

To Feed Ten Billion, Crop Yields Have to Rise

Future food systems depend heavily on agricultural intensification by smallholders

Marco Ferroni

Executive Director, Syngenta Foundation
for Sustainable Agriculture, Basel, Switzerland

Key messages

- > The predicted surge in demand for food, feed and fiber over the next 30 years poses huge production challenges. This is particularly true in developing countries.
- > Sub-Saharan Africa cannot rely much on food trade and needs to invest in agriculture. However, governments often lack the will to do this, and foreign investment is not always managed in the countries' best interests.
- > Better farm inputs would help farmers harvest more food; improved storage and transport would keep more of the produce in a suitable condition for consumers.
- > Greater agricultural intensification is essential – and possible. However, further intensification has to be achieved sustainably.
- > Intensification requires the use of more and better farm inputs, but also improves the efficiency of their use. The scope for improvement is huge.
- > Plant breeding and genetic gain offer the main hope for much-needed step-changes in productivity.
- > As well as improving crop varieties, the management of crops also needs to improve. In smallholder settings, this means the adoption of better technology and better practices by millions of farmers.

- > New technology initially costs more than old versions. Buying seed is more expensive upfront than saving it from the previous harvest. However, the returns on investment – both in terms of food production and farmer income – can be high.

The world's population reached seven billion in 2011 and could reach almost ten billion by 2050.¹ Over 98% of this growth will occur in less developed regions, primarily in Africa and Asia. Most of the food production there depends on smallholder farmers.

Globally, calorie demand will increase even faster than population. As people's income grows, so does their demand for higher value food such as meat and dairy products. Satisfying the rising meat demand will require more animal feed, particularly corn and soybean. Producing one kilo of meat requires much more than one kilo of feed, so demand for these cereals will rise even faster than if *per capita* meat demand remained stable.

The production challenges for developing countries

The predicted surge in demand for food, feed and fiber over the next 30 years poses huge production challenges. This is particularly true in developing countries. Their populations are worse hit by food price inflation than populations in industrialized nations. Large nations such as India and China, with heavy demand relative to world markets, will need to continue producing much of their own grain. High import dependency in any country is not a practical option anyway, because world markets for staple commodities are thin. The food crisis of 2007–08 revealed the dangers of depending too heavily on trade rather than fostering domestic supply.

For several reasons, Sub-Saharan Africa cannot rely much on food trade. Infrastructure there is generally poor, incomes are low, and many countries lack both foreign currency and sea ports. In addition, increased imports – including food aid – can displace farm income.² With rapid demand growth and a large



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part of the population engaged in farming, Sub-Saharan Africa needs to invest in agriculture. However, governments often lack the will to do so, and foreign investment is not always managed in the countries' best interests. Smallholders remain faced with a huge production task, but without many of the tools and services available to commercial growers elsewhere.

Some commentators play down the difficulties, for example by pointing to current low commodity prices. The FAO food price index³ in 2015 was below that of the previous six years, and in early 2016 was markedly lower than 12 months before. But this is deceptive. Production is increasingly hampered by natural resource depletion and degradation, and will be further impeded by climate change. Improvements in cereal yields are already lagging behind the likely rate of demand growth. Few countries can significantly increase suitable farmland without encroaching on valuable habitats. Overall, there is little slack in the world's food systems. Without additional intensification and therefore crop yield growth, new price increases are only a matter of time.

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“Greater agricultural intensification is essential – and possible”

Demand- vs. Supply-side management

Addressing this situation on the Demand side would be difficult: Dietary restrictions or extreme measures of population control may be undesirable or politically unfeasible. More could be done to reduce food waste; biofuel production targets could also be lowered. However, much of the focus needs to remain on the

Supply side. Better farm inputs would help farmers harvest more food; improved storage and transport would keep more of the produce in suitable condition for consumers.

Greater agricultural intensification is essential – and possible. However, further intensification has to be achieved sustainably. This does not only mean that more needs to be produced from less. It also requires a reduction in the negative environmental impacts of agriculture, and the maximization of its benefits for the countryside and biodiversity.

Building natural capital

Farming carries an environmental cost, which must be kept as low as possible. Land-clearing reduces biodiversity and increases carbon emissions. Wasteful use of farm chemicals and other unsuitable agronomic practices can cause further harm. Nitrous oxide linked to fertilization, carbon dioxide from fossil fuels, and methane from cattle or irrigated rice all raise greenhouse gas levels. Intensification based on modern management and crop varieties is the only way to mitigate these effects and feed a hungry world sustainably. Raising crop yields reduces the need to open up new land for farming.

Intensification requires the use of more and better farm inputs, but also improves the efficiency of their use. The scope for improvement is huge. There are many ways to reduce water use, for example. These include measures as varied as breeding water-efficient crops or building precision irrigation systems. Targeted pest management is as safe as possible for the environment, farmers and consumers. Breeding crops that are more resistant to pests and disease helps reduce the use of chemical treatments. Soil-testing, tailored agronomic recommendations and the availability of suitably applied fertilizers all contribute to field fertility. Crop diversity is desirable, and possible in many settings. In others, however, monocultures will continue to enable the most efficient production of food. Organic farming provides welcome business openings for some farmers. It is labor-intensive, however, which prevents smallholders from additionally pursuing other activities. Organic agriculture's low yields also waste farmland. Globally, it is not a sustainable answer to food security challenges.⁴

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Farm management can enhance or degrade ecosystems. As the largest land and water user, agriculture depends on, and generates, a wide variety of environmental processes. Paying farmers to adopt positive practices will encourage them to ensure sustain-

able, resource-efficient production. These “ecosystem services” could, for example, address landscape value additions, watershed protection, biodiversity conservation and carbon sequestration. Such services build natural capital and can open up new sources of income, not least for smallholders.

