

Longer Term Investments

Agricultural yield

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- Every day, 200,000 more people need to be fed. By 2050, the global population is projected to hit 9.8bn, so more food will have to be produced from less land per capita.
- The population increase and the rise in the consumption of land-intensive food such as meat mean 70% more food must be produced by 2050 than today.
- We think companies that help boost agricultural yields, though cyclical in the short term, can deliver fairly dependable 1–2% annual volume growth over the longer haul.

The challenge of feeding 200,000 more people every day may appear daunting. Calorie demand per person is continuing to increase, even in countries where food shortages are unknown. And diets are changing as rising incomes lead to greater demand for land-intensive food such as meat while available arable land for food production declines per capita.

The combination of these factors could lead to the fulfillment of Malthusian predictions. Thomas Robert Malthus theorized at the end of the 18th century that (exponential) population growth and (linear) food production increases would lead to disease, starvation, and war.

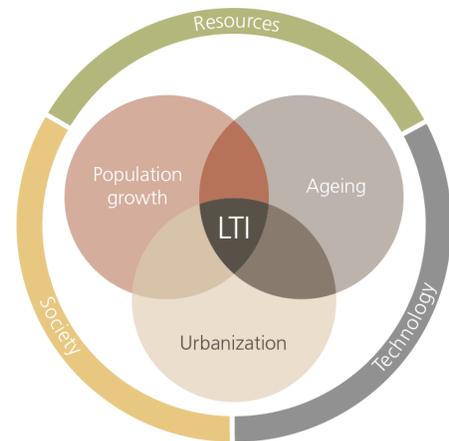
However, agriculture has come a long way from subsistence farming of the past to today's satellite-navigated field automation that plants "stacked traits" seeds. And productivity has multiplied along the way. The UN's World Food Programme (WFP) statistics show that the number of undernourished people worldwide has remained broadly flat since 1969, although the global population has almost doubled since then.

Today's most advanced agricultural production leaders can increase already-high yields. And applying already-known and tested methods in developing markets can help feed the world.

We think companies that help boost agricultural yields, though cyclical in the short term, can dependably increase sales along trend-growth rates over the long term. Profits should rise at least in line with subsector trend growth, with variations in profit margins as more benefit to farmers gives more pricing power, better margins, and hence higher profitability.

Introduction to the Longer Term Investments (LTI) series

- **The Longer Term Investments (LTI)** series contains thematic investment ideas based on long term structural developments.
- Secular trends such as population growth, ageing, and increased urbanization create a variety of longer term investment opportunities.
- These investment opportunities are influenced by the interplay of technological advancement, resource scarcity, and the societal changes.
- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.



More people eating more food

The UN estimates the current world population to be 7.5 billion. If we assume that fertility rates continue to decline and adopt the UN median scenario, world population will reach 9.8 billion by 2050, an increase of 30% (see Fig. 1).

The populations and incomes of developing countries are growing faster than those of developed countries. But calorie consumption is rising even in higher-income countries where food shortages are unknown (see Fig. 2).

Higher-quality foods and more meat increase the pressure

Higher incomes lead to the consumption of more resource-intensive food. Urbanized living allows consumers to source a wider variety of foodstuffs than traditional subsistence farming does. Meat, in particular, remains an aspirational food for many people, but its consumption is increasing.

China has already become the world's largest producer of pork; beef consumption there is also growing quickly. While pork is less popular in other countries, partly for religious reasons, the consumption growth of all meats is high. According to the estimates of the UN's Food and Agriculture Organization (FAO), meat production will nearly double by 2050. (See the Longer-Term Investments theme on protein consumption for more details.)

Higher meat consumption means higher wheat, soy, and corn consumption as more cattle, pigs, and chicken have to be fed. The production of higher-protein foods requires more basic resources and land, increasing the pressure to raise productivity (see Fig. 3).

