Achieving Food Security for All
The Role of Science, the Business Sector, and Public Policy

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It is a pleasure to be here today to speak at this forum, the York Biology Open Lecture Series. My topic is agriculture, the world’s food and the elimination of hunger. My presentation, therefore, is about food security, which refers to the availability of food and one’s access to it.

Food insecurity is rampant in some parts of the world, more so in rural areas than in urban ones. Food insecurity and hunger (whether of the seasonal or the more permanent kind) occur where people are poor. Poverty, in turn, correlates quite closely with backwardness in agriculture as evidenced by yield gaps in key crops. Sub-Saharan Africa and South Asia are the key vulnerable geographies in this respect. One thing they have in common is that agriculture is the predominant sector in terms of employment and livelihood, even though its share of the national product has been falling.

If agriculture is the main employer and many people are poor, the productivity of agriculture as measured by the returns on the main factors of production, in particular labor and land, must be low. This is indeed the case, as available statistics (such as those published by the Food and Agriculture Organization of the United Nations) show. The challenge and task is to raise those partial productivities, as well as total factor productivity in farming – the sum of the partial productivities augmented by the gains from improved organization and ‘smarts’.

Yield gaps – the difference between realized productivity and what could be achieved with the best genetic material, technologies and management – must be progressively closed. This is necessary both from a farm income and food supply perspective. And it is necessary because of environmental considerations and the need to conserve natural resources. Agriculture, including in particular smallholder farming in the developing countries and ‘emerging markets’, must be modernised and intensified, sustainably, to stop the encroachment of the plough into forests, protect biodiversity, conserve water and use it sustainably, provide for the adaptation of farming to climate change, and enable agriculture to contribute towards the mitigation of climate change.

On the matter of water, it is instructive to note that the negative correlation between yields per unit of land and the amount of water needed to produce a kg of crop is very high – around -.9 for key field crops. Closing per-hectare yield gaps, therefore, is good news on the water front, too.

Water and land are inseparable in agriculture. Dedicated water measures (urgently needed in semi-arid regions) comprise a range of interventions. They include plant breeding for drought and salinity tolerance, the development of chemical solutions to enhance crop vigour (crop enhancement chemistry), and agronomic, engineering and management efforts such as rainwater harvesting, conservation agriculture, moisture pattern-dependent crop and varietal choice, methods of cultivation such as aerobic rice that grows without flooding, precision agriculture, drip irrigation, canal lining, improved drainage, water recycling, and so on. A further (politically charged) class of measures is scarcity pricing where appropriate water charges are levied (and, in locations like India, the electricity or diesel that powers the pumps would stop being subsidized or offered for free) to rationalize water use and encourage conservation.

1 For information about the Syngenta Foundation, please visit www.syngentafoundation.org. Laura Johnson is thanked for her help in preparing this lecture.
How to close yield gaps – and in the process align water usage with what is available replenishably without mining fossil water or having agriculture compromise the growing water needs of urban areas and industrialization? That is what I propose to discuss in this presentation, starting with an explanation of why we must focus on small farmers.

Aren’t small farmers a lost cause, resource-poor as many of them are and with the limited prospects they seemingly have? The short answer is that for demographic and structural economic reasons there is no choice but to focus on small farmers for a period of perhaps 30 years or so. There are about 450 million small farms (up to 2 hectares) in non-OECD countries today. Assuming an average household size of five, about one-third of humanity depends on small-scale farming for at least part of its livelihood.

Economic development will over time lead to a significant decline in agricultural employment relative to the total. Many small farmers or their children will move out of agriculture at that stage, and land (or production) consolidation will occur. As a process, this is massively underway in China today. It is occurring in India at a (so far) lesser rate and has started in Africa. But the ‘reshaping of economic geography’ and economic diversification away from primary production is only possible with productivity growth in the four functions of agriculture: food, feed, fibre, and fuel/bioenergy. That productivity growth has to be mediated by farmers, and the only farmers there are in Asia and much of Africa are small farmers, most of them (in Asia) operating on a lot less than 2 hectares per farm. So there is no way around small farmers for the time being. They produce most of the food that is consumed today in developing and ‘emerging’ countries outside Latin America.

Smallness is not an economic condemnation, at least not when it comes to production. Small farms can be viable, and many that are not could be with the help of technology and other support. A voluminous literature in agricultural economics attests to the inverse relationship between farm size and land productivity in labour-abundant developing countries across most conceivable conditions. Small farmers (many of whom are women, with men tending to migrate to off-farm jobs) are hard-working and dedicated, managing family labour well. Small farms produce more per hectare per year than large farms. Yet their average productivity could be increased massively with the right stimuli, which in all cases revolve around the trilogy of technology, services and access to markets. China’s record (where farms are tiny and there has been and continues to be substantial investment in agriculture and rural areas) suggests what is possible on the productivity front with small farms: China’s average grain yield is twice India’s today and four times Africa’s.

What do I mean by ‘technology, services, and access to markets’?

