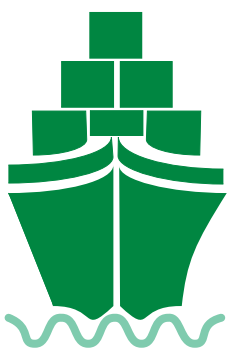
14

THE SEVENFOLD PATH TO INNOVATION

Enabling factors for new agricultural genetics in African countries

KEY THEMES

- Seven enabling factors.
- Assessing innovation readiness.
- The role of government.
- The needs of smallholder farmers.



Africa's agricultural exports currently total some US$ 55 billion, but the continent suffers from a negative balance in food trade, importing more than it exports.

Creating suitable conditions for innovation

If the crops of new genetics are to succeed in Africa they have to exist in an agricultural landscape capable of embracing innovation. It is not simply a matter of having access to desirable technologies or improved seeds.

An analysis of the potential applications of genetically modified (GM) crops, present and future (Box 14.1), shows how much these innovations could contribute to improving African farming. But for this to happen, certain key enabling factors have to be in play.

Seven enabling factors

To explore these factors in detail two countries have been selected – Ghana and Tanzania – with several considerations in mind: geography, governance, willingness to adopt new technologies, and levels of corruption.

Located in West and East Africa respectively, Ghana and Tanzania are close to nations that have either commercialised the new technology (Burkina Faso) or are near to doing so (Kenya and Uganda). As the following analysis shows, Ghana has made more rapid progress than Tanzania.

Factor one: current modifiable crops

Both Ghana and Tanzania have considerable potential for introducing GM varieties of a wide range of existing crops. In fact, for several crops there is no ready means of improvement without modern genetics. Conventional plant breeding does not work easily with bananas, for example, because they do not produce seeds, while the cowpea has too little natural genetic variation from which to select desirable traits.

Ghana's main crops are yam, cassava and bananas (including plantains), with maize, tomatoes and rice also important to its agricultural output. Given that GM maize and tomatoes are already grown elsewhere in the world and that GM yams, cassava and rice are in development, there is clearly scope for expansion. Sorghum and coconuts too could be added to the list. A rough estimate of Ghana's potential might be the value of its modifiable agricultural produce of US$ 3 billion per year.

BOX 14.1 Potential applications of GM technology

Current

- Tolerance to broad-spectrum herbicide in maize, soybeans, brassica.
- Resistance to chewing insects in maize, cotton, oilseed, brassica.
- Nutritional biofortification in staple cereal crops, sweet potato, banana.

In 5–10 years

- Resistance to fungus and virus pathogens in potato, wheat, rice, banana, cassava, fruits, vegetables.
- Resistance to sucking insects transmitting viruses in rice, fruits, vegetables.
- Improved storage and processing of wheat, potato, fruits, vegetables.

In 10–20 years

- Drought and salinity tolerance, improved nitrogen use efficiency and high temperature tolerance in staple cereal and tuber crops.

In more than 20 years

- Apomixis (reproduction without fertilisation), nitrogen fixation and conversion to a perennial habit in staple cereal and tuber crops.

In Tanzania, bananas are the chief agricultural product, followed by cassava, cowpea, chickpea and pigeon pea, and maize. Cotton is also significant. If one considers GM crops either being cultivated or in development, Tanzania could benefit from modified maize, cotton, cassava, bananas, rice, sweet potatoes, sorghum and potatoes. The total value of the country's potential GM crop is estimated to be US$ 2.2 billion.

Factor two: laws and regulations

A proper legal and regulatory structure must be in place for the commercial release of GM crops. Globally, the framework governing GM is based on two United Nations commitments (Box 14.2).

Ghana has a positive stance on GM crops and has made progress towards an enforceable regulatory framework. Parliament signed its Biosafety Bill in 2011, paving the way for confined field trials of crops such as insect-resistant *Bt* cowpea and GM sweet potato. Steps are also being taken to put in place a framework for the commercial cultivation of GM crops.

The situation in Tanzania is at present uncertain. Despite publicly announcing its support for the new crops, the government has been less than clear on its policies.

If a country's main agricultural exports are to countries that do not accept genetically modified products, there is little to gain from developing engineered varieties of those crops.

There have been press reports and quotes from government ministers that field trials have taken place for GM cotton, tobacco and maize. However, current legislation contains a strict clause that is likely to hamper both confined field testing and adoption of GM crops.

Factor three: trade flows

An important influence on whether a country adopts GM crops is the effect this might have on its international trade potential. If its main agricultural exports are to countries that do not accept GM products, there is little to gain from developing GM varieties of those crops. Conversely, there is much to be gained from developing crops with GM potential that are primarily for domestic consumption or for markets that welcome such products.

In 2010, Ghana exported agricultural products worth nearly US$ 6 billion, representing roughly three-quarters of its total revenue from exports. But only a very small share of these exported products are crops that have GM potential.

