The GAP Index™

In 2010, GHI calculated that global agricultural productivity (TFP) must grow by an average rate of at least 1.75 percent annually to nearly double agricultural output *through productivity* by 2050.

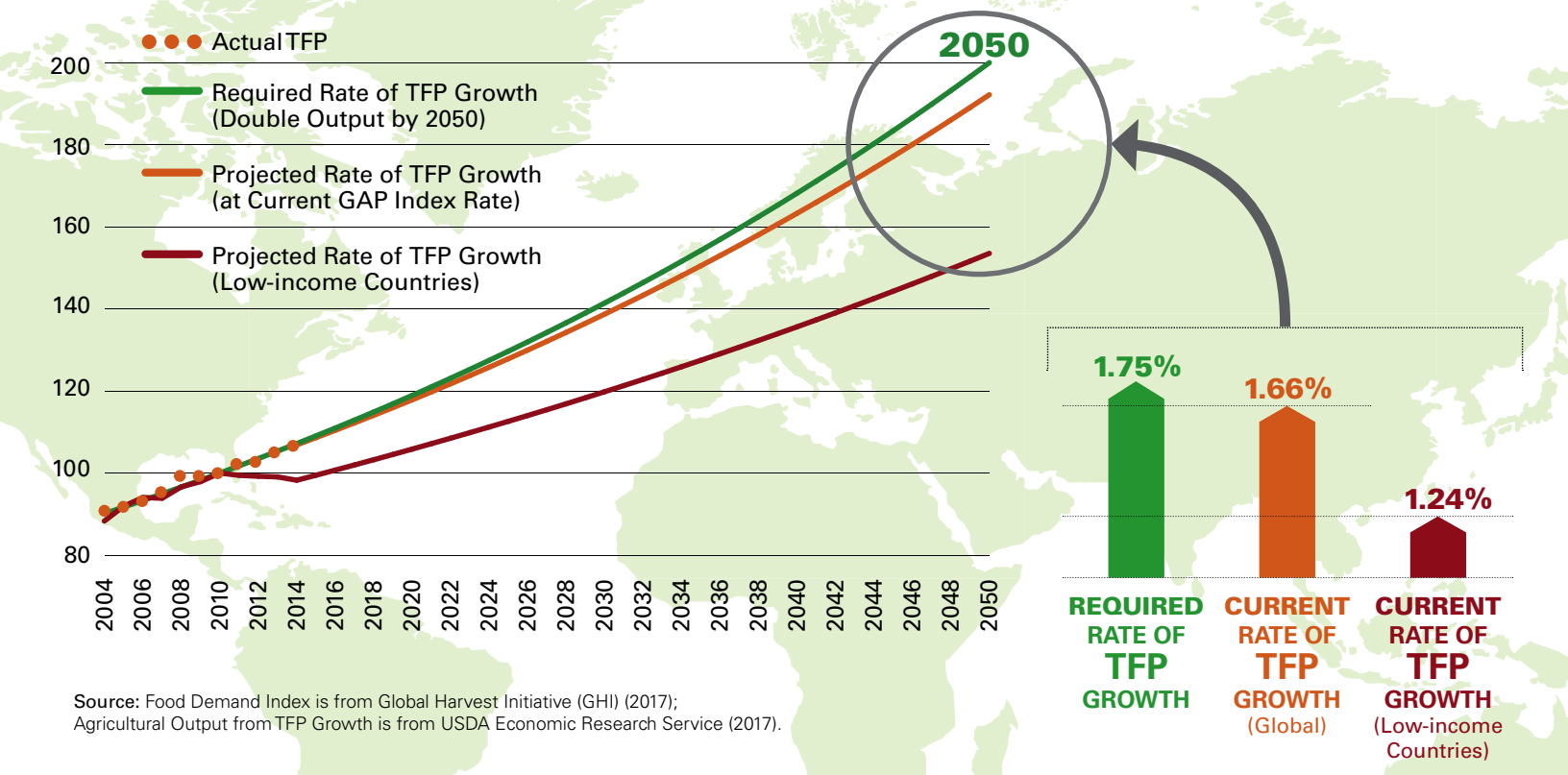
The 2017 GAP Index™ reveals that **for the fourth straight year global TFP growth is not accelerating fast enough** to sustainably double agricultural output by 2050. The U.S. Department of Agriculture's Economic Research Service (USDA ERS) estimates that since 2004, TFP growth globally has been rising by an **average annual rate of only 1.66 percent.**

While the global growth rate is close to the target, the **TFP growth rate in low-income countries continues to decline,** as tracked by the GAP Index™ from 1.5 percent (2015) to 1.31 percent (2016) to 1.24 percent (2017).[11] **This is well below the TFP growth rates needed to achieve the SDG 2 target of doubling productivity for small-scale farmers** in the lowest-income countries by 2030.