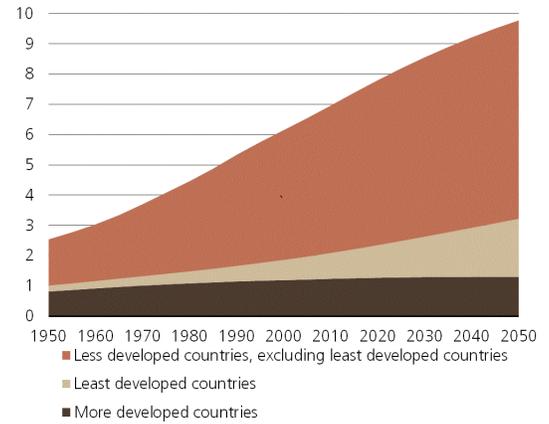
Arable land under threat, but not a one-way street

Arable land available for cultivating crops is under threat from population growth, urbanization, and the expansion of living and working spaces. This threat is exacerbated by erosion and desertification, which turn arable land into wasteland.

However, some of these losses are reversible. First, forests can be turned into productive fields, a controversial but ongoing practice. Second, single factors that limit productivity can be overcome. For nutrients, this is described by Liebig's law of the minimum (see Box 1). Removing a specific bottleneck leads to improvement. For example, areas with insufficient freshwater can benefit from irrigation, an unsuitable climate from recultivation and poor soil from fertilizers.

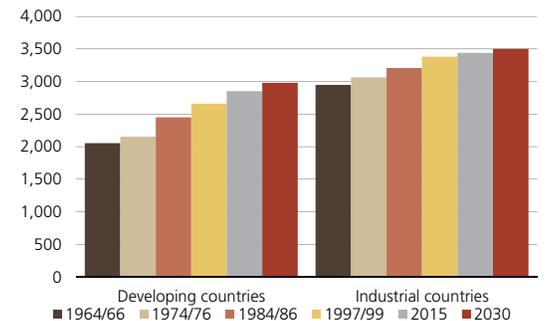
Furthermore, bridging the gap in capital availability can help productivity and hence increase arable land availability. Land-grabbing, which refers to the buying of large pieces of land by domestic and transnational corporations and governments, is a contentious issue. It can lead to the local populace being deprived of access to land. Still, it is an economically efficient way of bringing the resources of money and knowledge to bear on labor and land. Its execution determines its benefits for locals and foreigners.

Fig. 1: Population is continuing to grow
Number of people (in billions)



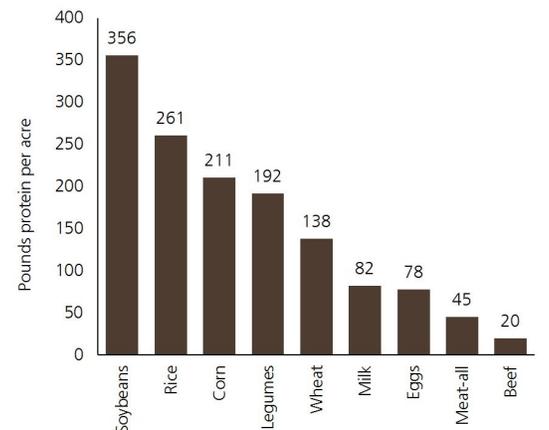
Source: United Nations, Department of Economic and Social Affairs, Population Division (2017), medium variant

Fig. 2: People are consuming more
Calories per capita per day



Note: Numbers include food waste. Source: UN Food and Agriculture Organization, as of November 2017

Fig. 3: Land-use efficiency is low for meat
Pounds of protein per acre



Source: UN Food and Agriculture Organization

These remedial measures should increase the amount of arable land, but, due to population growth, available land per capita will likely continue to fall (see Fig. 4). The only region in which agricultural land per person could rise is Latin America, where primary forest is being turned into arable land. But low-yielding pastures used for grazing could also be converted to higher-yielding uses. And techniques like double cropping, i.e., growing two crops on the same land per year, would increase yields further and open up more agricultural export potential for the region.

Increasing arable land and managing existing farmland more efficiently would require the use of engineered tools.

Spotlight on food security

The UN's WFP seeks to eradicate hunger and malnutrition. It does so through policy actions and direct food assistance. WFP statistics show that the number of people affected by undernourishment (as the WFP defines it) has remained in a fairly narrow band since 1969 at between 920mn and 780mn people. This is a disturbingly high number. The tragedy is only slightly relieved by the fact that the percentage share of the undernourished worldwide is clearly declining. But the question remains: How can we increase food security for everyone?