Tanzania's exported agricultural goods totalled US$ 1.2 billion, with crops that have GM potential representing a slightly higher proportion than is the case for Ghana. But even so, this was still a fairly small fraction.

This means that there is no obvious trade-related reason against adopting GM crops in either country. Any improved varieties now in development are not, as yet, important for export, especially to the large European market, which is the most reluctant to accept them.

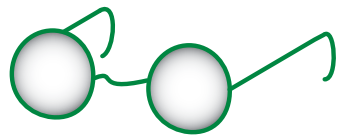
BOX 14.2 The international framework

The Convention on Biological Diversity of 1993 is an international commitment to conserving biological diversity, sustaining the use of biological resources and sharing fairly the benefits arising from genetic resources.

The Cartagena Protocol on Biosafety of 2000 is an international regulatory framework that reconciles the needs of trade and environmental protection in the context of the transboundary movement of genetically modified organisms. Countries that sign and ratify (or accede to) this protocol are bound by its provisions. By 2014, 41 of the 51 Sub-Saharan African countries had done this.

Factor four: research capacity

Agricultural innovations need to be supported by adequately funded and appropriately skilled research. Generally, agricultural research and development (R&D) in Sub-Saharan Africa were profoundly neglected during the last two decades of the last century. But this is changing, with African policy makers recognising that agricultural development is an engine of economic growth.



One thing threatens Ghana's ability to maintain its current research capacity: an ageing pool of scientists with qualifications that have changed little since the 1990s.

Between 2001 and 2008 there was a 20 per cent increase in investment in agricultural R&D. Ghana and Tanzania were among the highest spenders in the so-called Big Eight, along with Nigeria, South Africa, Kenya, Uganda, Ethiopia and Sudan. In 2008, these eight countries accounted for 70 per cent of public agricultural R&D expenditure in the region and 64 per cent of all the region's researchers.

Alongside public spending on R&D are contributions from international donors and funding agencies. Here, too, Ghana and Tanzania have been beneficiaries.

The broad picture for Ghana is that it has committed itself to an investment of 1 per cent of GDP in R&D. It has at least six institutes capable of agricultural biotechnology research and around 28 current projects in this area, of which just one involves GM work. Like other countries, Ghana is also beginning to take an interest in studying the genomes of orphan crops.

Overall, Tanzania's agricultural research capacity resembles that of Ghana. It has at least four institutes able to carry out agricultural biotechnology and an estimated 22 projects, one involving GM technology. The general aim, like Ghana's, is to drive up research investment in all sectors to 1 per cent of GDP and to increase researchers' salaries by more than 80 per cent.

In short, both Tanzania and Ghana recognise the significance of agricultural research as an enabling factor in developing and adopting the new technologies.

Factor five: intellectual property protection

Most African nations are some way from filing their own GM crop patents, with South Africa being to date the most advanced. Even so, Ghana and Tanzania are both members of the African Regional Intellectual Property Organisation – an intergovernmental body for hearing patent applications. Each country has only filed a couple of patents so far, but with improved funding for agricultural research in recent years, the number of applications is likely to go up.

Factor six: transport, power and communications

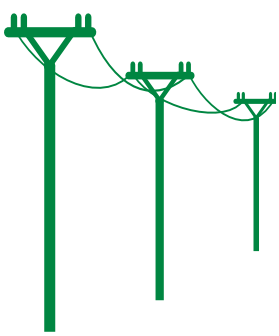
Good infrastructure is a key enabler of innovation. An efficient transport system, for example – as measured in road density, proportion of paved roads or motor vehicle ownership – is vitally important for seed distribution and access to markets. Sub-Saharan Africa generally has a high proportion of unpaved roads, with negative impacts on access.

Ghana has been active in improving its infrastructure over the past 30 years. Its ports are above average for Sub-Saharan Africa, but access to electricity – an indicator of readiness for technological innovation – is only around half the region's average.

Tanzania's roads are in a slightly worse condition than Ghana's, with road density lower than the regional average. Power consumption lies well below average, with large parts of the population, especially in rural areas, having only limited access to an electricity grid.

Technology-driven communication is most simply measured by mobile phone coverage or internet access. Mobile phone usage has soared across Africa in recent years: there are now more than half a billion mobile phone subscribers. That is comparable with the entire population of the European Union. The penetration of internet use is lower, however, with 13.5 per cent of the whole continent online in 2011, well below the world average of 32.7 per cent.

These trends suggest that there is some potential for information and communication technology (ICT) as a driver of agricultural extension services in rural areas in both countries, with mobile phones currently being a more viable communication channel than the internet. Ghana lies ahead of Tanzania in some areas of infrastructure development, but both countries are aware that more investment is needed if transport, power and communications are to be adequate to sustain agricultural innovation, including modern plant genetics.



Access to a reliable electricity supply is a prerequisite for technological development.