*Technology* is all about R&D-based inputs and practices: improved seed with relevant traits, soil tests, fertilizer, chemicals, cell phones, machinery, tools, practices such as integrated pest management and measures to preserve water, as discussed earlier, and take care of soils (low-tillage farming comes to mind).

*Services* include agricultural extension, mobile applications enabled by the spread of cell phones, financial services such as credit or crop and livestock insurance, infrastructure, and institutions such as farmer organizations that represent farmers’ interests and act as conduits for services. In a broad sense, ‘services’ may be said to include what economists call the incentive environment that farmers face. Incentives are shaped by agricultural policies and investment, the level of protection or disputation of agriculture, trade policies, and the ways in which fiscal, monetary and exchange rate policies affect the real exchange rate, a very important issue for agriculture.

*Access to markets* is what the term implies: farmers need access to markets to be able to intensify their own operation and sell the surplus they produce as a result. It is easy to see the point regarding market access: Intensification is about making better use of locally available resources in the context of improved cultural practices and putting purchased inputs and services to work in line with farmers’ financial and managerial capacity to absorb those means. External inputs cannot be procured without the ability to make money from sales.
Remunerative and predictable links to markets for farm products can be challenging to establish where infrastructure is poor. In this context, smallness can be a problem because the many consignments of minor quantities that small farmers offer for sale imply high transaction costs, which can make the buyers want to turn to large growers. The answer lies in cooperative or, at any rate, organized marketing, and arrangements such as contract farming. Making this work for smallholders in the context of organized value chains is a frontier in the quest for improved production and livelihoods, and is every bit as challenging as closing yield gaps. In fact, the two problems of closing yield gaps and linking farmers to markets interact and are linked; neither is possible without the other.

A circumstance that bodes well in this context is this: Despite occasional gluts in the market, both domestic markets in dynamic economies and export markets can absorb a lot more than is typically produced at prevailing farm yields, particularly when it comes to high-income elasticity products such as fruits, vegetables, meats, dairy products, honey, nuts and the like. Talk with food processors in Africa (including breweries, which procure grain as opposed to ‘high-value’ products) and you will hear time and again complaints about the difficulty of ‘developing the producer’ and sourcing enough raw material and produce. ‘Developing the producer’ is about closing yield gaps, linking farmers to markets, and instilling a business culture where contracts are respected and the concept that you need to invest to make money is accepted by all.

Let me dig into the topic of ‘developing the producer’ some more before turning to the other main topic that I want to cover, namely the role of the public sector, the business sector, and partnerships – both between the two and with others such as Foundations and NGOs, to develop the technologies that small farmers need, the input markets through which the technologies would be disseminated, and the output markets through which produce would be sold. My theory with respect to these markets is that they don’t come about spontaneously in the settings of reference but require ‘kickstarts’ and catalytic action that flows from partnerships between public and private – and private non-profit and for-profit – actors.

Developing the producer is about doing the right thing at the different levels of farm capability that one is likely to encounter in the field. Needs for technology and the capacity to absorb external inputs productively vary with the ‘capability’ of farms. Exhibit 1 suggests a way of thinking about agricultural intensification from ‘enhanced basics’ at the cash- and endowment-strapped bottom to successively more professional levels of inputs and technology as capability expands. It is an additive progression: basic elements of technology need to be present at each successive step.

At the low end of the spectrum, improved agronomy (and thus competent extension services), seeds (typically of the farmer-saved kind), and basic soil nutrients are the priority. At higher levels, there is scope for additions to the basics that farmers can afford if there are links to markets. These additions include hybrids, possibly transgenic traits and stacks, modern crop protection, crop enhancement chemistry, and advanced agronomy and management. Return on investment is the farmer’s decision paradigm: she or he will buy inputs if there is the prospect of realizing a return.

As Exhibit 2 shows, the ‘natural’ supporting actors in this model differ depending on the point in the progression. Not-for-profit actors (Foundations, the public sector, NGOs specialized in agriculture) are vital players at the lower end. For-profit companies and their distributors selling fertilizer, seed, tractors, implements and so on can be expected to come in as capability expands. This can create movement to the right in both pictures or vertically as a result of good agricultural extension or in response to relevant technologies that achieve uptake almost by themselves, as in the case of Bt cotton in some countries (India, for example). Again, farmers, even very modest ones, will buy inputs if they detect an opportunity to realize returns.

Now, how are technologies and solutions developed and how do they get to farmers, in particular to ‘resource-poor’ small farmers in the developing and ‘emerging’ world that are the focus of this presentation? Why, furthermore, is it seemingly so fashionable for people to talk about public-private partnerships in this context?
The answer to the latter question is that neither governments (in most countries) nor the market can by themselves be relied upon to develop and disseminate solutions for the millions of small farmers who desire to improve the way they farm. Capability and incentive limitations stand in the way. Public programs in agricultural R&D have been successful in important respects, but are notoriously ineffective when it comes to actually delivering products such as improved varieties of seed all the way to farmers. It is in the nature of the private sector to bring products to the markets and deliver value, including to small farmers. But the private sector goes where there is a commercial incentive. Farmers too remote or too poor to purchase inputs are not helped, and the technologies they need may not get developed. Hence the relevance of partnerships and cooperation that offer the prospect of overcoming each sector’s limitations: the business sector’s inability to operate where there is no market and the public sector’s limited ability to market research outputs. A confluence of contributions is required.