The issue is beyond the scope of this paper, but we think increasing productivity, reducing food waste, and improving distribution and knowledge can help alleviate the problem of food security. If more food is available, the vulnerable should get more of it as well. Applying techniques developed on a large scale to subsistence farmers on a small scale raises productivity and reduces losses. This is the laudable goal of numerous nonprofit development initiatives. But profit-driven initiatives are also helpful, for example, developing and consolidating (specialty) products from smaller farms and improving logistics to increase small farmers' trade volumes and thus their incomes.

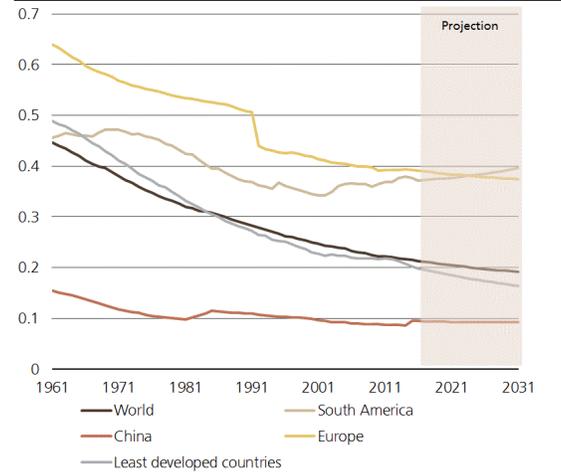
We believe market-driven forces that help people help themselves are among the strongest sustainable ways to maximize food security for all.

Food prices are driven by more than commodity prices

The world's least developed countries suffer the greatest impact from rising commodity prices as most of their food is bought unprocessed by the final consumer living close to the farm. Sometimes the food does not even leave the farm, as in the case of subsistence farmers. Here, the potential to improve their lot involves increasing field productivity and reducing losses due to inefficient food product allocation.

Meanwhile, in the most developed countries, for many food products, soft commodities only account for a single-digit percentage of the price on the supermarket shelf. Somewhere between 70% and 75% of consumer pricing is related to labor cost. This highlights both how little agricultural commodity prices affect OECD inflation and how large the opportunity for efficiency gains is in the value chain.

Fig. 4: Less agricultural land per person
Hectares per capita for selected regions



Source: UN Food and Agriculture Organization, OECD, UBS projections, as of December 2018

Box 1: Liebig's law of the minimum

Liebig's law of the minimum states that agricultural yields are constrained by the most limiting plant nutrient, whatever that may be. By removing this limitation, yields will rise until the next factor becomes the constraint.

Justus Liebig was a German professor of chemistry in the 19th century who discovered that, contrary to the notion that "organic" matter is essential to plant growth, mineral elements from the soil, carbon dioxide from the air and water are key. In addition to inventing a meat extract and other early food innovations, he is regarded as an early innovator in raising agricultural yields by applying fertilizers.

The biggest challenge, in our view, exists in the less developed countries, where food accounts for around 30% of the consumer price basket and where consumers with rising incomes change their consumption patterns the most. This challenge turns into an opportunity for increased efficiency and reduced waste by applying engineered tools (see "Steps for increasing agricultural yields" below).

Higher agricultural prices not a prerequisite for higher yields

At least in the short term, the earnings of companies involved in the agribusiness value chain are linked to farmer income, economic incentives to increase production, and consumers' price sensitivity to nutrition. Still, we think there is only a loose connection to soft commodity prices in the longer term, as the benefits from efficiency gains are more important.

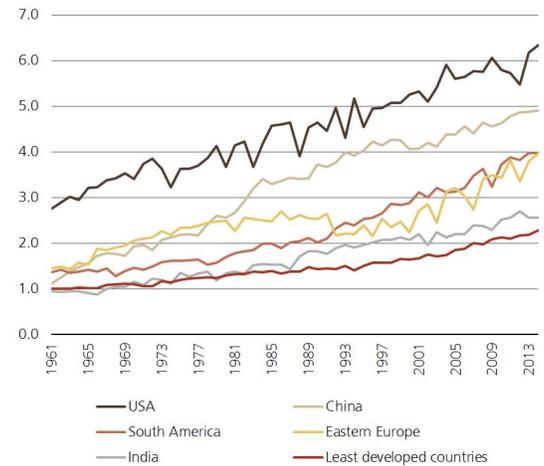
If, for example, a poor harvest temporarily restricts supply, agricultural prices can react swiftly, by rising. Higher prices can temporarily suspend additional demand for better quality foods, while the basic demand curve remains the same. This means that rising agricultural demand trends can indeed reverse temporarily. However, as global demand grows and the "natural" supply – produced without enhanced efficiency measures – stagnates, long-term "natural" food prices climb.

