

Longer Term Investments

Agricultural yield

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- Every day 200,000 more people need to be fed. By 2050, a global population of 9.7bn people is projected, so more food will have to be produced from less land per capita.
- The population increase and the increased consumption of land-intensive food such as meat will require 70% more food to be produced than today.
- We think companies that help boost agricultural yields, though cyclical in the short term, can deliver fairly dependable 1-2% trend volume growth over the longer haul.

The challenge of feeding 200,000 people every single day looks daunting. Calorie demand per person continues 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. The British reverend theorized at the end of the 18th century that (exponential) population growth and (linear) food production rises would lead to disease, starvation and war.

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

Still, even today's most advanced production leaders can increase yields. And applying already known and tested methods in less developed and least developed markets can help to feed the world.

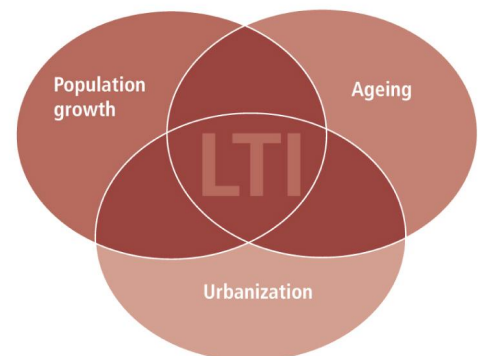
We think companies that help boost agricultural yields, while cyclical in the shorter term, can dependably increase sales along trend-growth rates long term. Profits should develop at least in line with sub-sector trend growth, with variations arising according to how much additional benefit a company brings to farmers and captures in its margin as part of the efficiency gain that this rise in yields represents.



Source: Quanjing.com

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.
- ▶ 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 current world population at 7.5 billion. If we assume that fertility rates continue to decline and adopt the UN median scenario, world population will reach 9.7 billion by 2050, an increase of 29% (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 and more resource intensive food. Urbanized living enables consumers to source a wider variety of foodstuffs than traditional subsistence farming does. Meat, in particular, remains an aspirational food for many people, but consumption of it 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. Therefore, according to the estimates of the UN's Food and Agriculture Organization (FAO), meat production will nearly double by 2050, from around 280m tons annually today to 470m.

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).

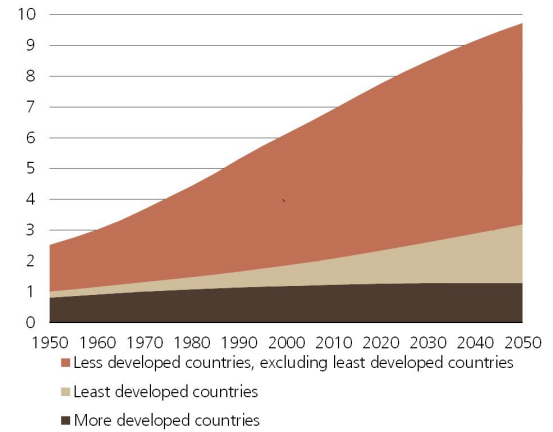
Arable land under threat, but not a one-way street

Arable land potentially available for cultivating crops is under threat by 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: Liebig's law of the minimum"). Removing a specific bottleneck leads to improvement. For example, insufficient fresh water, an unsuitable climate and poor soil can be improved by irrigation, re-cultivation and fertilizers, respectively.

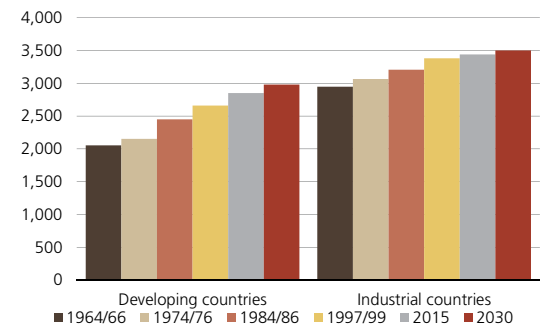
Furthermore, bridging the gap in capital availability can help productivity too and hence increase arable land availability. "Land-grabbing," which refers to governments and corporations buying up farmland in other countries, is a contentious issue. It can lead to the local popul-

