CHAPTER 1

INTRODUCTION

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Strong economic growth over the past 20 years has reduced by half the number of people in developing regions living in extreme poverty (UN, 2012). The agricultural achievements of past decades have been impressive. Even as the earth's human population increased by roughly 1 billion, the prevalence of hunger dropped to less than 15 percent, and people have increasingly been consuming more nutritious foods. Nevertheless, 842 million people were estimated to be suffering from chronic hunger in 2011–13, regularly not getting enough food to conduct an active life (FAO, IFAD and WFP, 2013). Most of these people live in rural areas and depend for food on small-scale farming and marketing systems. The projected increase in the global population to 9 billion and, with this, the expected 60 percent increase in the demand for food by 2050 leaves no room for doubt that individual countries and the international community need to make an extra effort to assist the poorest and most marginalized to secure their right to adequate food (Place *et al*., 2013).

The challenges faced in tackling and eliminating food insecurity and malnutrition – and doing so sustainably and equitably – are substantial. For example, rural populations are becoming relatively smaller as people move to cities. Farmers, fishers and forest-dependent people are facing new risks from climate change, disease and the overuse of renewable natural resources. The demand for biofuels is changing the way land is being used, and the current financial crisis and recent spikes and volatility in food prices are of increasing concern worldwide. These and other threats to the global food and agriculture landscape are certainly worrying but, while both the causes of and the solutions to hunger and malnutrition are often complex and varied, they are not insurmountable.

The key lies in empowering the millions of smallholder producers and landless workers who form the backbone of rural economies in most developing countries to grow their incomes and improve their livelihoods by raising agricultural productivity and engaging in markets. In effect, investments in agricultural development can be used as the catalyst for encouraging broad-based rural development and provide the basis for meeting hunger and wider sustainable development objectives such as reducing poverty, food and nutritional insecurity and environmental degradation. That such investments have paid off handsomely in the past (and continue to do so) is convincingly illustrated by the publication *Millions fed: Proven successes in agricultural development* (IFPRI, 2009). Of all the ingredients of success, arguably the most important, and certainly the most common, has been sustained public investment both in the research that developed technologies and knowledge for increasing land, water and labour productivity and in the extension and community services that promoted their diffusion.

Of course, the realities of producing, marketing and trading in food and agricultural products are more complex nowadays, which creates both risks and opportunities for farmers and consumers alike. Even so, the science-based technologies and knowledge now available to tackle these ever-changing challenges are also rapidly evolving. New and smarter science-based products, processes and ways of working continue to come on stream. These offer real opportunities for contributing to the elimination of hunger and malnutrition, provided that they are appropriately integrated with longer established approaches and traditional knowledge and skills, and that they are also underpinned by institutional and financial arrangements that recognize the vital role of smallholder production and marketing systems. The need to make such changes to improve people's lives is now more pressing than ever.

Agricultural biotechnologies are prominent among the suite of innovations available to producers through the national, regional and international research systems, extension services, ministries, civil society organizations and private sector companies that support them. FAO has long recognized the considerable potential of the tools provided by both new and older biotechnologies to promote sustainable agrifood development, but is also aware of the concerns surrounding some applications.

To provide a forum for the exchange and subsequent dissemination of objective science-based information about these technologies, it organized an international technical conference in Mexico in collaboration with global partners (FAO, 2011). Entitled "Agricultural biotechnologies in developing countries: Options and opportunities in crops, forestry, livestock, fisheries and agro-industry to face the challenges of food insecurity and climate change (ABDC-10)", this Conference brought together about 300 policy-makers, scientists and representatives of intergovernmental and international non-governmental organizations, including delegations from 42 FAO Member Nations. Plenary presentations covered the subject rigorously in all its dimensions, and delegates were provided with peer-reviewed background documents outlining the current status and options for using biotechnologies within all the major food and agricultural sectors, as well as the related policy issues. Coupled with presentations of case studies of successful applications of biotechnologies in developing countries, the rich and wide-ranging discussions during subsequent sector-specific, cross-sectoral and regional sessions offered delegates ample opportunity to reflect on lessons learned and consider options for developing countries as well as priorities for action by the international community.

One of the key messages to come out of the Conference was that, although biotechnologies are being applied to an increasing extent to alleviate hunger and poverty, adapt to climate change and maintain the natural resource base, they have still not been widely applied in many developing countries, and have not sufficiently benefited smallholder farmers and poor consumers. It is outside the scope of this publication to attempt even to summarize the great variety of factors responsible for this state of affairs. Nor do we have space here for a description of all the agricultural biotechnologies that are available for application on-farm or in laboratories, directly supporting farmers and national agricultural development and global "public goods", e.g. by analysing samples for a crop pest or animal disease. Readers interested in these aspects are referred to FAO (2011) or to Ruane and Sonnino (2011).

Even so, policy-makers and investors in agricultural development need to be able to tell what the most pressing needs in a country are to overcome hunger and malnutrition. They have to prioritize among the many competing demands for limited human and financial resources, and they need hard evidence that biotechnologies can tackle these priority issues. They also want assurances that R&D will have the desired impact when adopted by potential end-beneficiaries or used by service providers. They must ask themselves whether research results will translate into economic benefits for smallholder farmers and consumers, into better nutrition for their children, into lower pesticide use, into less disease etc.