Efficiency gains, however, reverse this trend and lead to lower prices for agricultural products. Long-term observations reveal falling real prices and a declining share of spending on food. Nevertheless, investments in agriculture productivity gains require only rising income per unit of land, that is, higher prices and/or higher output volumes, to be successful. Indeed, agricultural yields do increase (see Fig. 5).

Steps for raising agricultural yields

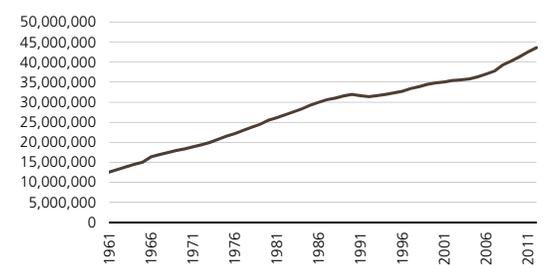
Mechanization is the first step to raising output per input, i.e., increasing efficiency. This means using less human labor or replacing the animal-drawn plow with a more powerful machine. However, it also means substituting capital for labor, which requires a framework for attracting capital. One benefit of mechanization is speed: even small windows of favorable weather can be used to efficiently till, plant, and harvest. Today, one tractor is used for every 32 hectares harvested compared to every 75ha in 1961, i.e., an increase of 2% a year (see Fig. 6).

Fig. 5: Agricultural productivity is rising
Yield in metric tons per hectare (average of corn, rice, wheat, soybean equally weighted)



Source: UN Food and Agriculture Organization, UBS, as of December 2017

Fig. 6: Mechanization is a first step
Number of 40-CV tractor-equivalent machinery units in use



Source: United States Department of Agriculture, UN Food and Agriculture Organization, as of 2018 (no longer updated)

Next, a proper understanding and optimal implementation of Liebig's law (see Box 1) is needed. This includes directing water supply by means of irrigation. Today, the area equipped for irrigation is 3.2mn square kilometers globally, more than the landmass of India. The share of area equipped for irrigation has risen from 12% in 1961 to 22% today (see Fig. 7). Increasingly, irrigation is moving from traditional field flooding to sprinklers and less wasteful drip irrigation.

Another way to raise yields is to increase the supply of nutrients. The use of fertilizers globally has reached 185mn tons per year, or 24.7 kilograms per capita (see Fig. 8). Almost 50% of fertilizers are used for cereals (wheat, corn, rice), which are staples in the standard diet and increasingly also used as animal feed.

The goalposts can be moved as well by adapting the product to production location with seed technology. This entails both traditional and "accelerated natural selection" instead of open pollination or genetic modification to make plants more resistant to temperature variability, droughts, pests, diseases, and agrochemicals. Water and nutrient utilization can also be optimized.

Reducing other plant-growth limiting factors by applying fungicides, herbicides, and insecticides are other methods of increasing yields that have proved successful, even if toxicity was not always considered sufficiently in the past. More targeted application, the use of beneficial organisms, better field planning, better weather prediction, and the adoption of plants with resistant traits are ways to reduce the negative impact on the environment and on people.

Spotlight on precision agriculture

In addition to raising yields through proven methods and procedures, the next revolution is underway in the form of precision agriculture. This term refers to optimizing uses of inputs and applying additional insights and predictive techniques using big data and artificial intelligence. It includes field management, soil sampling by satellite or on the ground, localized weather forecasting, "plant by plant" application of the right fertilizer at the right rate and the right time, seed density, and crop rotation planning.

