Timothy A. Wise's working paper, “Failing Africa's Farmers,” published by Tufts University's Global Development and Environment Institute, and available at: https://sites.tufts.edu/gdae/files/2020/07/20-01_Wise_FailureToYield.pdf.

The report, “False Promises,” is available at: www.rosalux.de/en/agra. Wise is grateful to Melissa Gordon and Rachel Gilbert for invaluable research assistance on the background paper. The research was funded by Rosa Luxemburg Stiftung.

2. High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, “Investing in Smallholder Agriculture for Food Security,” HLPE Report 6 (Rome, Italy: Committee on World Food Security, June 2013), http://www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-6_Investing_in_smallholder_agriculture.pdf.

3. AGRA web site, “What We Do: Grants,” <https://web.archive.org/web/20190406032154/https://agra.org/grants/>, accessed May 18, 2020. AGRA's stated goals have evolved over time. Recently it has removed this explicit goal statement from its grants web page. Some statements weaken the goals, stating that AGRA will “contribute to” doubling yields and incomes, or reducing them to just “increasing” yields and incomes. Some documents extend their timeline to 2021, though many still refer to the original 2020 deadline.

4. FAO, “The State of Food Security and Nutrition in the World 2020: Transforming Food Systems for Affordable Health Diets,” July 2020, <http://www.fao.org/3/ca9692en/online/ca9692en.html#>.

5. See, for example, the Alliance for Food Sovereignty in Africa (AFSA): <https://afsafira.org/gathering-evidence-for-the-transition-to-agroecology/>

6. Thus far, AGRA has not promoted genetically modified seeds, though nothing in the Green Revolution campaign excludes that possibility in the future.

7. AGRA, “AGRA Annual Progress Report, 2007-2016” (AGRA, March 2017), <https://agra.org/AGRAOld/wp-content/uploads/2017/06/2016-AGRA-Progress-Report-Final.pdf>; AGRA, “AGRA 2017 Annual Report” (Nairobi, Kenya: AGRA, 2018), <https://agra.org/wp-content/uploads/2018/08/AGRA-2017-Annual-Report0708201802.pdf>; Calculated from AGRA reports: AGRA, “AGRA 2018 Annual Report” (Nairobi, Kenya: AGRA, 2019), https://agra.org/ar-2018/wp-content/uploads/2019/07/AGRA-Annual-Report_v18_FINAL_Print-Ready_LR.pdf.

8. Data are from 2010 and 2011 from T.S. Jayne and Shahidur Rashid, “Input Subsidy Programs in Sub-Saharan Africa: A Synthesis of Recent Evidence,” *Agricultural Economics* 44, no. 6 (November 2013): 547–62, <https://doi.org/10.1111/agec.12073>.

9. InterPares, “Coalition Pour La Protection Du Patrimoine Génétique Africain (COPAGEN),” Inter Pares, accessed March 23, 2020, <https://interpares.ca/content/coalition-pour-la-protection-du-patrimoine-g%C3%A9n%C3%A9tique-africain-copagen>.

10. For a good overview, see: Glenn Davis Stone, “Commentary: New Histories of the Indian Green Revolution,” *The Geographical Journal* 185, no. 2 (June 2019): 243–50, <https://doi.org/10.1111/geoj.12297>; Kapil Subramanian, “Revisiting the Green Revolution: Irrigation and Food Production in Twentieth-Century India” (Ph.D., England, University of London, King's College (United Kingdom), 2015), <https://search-proquest-com.ezproxy.library.tufts.edu/docview/1837038837?pq-origsite=primo>.

11. See, for example, the chapter on India's Punjab in Joel K Bourne, *The End of Plenty: The Race to Feed a Crowded World* (W. W. Norton & Company: W. W. Norton & Company, 2015).

12. There are unconfirmed reports that the Gates Foundation conducted or commissioned an internal evaluation of AGRA in 2016. If so, the foundation has not released any information to the public.

13. AGRA, “AGRA Annual Progress Report, 2007-2016.”

14. We could find only partial evaluations of individual programs or interventions, which are detailed in Footnote 13 of the background paper, “Failing Africa's Farmers.”

15. Sarah K. Lowder, Jakob Skoet, and Terri Raney, “The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide,” *World Development* 87 (November 2016): 16–29, <https://doi.org/10.1016/j.worlddev.2015.10.041>.

16. Some African governments carry out household surveys that can offer more useful data. But because not all AGRA countries do such surveys, with consistent time-series data, we only use such data to supplement this analysis.
17. AGRA, “AGRA Annual Progress Report, 2007-2016.”
18. T. S. Jayne et al., “Africa’s Changing Farm Size Distribution Patterns: The Rise of Medium-Scale Farms,” *Agricultural Economics* 47, no. S1 (2016): 197–214, <https://doi.org/10.1111/agec.12308>.
19. Country-level data for all crops is available in the appendix of the background paper, “Failing Africa’s Farmers.”
20. Pre-AGRA period compares three-year periods 1997-99 and 2004-6, calculating compound annual yield growth from FAOSTAT data.
21. “Running to Stand Still: Small-Scale Farmers and the Green Revolution in Malawi” (Melville, South Africa: African Centre for Biodiversity, September 2014), <http://acbio.org.za/wp-content/uploads/2015/02/Malawi-running-to-stand-still.pdf>.
22. The full table of undernourishment and moderate food insecurity for AGRA countries is available in the background paper, “Failing Africa’s Farmers.”
23. IPES-Food, “From Uniformity to Diversity: A Paradigm Shift from Industrial Agriculture to Diversified Agroecological Systems” (International Panel of Experts on Sustainable Food systems, 2016), http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULLL.pdf.
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