Factor seven: macroeconomic and political stability

Macroeconomic stability has a profound impact on a country's competitiveness: no government can provide services efficiently if it is crippled by high debt. The current economic climate, with its effects on commodity prices, capital flows and foreign investment, is taking its toll on Africa's growth. Shrinking, recession-bound, conflict-prone and corruption-weakened economies impair the fight against poverty.

Table 14.1 Enabling factors for the adoption of genetically modified crops in Tanzania and Ghana

	Innovation readiness	
	Ghana	**Tanzania**
Current production of modifiable crops	High	High
Laws and regulations	High	Average
Importance of trade flows	Not relevant	Not relevant
Agricultural research capacity	Average	Average
Intellectual property protection	Low	Low
Transport, power and communications	Average	Low
Macroeconomic and political stability	Average	Average
Enabling factors, overall score	*High*	*Average*

Source: Bennett and Jennings, 2013

Both Ghana and Tanzania experienced GDP growth of around 5 per cent during 2003–2008, but both countries score weakly on macroeconomic stability, with poor central government balances and high inflation rates. This does not necessarily mean that their adoption of new technologies will stall: Burkina Faso has managed to succeed with GM cotton despite being in a similar macroeconomic position. But persisting uncertainties surrounding the willingness of banks to lend money to private investors are certainly slowing things down.

Inward investment across Africa is also negatively affected by the continent's high levels of corruption as measured by the Corruption Perceptions Index (CPI). Ghana scores relatively well, coming sixth out of the 45 Sub-Saharan African countries listed, although its economic effectiveness is quite low. Tanzania occupies 19th place, but is still seen as a relatively stable country.

Readiness to adopt new genetic technologies

Both nations can be classified as being of "average readiness" to adopt GM and other technologies. The World Economic Forum's *Global Competitiveness Report* summarised this as follows:

- Ghana has excellent public institutions and governance but has been losing macroeconomic stability. Overall there is good public trust in politicians, a relatively independent judiciary and low levels of corruption for the region as a whole. Some aspects of infrastructure – roads and ports – and financial markets are relatively good. However, education levels lag behind international standards, and the country is not making the most of new technologies such as ICT to enhance productivity. High government

deficits and interest rates and double-digit inflation suggest inefficiencies in Ghana's financial system.

- Tanzania's public institutions are also characterised by reasonable levels of trust in politicians, government even-handedness in its dealings with the private sector and good security by regional standards. Financial markets have also become more sophisticated. On the other hand, poor-quality roads, ports and electricity supply weaken its infrastructure. Primary education enrolment is high but secondary and university enrolment rates are among the lowest in the world. Related to this is poor take-up of new technologies such as the internet and mobile telephony. Another serious concern is the health of the workforce, with high levels of diseases such as malaria, tuberculosis and HIV/AIDS.

Support from government

The fact that a country fails to embrace all seven enabling factors does not mean that it will be incapable of adopting new crop production technologies. What is essential though is that it has political commitment and support from its national government.

Burkina Faso, a small, poor country, managed to adopt a GM crop – cotton – and put itself perhaps a decade ahead of other countries in the region. The government created an enabling regulatory framework and prepared its institutions to review and approve new technology in line with the Cartagena Protocol on Biosafety. All the necessary steps were taken to introduce its new *Bt* cotton, with stakeholders being informed right down the line as to what the technology would mean for farming practices, and for both human and environmental health.

Illegal, non-certified seed markets could cripple a country's ability to make the most of opportunities offered by the new genetics.

If governments act on modernising their seed sectors, provide credit and access to markets, enact regulations and coordinate the work of research institutes and government bodies, the way is open. Of course, there are still challenges, especially in establishing proper biosafety systems and preventing a surge in illegal seed markets. But it can be done; how quickly will vary.

Help for smallholders

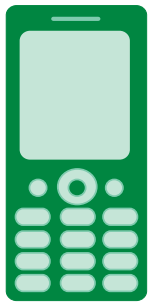
The needs of subsistence smallholder farmers make up one final, key piece in the GM adoption jigsaw. Small farmers have to get help and advice on matters such as crop types, partnerships with private, public and non-governmental organisations, investment, and financial incentives. External organisations providing this help need

to respect local demands and understand the different constraints and priorities that operate in different countries.

Effective communication is key here. Farmers need to know about many aspects of the new technologies and advances in plant breeding in order to manage their farming competently.

Also – and this is vital if innovation readiness is to be achieved – a country must address several questions:

- Does smallholder demand for innovations such as GM crops exist?
- Are smallholders aware of the potential benefits of all aspects of modern plant breeding and of the problems associated with farm-saved seed?
- Are the nation and its people ready, informed and able to fulfill smallholder demand?
- What improvements are necessary for readiness to be achieved?



There are now many informative agricultural apps available to the half a billion registered mobile phone users in Africa.