Link to sustainable investing

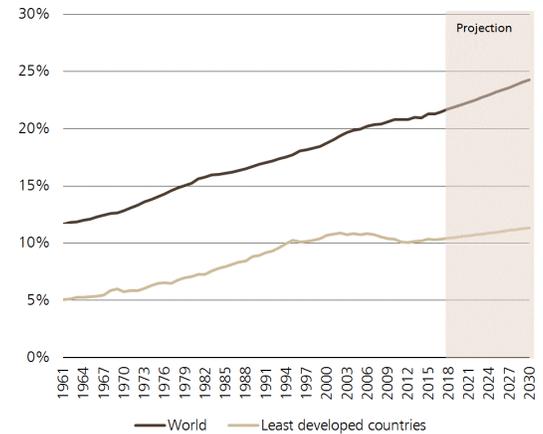
In the context of agricultural yield, the challenge is to make sure the world's population is fed, stamping out hunger and related deaths. At the same time, agricultural resources such as soil must be preserved and protected so that they remain suitable for future food production.

This is highlighted by two dilemmas. First, is it all right to convert primary forests into agricultural land and thus make the acreage directly more productive for mankind? Second, is genetically modified food acceptable if it increases productivity?

Each investor has to strike his or her own balance on these issues. We show all productivity options and leave it to the investor to decide when incorporating the individual sustainable investing.

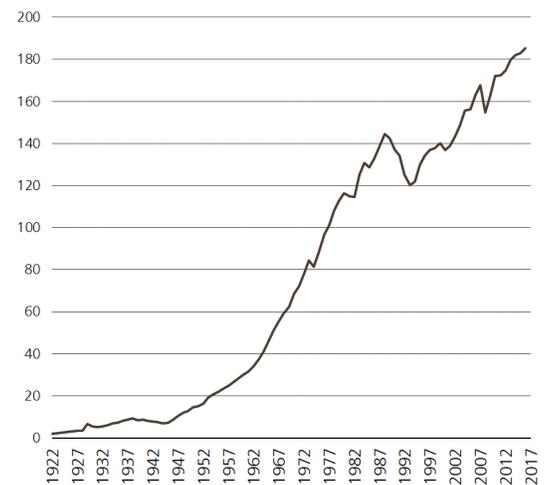
With fertilizer production seen as less acceptable from a "fundamental" sustainability angle, we still think that the theme is aligned with the idea of sustainably nurturing humankind. This also takes

Fig. 7: Irrigation continues to increase
Area equipped for irrigation, in % of arable land



Source: UN Food and Agriculture Organization, OECD, UBS projections, as of December 2018

Fig. 8: Fertilizers are boosting food production
Use of nutrients, in million tons



Note: The apparent reduction of demand in the early nineties is attributable to the collapse of the Soviet Union. Source: International Fertilizer Industry Association, as of December 2018

into account the sustainable development definition of the 1987 UN Brundtland Commission: "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs".

Link to impact investing and the UN Sustainable Development Goals (UN SDGs)

This section has been provided by James Gifford, Head Impact Investing; Andrew Lee, Head Sustainable and Impact Investing US; and Nicole Neghaiwi, Impact Investing Analyst.

About one billion people worldwide – nearly one-seventh of the global population – are affected by severe hunger and malnutrition. Three-quarters of the world's poor live in rural areas, where they depend on small plots of land for their food and income. Improving agricultural yields in emerging and developing countries holds enormous potential to drive improvements in human development and economic growth.

There are many reasons to be optimistic about the role that improved agricultural yields can play in achieving the SDGs:

- Agricultural growth in low-income and agrarian economies is at least twice as effective as growth in other sectors in reducing hunger and poverty and are thus directly linked to SDGs (1) No Poverty and (2) Zero Hunger, according to the 2008 World Bank Agriculture for Development Policy Brief. This is particularly the case when smallholder farmers are directly included in the growth process.
- Cereal yields in sub-Saharan Africa (with mostly least developed countries) average only 1.2 tons per hectare, compared with 5.5 tons per hectare for the European Union. Advances in technology, including efficient irrigation techniques, drought resistant seeds, and organic fertilizers, could drastically increase agricultural yields in developing countries, thus helping to reduce this productivity gap.
- As more and more people in rural communities gain access to mobile phones, apps that are enabling smallholder farmers to connect with international markets could help to alleviate poverty in rural communities, reduce food waste and realize economies of scale. Similar approaches may also be used to facilitate knowledge transfer.
- Agribusinesses that adapt sustainable farming practices will be able to grow more with less land, water, fertilizer and other costly inputs. In an era of increasingly scarce resources and more severe weather fluctuations due to climate change, investments that support sustainable agribusiness should help to ensure more resilient, long-term growth while preserving natural resources for generations to come.

