

CHAPTER 12

CHALLENGES AND POLICIES FOR THE WORLD AGRICULTURAL AND FOOD ECONOMY IN THE 2050 PERSPECTIVE

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Previous chapters have presented a number of scenario analyses on global agriculture, its connection with the expected evolution of the world economy, the availability of natural resources, investment requirements, and prospects for research and innovation. Chapter 11, by Alexandratos, has reviewed projections for main variables, highlighting differences, and their origins in the data and analysis. This last chapter takes a broader look at the main results, and proposes insights into how this wealth of information can be utilized. The need to shape policy action is currently one of the fundamental reasons for taking interest in long-term projection exercises such as the one presented in this volume. Another need is for looking beyond short-run phenomena, to understand what may be long-lasting phenomena, and disentangle these from what is likely to be short-run noise. The following discussion is based on the chapters of this book; hence it is less comprehensive than recent ambitious analyses of agriculture and the global food system, such as the one by the World Bank (2010) on climate change impacts, and the Foresight project report (Foresight, 2011).

This chapter is divided into three sections. The first section summarizes key conclusions from the four parts of the volume, highlighting the challenges that they pose. The second section highlights information and analytical gaps that may hinder understanding of the likely evolution of world agricultural and food economies over the coming decades. Lessons from the rest of the volume are identified in terms of areas where more information and knowledge would be useful. The third section uses conclusions from the four parts of the volume to outline policy directions and identify intervention areas that could be explored today, given the outlook to 2050. Some concluding remarks close the chapter.

Challenges and opportunities

The first part of this volume shows how challenging and controversial projection exercises for world agriculture can be. Insights presented in the three chapters by Alexandratos, Msangi and Rosegrant, and Fischer indicate that such projections are the result of a complex combination of data, assumptions and modelling, drawing on different subject areas. In Chapter 1, Alexandratos concludes that the last comprehensive projection to 2050, undertaken a few years ago by FAO (2006) without accounting for the impact of biofuels, is still to a large extent valid. This implies that the turbulence observed in food markets during recent years is not necessarily going to affect the long-term picture, at least as regards global quantities of consumption and production. The presence of potentially disruptive forces, including further development of the bioenergy sector and climate change, is acknowledged, but uncertainties surrounding these phenomena warrant a cautious attitude: the emphasis is on what is not yet known. Chapter 3, by Fischer, addresses these two aspects – bioenergy and climate change – to conclude along similar lines. Climate change, it is argued, will not necessarily imply large changes in the world food system until 2050, and there may be room for farmers to adapt and mitigate. The combined influence of climate change and a fast development of biofuels may make the situation more critical and generate significant stress on resources and markets, but this result is judged to be the upper extreme of a range of possible outcomes.

While taking a similarly cautious attitude, in Chapter 2 Msangi and Rosegrant emphasize the likelihood of extreme conditions materializing in the 2050 horizon. Changes in climate variables are expected to impose considerable pressures on land and water resources. Combined with the dynamics of major crop yields, it is argued, this could lead to very high increases in real prices of key agricultural commodities by 2050. Depending on the climate scenario, Msangi and Rosegrant project reductions of up to 30 percent in yields of rainfed maize in developed countries, up to 18 percent in yields of irrigated rice in developing countries, and up to 34 percent in the yield of irrigated wheat. In sub-Saharan Africa, the number of malnourished children in 2050 is projected to be up to 24 percent higher under climate changes scenarios. The decline in malnutrition prevalence expected in sub-Saharan Africa in the baseline projection becomes contingent on significant investment to improve knowledge, science and technology. This is deemed necessary to dampen the increases that are otherwise expected in the prices of key staples, such as cassava and maize.

Even without climate change, Msangi and Rosegrant project meat demand to generate substantive increases in feed demand for cereals, following fast per capita income growth, especially in East Asia. Alexandratos's comparison of global

cereals consumption (without biofuels) projected for 2050 (Chapter 11, Figure 11.5) shows that there are wide differences. Broadly speaking, the projections of Msangi and Rosegrant are on the low side, those of Fischer are on the high side and those of FAO are in between. Alexandratos suggests that a major cause of these differences is to be found in the different historical data used by the three projection studies.

The expected development of biofuels, according to Msangi and Rosegrant, may require developing countries to increase their yield growth by 1 percent per year up to 2030, over and above the increases foreseen in the authors' scenario without biofuels. Biofuels are projected to result in substantive increases in market prices and a worsening of food security conditions. In Chapter 1, Alexandratos instead argues that the quantities by which biofuels would increase world aggregate cereals utilization would be a relatively modest 7 percent of world consumption in 2015 – based on the FAO/OECD outlook figures – and much of it will likely come from increased production over and above what it would have been without biofuels.

The three projection exercises of the first part of the volume disagree on the extent and likelihood of a global stress in food markets. However, they all seem to point towards two main challenges. First is the need to improve efforts on the supply side of the market, towards increasing productivity. This is especially urgent in poor developing countries, given that they may be vulnerable to changes in the natural environment, and that their consumption levels are more directly related to production. Second is the need to improve the functioning of agricultural markets, again especially in poor developing countries, where transaction costs and lack of infrastructure may hinder the transmission of scarcity signals and contribute to distorting incentives. The three outlook exercises attribute different emphases to the generation and adoption of technology, but there seems to be less controversy regarding the importance of market incentives and policies to promote increased productivity as one way of addressing undernutrition. As noted in Chapter 11, the three projection exercises pay less attention to opportunities; in fact, higher prices over the coming decades, although a potential problem for poor consumers, may also serve to drive investment and technical change, as well as an improved functioning of production chains.