Improving crop yields

One core element of intensification is the improvement of crop yields, as indicated above. Changes in yield are largely a function of genetic gain and crop management, which interact with each other. “Genetic gain” is the increase in plant performance attained through breeding. In sophisticated agricultural settings, it is responsible for the bulk of yield growth: 70–75% in US corn, for example, according to one long-term study.⁵ In less advanced agriculture, management plays a proportionately greater role in yield increases. But plant breeding and genetic gain offer the main hope for much-needed step-changes in productivity. Expert assessment suggests that 50–60% of grain yield growth in developing and emerging markets by 2030 will come from improved varieties.⁶ To achieve this, plant breeders will use conventional and, to a lesser extent, marker-assisted methods. Genetic modification will play only a small role, as many countries forbid its use.

Improving crop management

As well as improving crop varieties, the management of crops also needs to improve. In smallholder settings, this means the adoption of better technology and better practices by millions of farmers. There are four main drivers of this process:

- > In the first place, smallholders need products and solutions



Training in the field plays a key role in improving smallholders' yields

which are relevant to their situation and which offer attractive returns at low financial risk.

- > The second driver group is composed of “enablers.” These include training, loans and weather insurance.
- > A third crucial factor for improved management is delivery: ensuring that new products do not stay in laboratories, but actually reach smallholders. Hand-outs are not the answer here: researchers need to link up with commercial partners who establish organized and sustainable markets.
- > Fourth, markets also play a vital role on the output side. For smallholder farming to be sustainable, and to offer the rural young an attractive alternative to urban migration, farmers must be able to earn good incomes from their produce.

“Lack of seed access is the single most important reason for Africa’s low crop yields”

When small farmers benefit from these four drivers, they can be efficient producers and careful stewards of natural resources. Sadly, this is often not the case. Good infrastructure, wise policies, public and private investment and public-private cooperation are all needed to overcome the market and institutional failures that often prevent smallholders’ success. An example of market failure is the limited access of many smallholders to certified, healthy, modern seeds. In Sub-Saharan Africa alone, critically important crops such as sorghum, potatoes, beans and cassava grow on more than 29 million hectares and support



Future global food security depends heavily on smallholders' access to modern technology

Case study: Seeds2B

Together with partners, the Syngenta Foundation runs a program known as Seeds2B. It is designed to strengthen seed systems through technology transfer and capacity building for local seed production. Seeds2B currently runs in Sub-Saharan Africa and parts of Asia. The operating models, called Connect and Build, increase the choice of seed. They help smallholders raise their income and improve food security.

Seeds2B “Connect” facilitates the introduction of quality seeds to local businesses. It links a wide range of public and private breeders with seed producers and distributors. Services include trialing, selection and registration. This approach is particularly suitable for technology transfer where demand is initially unproven, and for niche markets or vegetables. The focus is on low-volume, high-value products. “Build” helps establish local production of licensed varieties. This approach is particularly relevant for bulky and perishable seeds, where local demand is significant but transport expensive. It builds the market through investment coupled with technical and regulatory improvements, and helps link breeders with local producers. Potatoes are an example of a crop whose yields can benefit hugely from the “Build” model.

over 100 million smallholders. Yet only a tenth of the seed used there is of certified quality. Business models are often lacking, and markets are uncertain. Lack of seed access is the single most important reason for the region’s yield gap. Market entry for small and medium-sized companies therefore needs to be made much easier.

Creating a virtuous circle

Clearly, new technology initially costs more than old versions. Buying seed is more expensive upfront than saving it from the previous harvest. However, the returns on investment – both in terms of food production and farmer income – can be high. The requirement, therefore, is for smart ways which can lower the entrepreneurship threshold – in other words, to make it easier for smallholders to invest in their harvests. Government subsidies may help kick-start a change, but are not a sustainable option. Making credit and/or insurance affordable and accessible is a better way to encourage investment, year after year. Well-designed insurance products not only help shift the burden of risk from smallholders’ shoulders. By acting as security, they can also open the door to loans. With the initial barriers to investment reduced, smallholders can wait much more confidently for the increased yield and income brought by better seed. Be-

fore, they were caught in a poverty trap caused by very understandable reluctance to invest their limited cash months before a harvest can be sold. Now a virtuous circle can begin instead.

Conclusion

The world’s population will continue to grow over the coming decades. With increasing wealth in many countries, calorie demand will rise even faster. Reducing harvest losses and food waste will help close the production gap to a degree. However, the main contributor to future food security will be the sustainable intensification of agriculture, with resulting increases in crop yields. Smallholders have a crucial role to play in farming worldwide. To grow more and better food, they need improved access to technology and training, to credit and insurance, and to markets in which they can earn good incomes.

Abridged and adapted from an article by Marco Ferroni and Yuan Zhou submitted to the November 2015 Emerging Markets Forum in Tokyo, and included in a recently published book.

Correspondence: *Marco Ferroni, Executive Director, Syngenta Foundation for Sustainable Agriculture, Schwarzwaldallee 215, 4058 Basel, Switzerland*
Email: *syngenta.foundation@syngenta.com*

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