If this trend continues, farmers in low-income, food-deficit countries (where population growth is rapidly rising) will use more land and water to increase their output, straining a natural resource base already threatened by extreme weather events and climate change.

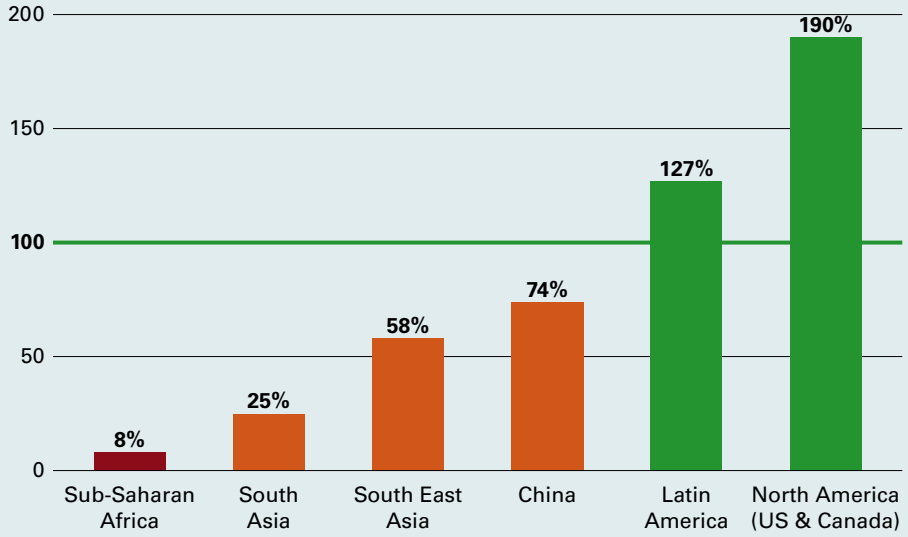
Many low-income countries will need to import food but lack sufficient income to purchase enough to meet the needs of their citizens. Poor urban households will bear the brunt of higher food prices in these countries, but they will also impact low-income rural populations since they are net food buyers. Some of the food demand will not be met and millions of people will be debilitated by hunger and malnutrition.

THE GLOBAL AGRICULTURAL PRODUCTIVITY (GAP) INDEX™



Source: Food Demand Index is from Global Harvest Initiative (GHI) (2017); Agricultural Output from TFP Growth is from USDA Economic Research Service (2017).

Figure 5: Percent of Food Demand Met Through Productivity (TFP) Growth in 2030



Source: Food Demand Index is from Global Harvest Initiative (2017).
Agricultural Output from TFP is from USDA Economic Research Service (2017).

Note on methodology: The projection of agricultural output from TFP growth uses USDA ERS (2017) estimates of average TFP growth during 2004–2014 and assumes this is maintained through 2030. The projected growth in food demand uses UN estimates of population, World Bank estimates of GDP forecasts and PricewaterhouseCoopers LLP (PwC) estimates of GDP growth in PPP, and estimates of the income elasticity of food demand from Tweeten and Thompson (2008). The income elasticity of food demand indicates the share of the growth in per capita income that will be spent on food. Multiplying the income elasticity by the growth rate in per capita income gives the growth rate in per capita food consumption holding food prices fixed. Adding this to the population growth gives the total growth in food demand for a given price level.

REGIONAL TFP GROWTH RATES RAISE CONCERNS

In the 2012 GAP Report®, GHI established a series of regional estimates comparing food demand indexes against projected agricultural output from TFP growth for the period 2000 to 2030. Figure 5 compares the percentage of the estimated food demand for 2030 that can be met with projected TFP growth for six world regions and China.

At current rates of TFP growth, sub-Saharan Africa (SSA) will meet only 8 percent of its food demand through productivity. This is almost 50 percent lower than the 2014 projection of 15 percent, a troublesome trend. Trade plays a key role in closing Africa's food demand gap; 50 percent of its vegetable oils, 35 percent of its poultry meat and 23 percent of its sugar requirements are imported.[12]

Without significant increases in agricultural productivity growth, African countries will not meet their SDG targets for reducing hunger, malnutrition and poverty.