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



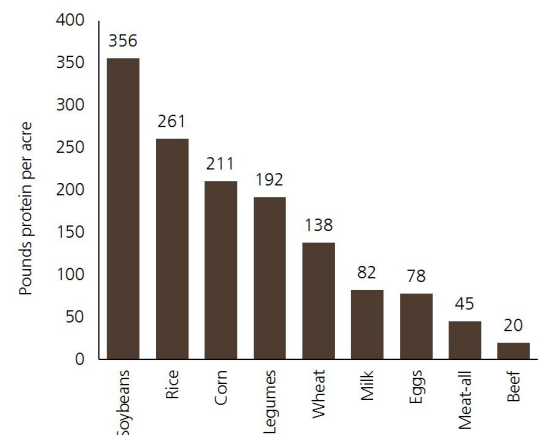
Source: United Nations Population Division (median prediction interval), as of July 2015

Fig. 2: People consume more
Calories per capita per day



Source: Food and Agriculture Organization of the United Nations, numbers include food waste, as of January 2016

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



Source: Food and Agriculture Organization of the United Nations

lace being deprived of access to land, which is sometimes described as neo-colonialism. However, it is also an economically efficient way of bringing the resources of money and knowledge to bear on labor and land. The execution of it determines its benefits for locals and foreigners.

These remedial measures should increase the amount of arable land, but, due to population growth, available land per capita will continue to fall (see Fig. 4). The only region in which agricultural land per person could rise is Latin America, where primary forest has been 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 use of "engineered tools."

A spotlight on food security

The UN's World Food Programme (WFP) seeks to eradicate hunger and malnutrition. It does so through policy actions and direct food assistance. WFP statistics illustrate that the number of people affected by undernourishment (as the WFP defines it) has remained fairly constant since 1969 at between 920m and 780m people. This is a disturbing number, the tragedy of which is only slightly relieved by the fact that the percentage of the undernourished worldwide is clearly declining. The question remains: How can we increase food security for everyone?

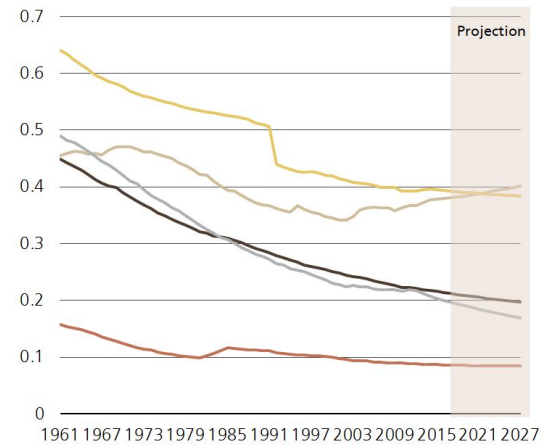
Clearly, the issue lies beyond the scope of this paper, but we think that increasing productivity, reducing food waste and improving distribution and knowledge can help to alleviate the problem of food security. If more food is available, the vulnerable should get more of it as well. Applying techniques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

In our view, market-driven forces that help people to help themselves are the strongest sustainable ways to maximize food security for all.

Food prices are driven by more than commodity prices

The least developed countries suffer the greatest impact from rising commodity prices, as most of their food is bought unprocessed by the final consumer 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.

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



Source: Food and Agriculture Organization of the United Nations, Organisation for Economic Co-operation and Development, UBS projections as of February 2017

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 found 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.

Meanwhile, in the most developed countries, the soft commodity input price for many food products is only a single-digit percentage component 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. 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 most. This challenge turns into an opportunity for increased efficiency and reduced waste by applying "engineered tools." (see section "Steps for increasing agricultural yields")

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 bad crop temporarily restricts supply, agricultural prices can react swiftly, rising and remaining volatile for a while. 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.

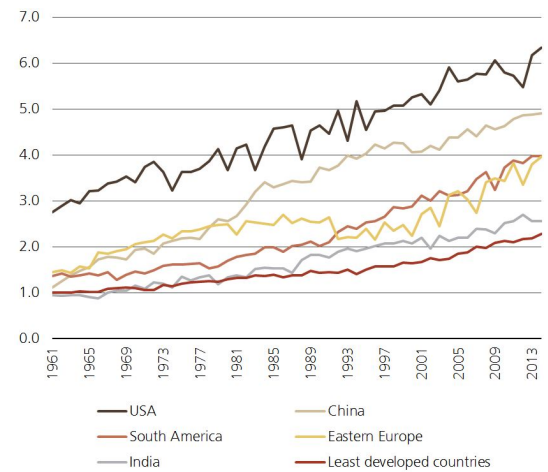
Efficiency gains, however, reverse this trend and lead to lower prices for agricultural products. Long-term observations reveal falling real prices and a declining share of spending on food. Nevertheless, investments in agriculture productivity gains require only rising income per unit of land, that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