At the Syngenta Foundation, we are engaged in brokering R&D partnerships in agriculture, as well as partnerships to develop input and output markets that serve farmers. In R&D we are working on innovation commons, where private companies with advanced crop science capability, universities, and national or international agricultural research institutes join forces to develop solutions, including new traits and crop varieties, of interest to small farmers in poor countries.

In these partnerships, intellectual property is shared among the members of the commons, pre-breeding information is made publicly available (at least that’s the aspiration), and there is freedom for partners to use jointly developed knowledge and resources to develop products for their own markets.

As an example, our Foundation brokered a partnership last year between CIMMYT and Syngenta Corporation’s wheat R&D group to develop wheat rust Ug99 technology focusing on identifying, characterizing and mapping QTLs to stem rust, identifying markers for use in marker assisted trait selection, characterizing the known gene complexes, and determining how these interact with other important genes in wheat. Pre-breeding information is being made available to breeders elsewhere, but breeding products are proprietary. This example and others we are working on is only the beginning of an intended programmatic thrust in this direction. Being who we are, a non-profit, public purpose entity with close links to the private sector, qualifies us uniquely as brokers of public-private partnerships in R&D.

The Syngenta Foundation is also active in the area of linking farmers to input and output markets. We are supporting up-and-coming seed companies in Africa and outgrower systems, for example, with a view to accelerating the process of making quality seed available to farmers. Three recurring aspects need attention: business advisory services to seed companies (the seed business is anything but simple, and the rate of attrition of seed companies rivals that of new restaurants in cities such as York), lines of credit for seed companies and
other forms of finance, and, critically, the harmonization of seed laws and regulations among countries. This is needed because national seed markets are small in small countries, and thus for the seed industry to be able to grow, companies must have the ability to trade across borders.

An area of innovation dear to our hearts at the Syngenta Foundation is agricultural insurance, in particular weather index-based insurance against drought and other disastrous weather phenomena such as excess rain prior to harvest that can destroy entire crops. In partnership with the Kenyan UAP Insurance Company we have developed an insurance product that is now offered commercially and has been bought by some 12,000 farmers during the main cropping season of 2010. The product insures farmers’ expenditure on eligible purchased inputs (seed, fertilizer and certain crop protection products). Farmers get their money back if they lose their crop as a result of insured weather events if and when they occur. You may need to think about this for a moment to realize how transformational this is: insurance is what’s needed to enable farmers to invest; investment (such as in the form of procuring inputs), in turn, is what’s needed to intensify production and put yourself on an improved footing in terms of a range of desirable outcomes, starting with income and food security. There is no intensification of agriculture without investment.

Finally, output markets. Food markets and marketing are modernizing at a very rapid rate in most developing countries. Supermarkets are springing up everywhere and processed food is becoming ever more present in response to the growing demand that accompanies urbanization and the spread of new lifestyles. This is an opportunity for farmers, but (as mentioned) farmers must be organized in order to have the ability to deal with buyers on reasonably equitable terms. Our Foundation is engaged in a number of contract farming and outgrower schemes where buyers aggregating produce for processors and retailers offer predictable outlets and pricing conditions.

What you may conclude from all of this is that markets and the business sector are fundamental to the task of ‘developing the producer’. And so is science fundamental for many reasons that don’t need to be explained in the particular venue of your Biology Department. What does need mentioning, perhaps, is that for markets and the business sector to be able to function, there needs to be a business climate that’s ‘conducive’, in other words supportive public goods, governance, stability and social peace, infrastructure, and enabling policies and regulation. This is the public sector’s part of the deal, making it easy to see why the public sector and public policy are fundamental, too.

To come to my final point, something else is fundamental also, namely, might I suggest, farming first as an attitude. Public opinion should come to recognize the importance of agriculture and – particularly in the rich countries where this is a big issue – be open-minded about science and technology. Smallholder strategies, ‘developing the producer’, water management, food security, and sustainability in agriculture are not possible without a strong science base, sensible public policies and a private sector intent on creating value for farmers and consumers alike. Farmers know what they want: technology, services and access to markets, as discussed. The rest of us are locked in debate over the false choice of the ‘technological’ versus the ‘environmental’ approach. The two sides in this debate must come together. Science- and evidence-based argumentation and decision-making are what’s called for – probably not something that needs to be stressed in this venue, but an issue and challenge that you can help shape and address. There is room for bringing together many ideas from diverse approaches to agriculture with an emphasis on systems analysis and a view to optimizing the use of resources as farmers adapt to the challenges that lie ahead.

Thank you.