With 60 percent of the world's population and considerable economic diversity, the **Asian regions** (South Asia, South East Asia, East Asia, including China) exhibit varying degrees of capacity to meet food demand through productivity.

China has prioritized agricultural development and food security and has achieved great progress in reducing hunger. Yet with little arable land and growing affluence, China will require more investments in productivity and more trade to meet future demand.

Other Asian countries, such as **India, Indonesia and Vietnam,** could potentially reduce hunger and improve agricultural productivity, but face significant threats from climate change, requiring accelerated investments to keep up with the challenge.

Latin America (LAC) continues to position itself as a rising global breadbasket. At present TFP growth rates, LAC will be able to meet 127 percent of regional food demand through productivity growth, an increase of 11 percentage points since 2014.

The LAC region and particularly the southern cone nations of Argentina, Brazil, Paraguay and Uruguay comprise the world's largest net exporting zone of agriculture products.[13] These countries and others in Latin America have the potential to vastly increase their productivity to sustainably supply food and other agricultural goods to a growing world.

Harmonizing trade rules and improving the trade capacity of low-income countries, coupled with improvements in supply chains and infrastructure, will foster timely and beneficial trade to close food and agriculture demand gaps.

In 2030, **North America** is projected to reliably supply safe, abundant food for the world, producing 190 percent of its own food demand. However, the potential for a new era of trade protectionism has sent a chill through agricultural producers who fear they will lose access to traditional trade partners or fail to access new markets at a time when prices are low and farmers are struggling.

HOW WILL WE MEET FUTURE DEMAND?

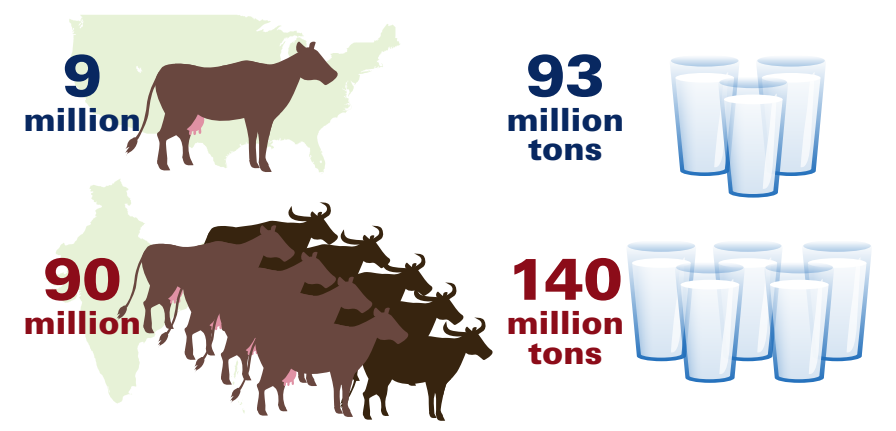
The previous 10 years have witnessed unprecedented demand for agricultural commodities, driven by income increases and population growth in China and India, as well as demand for biofuels stimulated by high energy prices.

Over the next decade, the OECD and the United Nations Food and Agriculture Organization (FAO) project that the rate of demand growth for all agricultural commodities will slow compared with the last decade. The rate of demand growth for cereal grains, meat, fish and vegetable oil will be cut nearly in half, the notable exception being increasing demand for fresh dairy.[15] OECD and FAO attribute the decline in the rate of demand growth to moderating rates of economic growth, particularly in China, and a decline in demand for biofuels.

While the *rate of demand growth* may be slowing (compared to the previous 10 years), the **overall demand for food and agriculture products is still rising,** as is the global population. In fact, **the highest demand growth for many agricultural products is coming from regions with high rates of population growth and low rates of agricultural productivity,** such as sub-Saharan Africa.

These regions are characterized by small farms, with little access to productive inputs. As production increases to meet the growing demand, concerns are rising about the environmental impact these low-productivity systems will have on the natural resource base, along with rising greenhouse gas emissions.

MEETING INDIA'S MILK DEMAND[14]



India has 10 times as many dairy-producing bovines as the U.S., but produces only 50 percent more milk. FAOSTAT (2014).

Over the next decade, India will account for 54 percent of the increase in global demand for fresh dairy products, requiring an additional 56 million tons of milk. India is already the largest dairy producer in the world, but dairy cattle and buffalo productivity is low.

In 2014, India had 50 million dairy cows and 40 million water buffalo, a total of 90 million animals producing 140 million tons of milk. Dairy cattle produce an average of 14,000 hectograms per animal and buffalo produce 19,000 hectograms per animal.