Steps for increasing agricultural yields

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

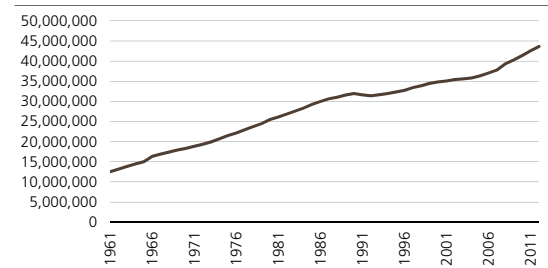
Next, a full understanding and optimal implementation of Liebig's law (see Box: Liebig's law of the minimum) are required. This includes directing water supply by means of irrigation. Today, the area equipped for irrigation is 3.2m square kilometers globally, more than

Fig. 5: Agricultural productivity increases
Yield in metric tons per hectare (average of Corn, Rice, Wheat, Soybean equally weighted)



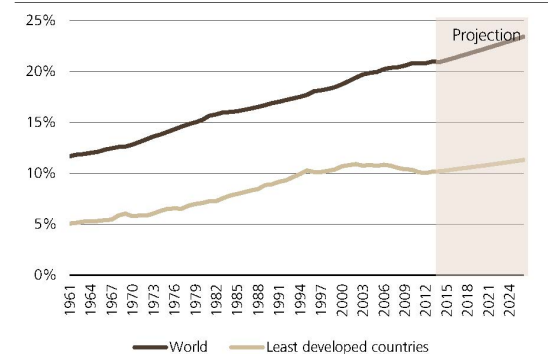
Source: Food and Agriculture Organization of the United Nations, UBS as of February 2017

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



Source: United States Department of Agriculture, Food and Agriculture Organization of the United Nations, as of 2016

Fig. 7: Irrigation with more potential
Area equipped for irrigation in % of arable land



Source: Food and Agriculture Organization of the United Nations, Organisation for Economic Co-operation and Development, UBS projections as of December 2015

the landmass of India. The share of area equipped for irrigation has risen from 12% in 1961 to 21% today (see Fig. 7). Increasingly irrigation is moving from traditional field flooding to sprinklers and less wasteful drip irrigation.

An additional way to raise yields is to increase the supply of nutrients. A step-change came by applying fertilizers, whose use has reached 183m tons per year, or 24.4 kilograms per capital globally (see Fig. 8). Almost 50% of fertilizers are used for cereals (wheat, corn, rice), staples in the standard diet and increasingly used as animal feed.

Meanwhile, the goal posts 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, using beneficial organisms, better field planning and weather prediction, and adopting plants with resistant traits are ways to avoid having a large negative impact on the environment - and on people.

A spotlight on precision agriculture

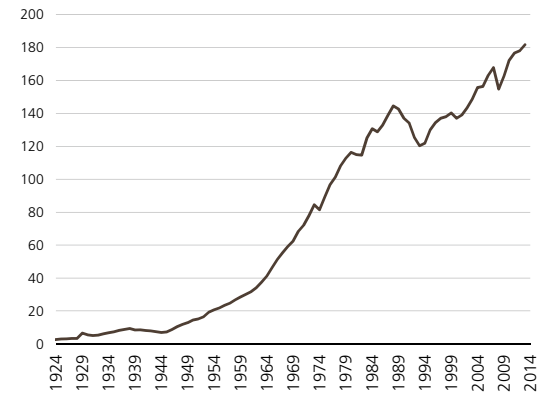
In addition to raising yields through proven methods and procedures, the next revolution is underway in the form of precision agriculture. This generic term refers to optimizing uses of inputs and applying additional insights and predictive techniques utilizing big data and artificial intelligence. It 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

To identify whether a Longer Term Investment (LTI) theme qualifies as sustainable investment (SI) theme, we follow a two-step process. The first works top down. LTIs are assessed according to whether they match one or more of the sustainability topics within the environmental, social or governance (ESG) categories (see Fig. 9). In general, these themes must contribute to environmental sustainability (e.g. a low-carbon economy), resource efficiency (e.g. energy, water), a sustainable society (e.g. health, education, poverty reduction, equality and social inclusion, etc.) or sustainable corporate governance.