A robust *ex ante* project design is a prerequisite for securing funding for development research and ensuring it achieves the desired outcomes. The project must therefore identify the pathways through which the intended interventions can achieve the desired impact. Together with rigorous priority and needs assessments, impact pathways and associated performance indicators that set out, among other things, what will be achieved, by whom, where and when are key components of a monitoring and evaluation system, which will support feedback and learning. Upon completion of the intervention, the *ex post* impact assessment seeks to establish whether the technological package actually improved rural livelihoods.

Making the link between agricultural biotechnologies and economic, social and environmental outcomes and impacts is neither conceptually nor practically straightforward. Methodological challenges in the economic sphere (see e.g. de Janvry, Dustan and Sadoulet, 2011) become even more complex when measured also with reference to "people benefits", such as better nutrition or improvements in the biophysical environment. Further, formal impact analysis takes time and requires, among other things, the collection and evaluation both of objective information and of subjective stakeholder assessments at the micro and macro level, as well as substantial levels of funding, computer modelling and wider project management skills. All of these are in short supply in most developing countries. Little wonder, then, that the information base about what biotechnologies work for agricultural development is so narrow.

Inspiration for this publication came from an initial series of five short sector-specific parallel sessions which took place during ABDC-10 (session reports are provided in Chapter 11.3 of FAO [2011]) dealing with case studies of what were generally considered to be "successful applications" of biotechnologies in developing countries. During these sessions, two to three case studies were presented, followed by a facilitated discussion, providing people with an opportunity to evaluate the key factors responsible for the results. This publication attempts to build upon these sessions and to examine in greater detail some of the issues they raised. It does so through the presentation of 19 case studies written by different authors covering the crop, livestock and fisheries/aquaculture sectors (with five to seven studies for each sector). They were chosen after a widely disseminated open call for proposals relating to case studies in which biotechnologies have been applied to serve the needs of smallholders in developing countries.

The publication also endeavours to pull out "lessons learned", i.e. the obstacles/challenges encountered, what worked and why, while recognizing the many pitfalls in claiming "success" in achieving the ultimate long-term goal of actually reducing hunger, malnutrition or poverty. Indeed, most of the reported successes relate to meaningful outcomes. That is to say, they describe instances in which the technology and related knowledge were used and adopted by smallholder producers, who thereby set in motion a series of changes that ultimately improved their own and other people's lives. While these case studies may be best described as initial steps towards assessing the benefits of agricultural biotechnologies, it is also hoped that they will provide useful information for policy-makers, potential investors, development specialists and scientists and encourage further investments both in R&D and in the diffusion of these and other biotechnologies.

Several criteria were used for choosing the case studies. First, what constitutes a biotechnology? The definition was taken from the Convention on Biological Diversity and was also used at ABDC-10, i.e. "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". As such, it covers a broad range of technologies – often referred to variously as "traditional/conventional" or "low-tech" through to "modern" or "advanced" approaches – that are used for a number of different purposes, such as the genetic improvement of plants and animals to increase their yields or efficiency; the characterization and conservation of genetic resources for food and agriculture; plant and animal disease diagnosis; and the production of fermented foods. The publication tried to reflect the breadth of this definition by choosing case studies relating to several different biotechnologies and diverse applications.

Second, what constitutes a case study? Here, it was decided that it must involve the application of the biotechnology (or biotechnologies) in the field, and so should have gone beyond the research or experimental stage. To qualify for inclusion, a case study did not necessarily have to represent a success, defined in terms of "people benefits". Rather, the aim was to produce a package of case studies that would illustrate the very different realities of applying biotechnologies in developing countries, and consider the many variables such as context, background/history, key problem(s) to be addressed, the specific biotechnology itself and the mode of implementation, the obstacles and challenges encountered, the factors of success (or failure), the impacts and the lessons learned.

Third, what is a smallholder farmer? Here, there was more scope for flexibility since the definition varies from country to country and between agro-ecological zones (FAO, 2004). In favourable areas with high population densities, a smallholder may often cultivate less than one hectare of land, keep two or more cows and/or have a backyard family fish pond of perhaps 200 m^2, whereas in semi-arid areas they may cultivate 10 ha or more, or manage 10 head of livestock.

Finally, in selecting the case studies, every effort was made to ensure that they came from different regions of the developing world and that, within each sector, a range of applications involving different species was included. The 19 case studies that were finally chosen are illustrated in the following three chapters and cover the crop, livestock and aquaculture/fisheries sectors respectively. They include applications of biotechnologies to overcome biological and technological constraints in order to increase productivity, improve people's livelihoods, tackle diseases and pests, expand market opportunities through diversification and value addition, and conserve some of the unique but threatened genetic resources needed for ensuring the sustainability of smallholder production systems. The final chapter attempts to summarize both the benefits and downsides of the technologies introduced and to recapitulate the lessons learned from technical, policy and institutional perspectives.

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