Despite these opportunities, investors must also consider the potential SDG-related risks of investments in this theme. Several SDGs are concerned with protecting biodiversity and the environment, but these are presented separately from the food security goal. As agriculture accounts for roughly 70% of global water withdrawals and nearly one-third of greenhouse gas emissions, investors in this sector must ensure that increasing agricultural yields does not come at the expense of other SDGs. It is also important to note that success in agriculture does not always reduce poverty. In countries where agricultural growth is concentrated in large, export-oriented firms, growth could in fact lead to adverse affects for local populations, including land conflict, increased food insecurity and exploitative labor practices. These risks are particularly acute for women, who make up the majority of agricultural labor in developing countries but own significantly less land. Directly including women and smallholder farmers in the growth process can help mitigate these risks and ensure a more equitable distribution of benefits.

By managing these risks and understanding the value of sustainable agribusiness, investors in this theme can achieve both significant environmental and social impacts and attractive financial returns. Dedicated but smaller scale impact investing solutions exist for investors looking to invest in this theme, primarily in private equity, fixed income and venture capital funds. In addition, investors may access this theme through generalist private equity and venture funds or via direct investments. When investing using non-impact-specific vehicles, impact investors must assess on their own whether individual investments meet impact criteria including intent, measurability, verification and additionality. In addition, investors should be aware of any potential unintended consequences associated with their investment (see Box 2 for more information on the Jevons paradox).

Conclusion

The demand for more and higher-quality food calls for the ingenuity of mankind to overcome the risks of bottlenecks for this basic need.

Developing markets will likely deploy a different tool-set compared to developed markets to meet and benefit from rising food demand. Today's most advanced production leaders can increase yields. Meanwhile, applying known and proven methods in less developed markets can help feed the world.

We think companies that help boost agricultural yields, though cyclical in the shorter term, can dependably increase sales along trend-growth rates in the long term. Profits should rise at least in line with subsector trend growth, with variations in profit margins as more benefit to farmers gives more pricing power, better margins, and hence higher profitability.

Companies making purely commoditized products such as standard fertilizers will largely depend on controlling costs to boost their margins. A seed company with protected intellectual property, on the other hand, can ask for a share of the greater profits from the farmer and grow at an above-trend rate.

Box 2: Jevons paradox (rebound effect)

The Jevons paradox occurs when technological progress increases the efficiency with which a resource is used but – as opposed to conserving resources – leads to an increase in the rate of consumption. For example, efforts to curb deforestation in palm oil production by increasing land-use efficiency may in fact lead to more deforestation as higher yields create incentives for palm oil producers to expand into new territories.

Risks

Climate and soil conditions, access to capital, and infrastructure are key differentiators between regions that result in competitive advantages when producing specific agricultural goods. Optimal global productivity and cost efficiency would be achieved by focusing on comparative advantages and then exchanging goods.

Exogenous shocks that lead to a shortage in an agricultural good may raise the risk of protectionist policies, export bans, or warehousing and hoarding, which in turn lower local and overall efficiency.

Companies that help boost agricultural yields can be affected by price swings of agricultural goods in the short term (see section titled "Higher agricultural prices not a prerequisite for higher yields"). Agricultural policy changes can reduce farmer incomes and their willingness to invest. Regulations regarding patent protection of the elements that raise agricultural yields can have a disruptive and lasting impact.

Appendix

Terms and Abbreviations

| Term / Abbreviation | Description / Definition | Term / Abbreviation | Description / Definition |
|---------------------|--|---------------------|--------------------------------|
| A | actual i.e. 2010A | COM | Common shares |
| E | expected i.e. 2011E | Shares o/s | Shares outstanding |
| UP | Underperform: The stock is expected to underperform the sector benchmark | CIO | UBS WM Chief Investment Office |

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