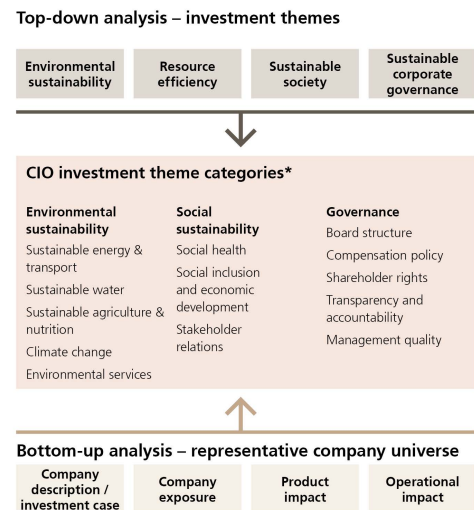
In the context of agricultural yield, the challenge is to make sure the world population is fed, stamping out hunger and related deaths; thereby, however, agricultural resources such as soil must be preserved and protected so that they remain suitable for future food production.

Fig. 8: Fertilizers boost food production
Use of nutrients in million tons



Remark: the apparent reduction of demand in the early nineties is attributable to the collapse of the Soviet Union
Source: International Fertilizer Industry Association (IFA), as of December 2015

Fig. 9: Overview of LTI topic clusters



* For simplicity, all topic clusters include several subcategories not included in the graph. For example: sustainable water includes water utilities, treatment, desalination, infrastructure & technology, water efficiency and ballast-water treatment. Within each subcategory are further specifications; e.g. water treatment includes filtration, purification and waste treatment. In total, we have more than 100 categories (potential sustainable investment themes) in our thematic database.

Source: UBS

This is highlighted by two exemplified dilemmas: a) is it OK to convert primary forest into agricultural land and hence make the acreage directly more productive for mankind? and b) is genetically modified food acceptable if it increases productivity?

For the questions above, each investor has to strike his or her own balance. We show all productivity options and leave the inclusion or exclusion process when incorporating the individual sustainable investing to the investor.

The second, bottom-up step consists in considering a thematically aligned representative universe of companies, 80% or more of which must align with one or more of the ESG categories. For each company, a minimum business involvement threshold is applied, e.g. 25% of revenues must derive from the thematic activity under consideration.

Link to impact investing and the United Nation Sustainable development goals (UN SDGS)

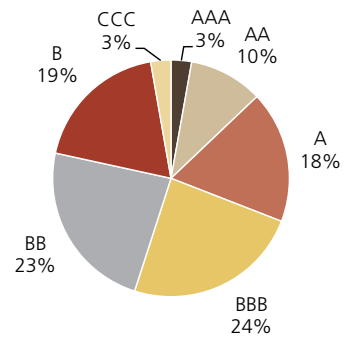
The section "Link to impact investing and the UN SDGS) has been provided by Andrew Lee, Head Impact Investing and Private Markets; James Gifford, Senior Impact Investing Strategist and Nicole Neghaiwi, Impact Investing Analyst.

Approximately 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 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

Fig. 10: Entire MSCI ESG Research corporate coverage
Rating distribution in %, 5720 companies



Note: AAA = best possible ESG rating; CCC = worst
Source MSCI ESG Research, UBS, as of 24 February 2017

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 percent 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 and least-developed markets will likely deploy a different toolset than developed markets to meet and benefit from rising food demand. Even today's most advanced production leaders can increase yields. Meanwhile, applying known and proven methods in less developed and least developed markets can help feed the world.

Box 2: Jevons paradox

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. Investors should carefully consider potential unintended consequences before investing in this theme.

We think companies that help boost agricultural yields, while cyclical in the shorter term, can dependably increase sales along trend-growth rates long term. Profits should develop at least in line with sub-sector trend growth, with variations arising according to how much additional benefit a company brings to farmers and captures in its margin as part of the efficiency gain that this rise in yields represents.

Companies making purely commoditized products such as standard fertilizers will largely depend on controlling costs to boost their margins. A seeds 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.

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 this comparative advantage and then exchanging goods.

Exogenous shocks that lead to an already perceived shortage of an agricultural good raises the risk of protectionist policies, export bans or warehousing and hoarding, which in turn lowers local and overall efficiency.

Companies that help boost agricultural yields can be affected by price swings of agricultural goods in the shorter term (see chapter "Higher agricultural prices not a prerequisite for higher yields"). Agricultural policy changes can reduce farmer incomes and their willingness to invest. Regulation of the use of or decisions about the 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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