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AGROBIOTECHNOLOGY IN THE DEVELOPING WORLD

Nicholas G. Kalaitzandonakes[1]

The importance of agrobiotechnology for the less developed countries (LDCs) has been debated for almost two decades. Food security has been a focal issue. However, discussions have been far more expansive and complex. With technological capacity being a centerpiece in development theories, agrobiotechnology has generally been discussed against the broader context of economic growth, social justice, and environmental sustainability.

In this special issue of *AgBioForum*, experts and decision-makers from around the globe address some key questions on the relevance of agrobiotechnology for LDCs. Specifically, the following questions are addressed:

- Can LDCs benefit from agrobiotechnology? That is, do benefits outweigh risks to justify implementation?
- If LDCs can indeed benefit from agrobiotechnology, what are the likely pathways of implementation (e.g., develop indigenous technological capability, transfer technology, trade for products)?
- If implementation is justified, what kinds of institutional adjustments are necessary to maximize benefits and minimize risks?

Answers to these and similar questions advance our understanding on the potential contributions of agrobiotechnology towards economic, environmental, and social sustainability, with improved social welfare in LDCs.

Can LDCs Benefit From Biotechnology?

Food security has dominated the risk-benefit analyses of agrobiotechnology in LDCs. And not without reason. There have been chronic problems on both the demand and the supply side of the food equation in LDCs.

On the demand side, meeting the food needs of a growing population and overcoming nutritional deficiencies are prime considerations. In the absence of major population redistribution through migration, the vast majority of population growth is projected to occur in LDCs and emerging economies over the next several decades. Projections of population growth are typically accompanied

[1]Nicholas Kalaitzandonakes is an Associate Professor of Agribusiness at the University of Missouri and the Editor of AgBioForum.

by estimates of increased food demand and worsening deficits in the food supplies of LDCs (Prakash, McGloughlin). Projected deficits are exacerbated when possible income effects are explicitly accounted for. Experience suggests that income growth among consumers in LDCs quickly translates into increased demand for animal protein (e.g., fish, poultry, red meat). With typical conversion rates of plant to animal protein ranging from 2.5-5.0:1, significant increases in the consumption of animal protein results in disproportionate increases in the demand for feed thereby worsening the food balance sheet in LDCs.

Nutritional deficiencies also continue to tantalize LDCs. As common diets in LDCs depend on staple foods, energy requirements maybe satisfied but deficiencies in micronutrients remain, with significant negative impacts on health (Conko & Smith, McGloughlin).

On the supply side, perpetual lack of infrastructure and inconsistent supplies of modern inputs (e.g. fertilizers, mechanical implements), limit the productive capacity in LDCs. Limits on productive capacity are also placed through abiotic stress (e.g., drought, monsoon) and marginal lands, both of which feature prominently in LDCs.

Agrobiotechnology has promised solutions to all such problems and more. Insect resistant plants that improve yields and use less synthetic pesticides, plants that are tolerant to cold, drought or salt, and staples with improved nutritional profiles have been, or are being, developed to battle input shortfalls, production shortages, nutritional deficiencies and environmental degradation (Conko & Smith, McGloughlin, Woodward *et al*.). Delivery of pharmaceuticals, like edible vaccines, by incorporating them in food staples further expands the range of potential benefits of bioengineered crops in LDCs. Limited empirical evidence suggests that agrobiotechnology is delivering on its initial promises (McGloughlin, Woodward *et al*.).

Some have argued, however, that agrobiotechnology is neither necessary nor sufficient for addressing the chronic food supply and nutritional problems of LDCs, and, that the potential environmental and food safety risks outweigh possible benefits (Altieri & Rosset). Instead, emphasis on traditional diversified farming systems that employ agroecological principals are more sustainable and productive (*ibid*.). This is an important and heavily debated issue. To fully represent such opposing views we invited specific authors to develop them. Altieri and Rosset and McGloughlin have developed exhaustive point-counterpoint accounts of the benefits and risks of bioengineered crops. Readers can draw their own conclusions about the relative importance of the potential benefits and risks of agrobiotechnology. Most authors in this issue, however, seem to agree that there is a need and a role for biotechnology in LDCs.

What Role And Through What Pathways?

While there may be a need and a role for agrobiotechnology in LDCs, the pathways and implementation strategies will likely differ from one country to another. Less developed countries differ significantly in their capacity to develop, transfer, use or even regulate agrobiotechnology (Falconi, Sahai, Tzotzos). Countries like China, India, and Mexico with their own indigenous research capability are targeting benefits through implementation in their farm sectors (Sahai, Falconi, Woodward *et al*.). This is not the only way to capture benefits from agrobiotechnology though. Innovation benefits are regularly transferred through market transactions and trade flows (Frisvold *et al*.). Yet the level and distribution of innovation benefits can be markedly different through these different venues. Innovation benefits generated through trade typically accrue to consumers (ibid.). Development of local productive capacity transfers some of the benefits to

producers. Of course, all such benefits will differ for each country depending on whether it is a net importer or exporter (Pinstrup-Andersen).

In addition to trade orientation and level of investment, a variety of other factors affect the size and distribution of benefits, including the institutional capacity to regulate agrobiotechnology and protect relevant intellectual property rights (Tzotzos, Traxler, Kerr *et al*.). The key point here is that conditions specific to each LDC, will likely determine the pathways and the ways benefits and risks are distributed. It is within this context that national strategies are relevant (Falconi).

Institutional Adjustments

Rapid technical advance in the laboratory has forced rapid institutional change both at national and international levels. Institutional change through adjustments in organizations and regulations is necessary to maximize the benefits and minimize the risks of agrobiotechnology (Juma, Tzotzos). In some cases, maximizing benefits for a country (region, social group) comes at the expense of another. In these cases, strategic positioning pays off. In other cases, benefits can be jointly maximized and hence motivate mutual agreements. It is within this context that introduction of mandatory labeling, the application of the precautionary principle, the application of the WTO rules or the introduction of the Cartagena Biosafety Protocol should be understood. To use Tzotzos' statement, "the questions biotechnology raises have little to do with it being inherently risky. Rather, they have to do with civic organizations and mechanisms affecting the equitable distribution of social and economic dividends."