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Agricultural technologies for a warming world

by Lim Li Ching

Climate change endangers the livelihoods and food security of the planet's poor and vulnerable, largely because it threatens to disturb agricultural production in many parts of the world. The Intergovernmental Panel on Climate Change (IPCC) projects that crop productivity would actually increase slightly at mid- to high latitudes for local mean temperature increases of up to 1-3 degrees Celsius, depending on the crop. However, at lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2^{o}C). In some African countries, yields from rain-fed agriculture, which is important for the poorest farmers, could be reduced by up to 50 percent by 2020. Further warming above 3^{o}C would have increasingly negative impacts in all regions.

Recent studies suggest the IPCC may have significantly understated the potential impacts of climate change on agriculture. New research suggests that production losses across Africa in 2050 (consistent with global warming of around 1.5^{o}C) are likely to be in the range of 18 to 22 percent for maize, sorghum, millet and groundnut, with worst-case losses of 27 to 32 percent.[1] Other research suggests that rice production in South Asia, one of the most affected regions in terms of crop production, could decline by 14.3 to 14.5 percent by 2050, maize production by 8.8-18.5 percent and wheat production by 43.7 to 48.8 percent, relative to 2000 levels.[2] As such, unchecked climate change will have major negative effects on agricultural productivity, with yield declines and price increases for the world's staples.

The number of people at risk of hunger will therefore increase. Moreover, the impacts of climate change will fall disproportionately on developing countries, although they con-

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tributed least to the causes. The majority of the world's rural poor who live in areas that are resource-poor, highly heterogeneous and risk-prone will be hardest hit. Smallholder and subsistence farmers, pastoralists and artisanal fisherfolk will suffer complex, localized impacts of climate change. For these vulnerable groups, even minor changes in climate can have disastrous impacts on their livelihoods.

No wonder then that the world is desperately seeking solutions. Genetically modified organisms (GMOs) are one of the proposed options, for example through the development of drought-tolerant GM crops. There has been rather a lot of hype about these new GM crops, but closer examination reveals constraints. From the limited data supplied by Monsanto to the US Department of Agriculture, its drought-tolerant corn (recently deregulated in the US) only provides approximately 6 percent reduction in yield loss in times of moderate drought.[3]

Drought is a complex challenge, varying in severity and timing, and other factors such as soil quality affect the ability of crops to withstand drought. These complications make it unlikely that any single approach or gene used to make a GM crop will be useful in all – or even most – types of drought. Furthermore, genetic engineering's applicability to drought tolerance is limited insofar as it can only manipulate a few genes at a time, while many genes control drought tolerance in plants, raising questions as to whether the technology is fit for this purpose.

In contrast, conventional breeding has increased drought tolerance in US corn by an estimated 1 percent per year over the past several decades. According to the Union of Concerned Scientists:

... that means traditional methods of improving drought tolerance may have been two to three times as effective as genetic engineering, considering the 10 to 15 years typically required to produce a genetically engineered crop. If traditional approaches have improved corn's drought tolerance by just 0.3 percent to 0.4 percent per year, they have provided as much extra drought protection as Monsanto's GE [genetically engineered] corn over the period required to develop it.[4]

While water availability during times of drought is also an important issue, there is little evidence that genetic engineering can help crops use water more efficiently, i.e., to use less water to achieve normal yields. Drought-tolerant crops typically do not require less water to produce a normal amount of food or fibre, and Monsanto has not supplied any data measuring water use by its drought-tolerant corn to suggest that it has also improved water use efficiency.

There are, moreover, biosafety issues with GMOs, and they have potential environmental, health and socio-economic risks. That is why there is an international law regulating GMOs: the Cartagena Protocol on Biosafety, ratified by 164 countries. Parties to the Cartagena Protocol have obligations to ensure that the risks are robustly assessed. There are also obligations in terms of risk management, monitoring, addressing illegal and unintentional transboundary movements, and public awareness and participation. Therefore, any decision to approve or release a GMO has to be weighed seriously and decision-makers should consider the full range of options available.

With regard to climate change and its implications for poor farmers, a key question to ask then is whether the proposed option can meet the needs of small farmers with the least cost/most benefit, and lowest risks. What option can best contribute to resilience to deal with unpredictable climatic options? And given that the climate change challenge is so urgent, what can deliver results quickly?

The emerging consensus is that the world needs to move away from conventional, energy- and input-intensive agriculture, which has been the dominant model to date. Thus, the call has been for a serious transition towards sustainable/ecological agriculture. The International Assessment on Agricultural Knowledge, Science and Technology for Development (IAASTD)[5] stressed this in an extraordinarily comprehensive assessment of the global state of agriculture, involving more than 400 scientists.

The ecological model of agricultural production, which is based on principles that create healthy soils and cultivate biological diversity and which prioritizes farmers and traditional knowledge, is climate-resilient as well as productive. Ecological agriculture practices and technologies are the bases for the adaptation efforts so urgently needed by developing-country farmers, who will suffer disproportionately from the effects of climate change. Many answers already exist in farmers' knowledge of their region and their own land – for example, how to create healthy soils that store more water under drought conditions or how to grow a diversity of crops to create the resilience needed to face increased unpredictability in weather patterns.

Ecological agriculture practices improve and sustain soil quality and fertility, enhance agricultural biodiversity, and emphasize water management and harvesting techniques. Practices such as using compost, green manures, cover crops, mulching and crop rotation increase soil fertility and organic matter, which reduce negative effects of drought, enhance soil water-holding capacity and increase water infiltration capacity, providing resilience under unpredictable conditions. Moreover, cultivating a high degree of diversity allows farmers to respond better to climate change, pests and diseases and encourages the use of traditional and locally-adapted drought- and heat-tolerant varieties and species.

There is also increasing evidence that ecological agriculture can increase yields where they matter most – in small farmers' fields – with low-cost, readily adoptable and accessible technologies that build on farmers' knowledge. A review of 286 ecological agriculture projects in 57 countries showed a 116 percent increase in yields for African projects and a 128 percent increase for East Africa.[6] During times of drought, scientific side-by-side comparisons at the Rodale Institute, USA, have demonstrated that organic yields are higher than yields under both conventional and GM agriculture.[7]

While there is great potential in ecological agriculture, there has been little attention to it in terms of research, investment, training and policy focus. The challenge is to re-orient agriculture policies and significantly increase funding to support climate-resilient ecological agricultural technologies. Research and development efforts should be refocused towards ecological agriculture in the context of climate change, while at the same time strengthening existing farmer knowledge and innovation.

In conclusion, a comparison of genetic engineering with other technologies, such as conventional breeding and ecological agriculture, shows that the latter are more effective than the former at meeting the climate challenge, and at lower cost. An excessive focus on genetic engineering at the expense of other approaches is a risky strategy.

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Endnotes

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