By contrast, the U.S. had just 9.2 million dairy cows and produced more than 93 million tons of milk, an average of 101,000 hectograms per animal.

Given the projected demand in India, improving the health and productivity of the current dairy cow and buffalo populations needs to be prioritized. Indian farmers and consumers are increasingly choosing buffalo over dairy cow milk. Consumers prefer the higher fat content of buffalo milk and it brings a higher return to farmers. Buffalo are more adaptable to the changing climate in India and they convert the low-quality indigenous grasses into milk more efficiently than cattle.

Improving genetics, feed and animal care practices can provide more milk using fewer animals. Increasing access to mechanization for small and medium-scale farmers would reduce reliance on cattle for draught power, allowing investments in milk production.

DOUBLING AGRICULTURAL PRODUCTIVITY IS THE RIGHT GOAL

The projected slowdown in demand for food and agriculture products over the next decade has prompted calls for a reduction in the agricultural output targets for 2050.[16]

Yet a large and growing body of sophisticated modeling by agricultural economists examining long-term scenarios for agriculture, food and the environment indicates that **it may be too soon to consider revising these goals downward.**

POLICIES TO HELP FARMERS BEAT CLIMATE CHANGE

Recent analysis of the climate impact on crop yields has produced sobering results. Each 1° Celsius increase in global mean temperature would result, on average, in a decrease in yields of maize by 7.4 percent, wheat by 6.0 percent, rice by 3.2 percent and soybeans by 3.1 percent.[17] The study's authors argue that **improved crop genetics and effective climate smart agriculture practices are the principal strategies for reducing climate impacts on crop yields.**

The development and widespread adoption of these technologies and practices will not happen without sustained policy leadership and innovation, particularly in low-income, food-deficit countries where productivity (TFP) rates are lowest. Avoiding the worst-case predictions of climate change on crop yields is still possible, but requires an immediate surge of investment in science-based innovation, since research pipelines require time to produce results that reach the field.

Public-sector investments in agricultural R&D support foundational research that the private sector further develops and brings to market, including drought and climate-resilient seeds, improved crop protection technologies, livestock breeds and health products and best practices in fertilizer use and animal care. A predictable, efficient regulatory environment stimulates private-sector R&D, enabling farmers to get the technologies they need, when they need them. Improved transportation infrastructure reduces the cost of agricultural inputs and increases access for small-scale farmers. New approaches to agricultural extension can more rapidly reach farmers with climate-smart agriculture innovations and practices, improving their ability to beat climate change.

The **Agricultural Model Intercomparison and Improvement Project (AgMIP)** is an international collaborative effort to improve agricultural economic models. AgMIP coordinates regional and global assessments of climate impacts and uses multiple scenarios for crop and livestock production across differing geographies to explore the effects of uncertainty, data selection and methodology on the models' results.

AgMIP's analysis of 10 leading global multi-sectoral projection models found that **world agricultural production of crops and livestock between 2005 and 2050 will need to rise by between 60 and 111 percent,** with demand growth particularly strong for ruminant products (cows, sheep) as well as for commodities used in the production of biofuels - sugar, coarse grains and oilseeds.[18] (The OECD/FAO prediction of a decrease in the rate of demand growth for food and agriculture products extends only to 2026, not to 2050.)

Most importantly, AgMIP points to the impact climate change will have on the ability of agriculture to meet future demand. **The 10 models suggest that climate change will generate higher prices for agricultural commodities in general and particularly for crops.** The impact of climate change must be considered to avoid a downward bias in projected supply estimates.

PRODUCTIVITY AND INNOVATION ARE THE KEYS TO THE SDGS

The United Nations Sustainable Development Goal 8 (SDG 8) lays out specific targets for the economic growth required to end poverty and hunger; in the least developed countries, this must reach at least 7 percent annual GDP growth. **The realization of UN SDG 8 will lead to higher demand for agricultural output in developing countries, where there is presently insufficient agriculture and food production.**

Doubling agricultural *productivity* from 2005 to 2050 is the right goal. It is aligned with the SDG 2 target of doubling agricultural productivity and incomes of small-scale farmers and food producers. It also considers the additional demand generated by achieving the SDG 8 target for economic growth. And it provides for the need to increase agricultural output while also conserving natural resources and reducing the climate impacts of agricultural production.

Increasing R&D investments is required to meet the SDGs. These investments enable farmers to produce food more sustainably while conserving natural resources. Without these innovations, farmers, particularly in food-deficit countries, will put more fragile land into production to increase output and will experience greater hunger and poverty.