The second part of the volume presents less controversial evidence. This seems to be mostly the consequence of one key assumption – made in Chapters 4 and 5 and described in Chapter 11 – of faster GDP growth in non- OECD countries compared with OECD ones. In Chapter 4, Hillebrand indicates that global per capita income is expected to grow at an average annual rate of 1.9 to 3 percent from 2005 to 2050, corresponding to 2 to 2.9 percent in high-income countries,

and 2.4 to 3.6 percent for developing countries. The faster dynamic of the latter group is expected to generate significant reductions in absolute poverty and undernourishment. If Hillebrand's "high" scenario GDP projections materialize, which is an optimistic scenario, the incidence of global poverty could fall from about 21 percent in 2005 to 2.6 percent in 2050, and the number of people living in absolute poverty could decline by 1.1 billion. The absolute gap between per capita incomes in OECD and non-OECD countries, and the global Gini coefficient are still expected to remain high. That is, relative inequality is still expected to remain high between today and 2050.

However, Hillebrand also shows that if regions that have been lagging do not achieve growth rates higher than those observed in the last 25 years, the picture may be far different, and poverty could still be considerable in 2050, especially in sub-Saharan Africa. The picture may also look less optimistic if resource constraints are taken into account, or if the assumption that technological solutions will become available is relaxed.

Agriculture can contribute significantly to economic growth, especially in developing countries, where the sector's share in GDP is relatively high. However, if growth prospects materialize, one challenge in these countries will be the adjustment that is likely to be associated with growth. Agriculture will be called on to adapt and diversify its productive role. In this respect, bioenergy could constitute an opportunity for farmer communities to obtain access to larger and possibly more dynamic income sources. Price conditions, so far, do not seem viable: the use of agricultural feedstock for energy production is mostly policy-driven, apart from in few cases, such as Brazil. More opportunities may be found in the area of environmental services, provided that private and public demands combine to create viable markets.

The potential impacts of climate change on economic growth, analysed by van der Mensbrugge and his colleagues in Chapter 5, appear altogether limited. As also Alexandratos notes in Chapter 11, the highest impacts would occur in South Asia and sub-Saharan Africa, where income in 2030 may be, respectively, 4.5 and 3.5 percent lower. Globally, agriculture is the largest user of natural resources, accounting for about 14 percent of total greenhouse gas emissions without considering deforestation, and for up to 30 percent when deforestation is included in the computation. The characteristics of agricultural production processes therefore have an important impact on carbon emissions and mitigation.

Based on this picture, one challenge for global agriculture is to be able to counteract its own potential negative impact on climate change, while contributing to climate change mitigation. As FAO (2009) shows, there are many potential synergies between certain agricultural practices and climate change mitigation.

The challenge is therefore to enhance the latter while reducing the former. This entails the adoption of specific farming practices, such as crop rotations, more efficient fertilizer use, low-energy irrigation and conservation techniques, which are often site-specific. Opportunities may be explored for providing farmers with incentives for adopting these practices, so that they can assume the short-run costs of adapting production systems while improving the long-run sustainability of their activity.

The third part of the volume quantifies the amounts of capital, investment and natural resources required to produce the foods, feeds and fibres that are expected to be demanded and consumed in 2050. The resource outlook proposed by Bruinsma in Chapter 6 makes the point that at the global level, the amounts of land and water available is probably sufficient to support the increase in production needed to satisfy projected consumption. The projected growth in crop production to 2050, following the FAO baseline, would result in a net expansion of arable land of about 70 million ha, with an increase of 120 million ha in developing countries being offset by a decline of about 50 million ha in developed countries. Globally, available water resources are also judged to be most probably sufficient to support expected yield increases, but they are unevenly distributed: there is already considerable scarcity in the Near East and North Africa and in South Asia, and the situation in these regions is projected to worsen. More in general, one interesting conclusion in Chapter 6 is that yield increases that may materialize are likely to bring about increased environmental pressures. Considerable efforts are therefore required to manage resources more efficiently. Public interventions and private participation will be necessary to prevent and mitigate damages.

These requirements have to be added to an already large bill. In Chapter 7, von Cramon-Taubadel and colleagues argue that fixed capital stock in agriculture, at the global level, has been growing steadily over the last three decades, although at declining rates. Government expenditure on agriculture is correlated with capital formation in a sample of developing countries, and is shown to have a significant positive impact on total factor productivity (TFP), as well as on foreign direct investment. According to Schmidhuber, Bruinsma and Boedeker in Chapter 8, the amount of gross investment required for developing countries' agriculture to produce a volume of supply consistent with FAO's long-term outlook is projected at USD 9.2 trillion over the next 44 years, corresponding to an annual gross investment of about USD 210 billion, from both private and public sources. Primary agriculture accounts for about 46 percent, while the rest is projected to be absorbed by processing, transportation, storage and other downstream activities. Within primary agriculture, mechanization and irrigation would together account for about 54 percent. Net investment is projected to show a declining trend over

the coming decades, owing to various reasons, including the expected decline in the rate of production increase. This tendency should complement the shift towards more efficient input use and more capital-intensive production, in which capital is expected to replace labour at an increasing pace. Sub-Saharan Africa and Latin America show incremental capital output ratios that are lower than those in other parts of the world. This suggests that large additional supply can be obtained with relatively less capital investment in these regions.

Over the last few years, agriculture has attracted considerable attention in high-level political fora, following the sense of urgency generated by the turbulence of world prices. A number of international initiatives have been launched recently, accompanied by resource mobilization commitments: the Aquila Food Security Initiative, the European Union's (EU's) food facility, and FAO's Soaring Food Prices Initiative; the establishment of the United Nations (UN) Secretary-General's High-Level Task Force on the Global Food Security Crisis, and the reform of the UN Committee on World Food Security. Coherence in resource mobilization for agriculture and food security is sought through the Global Agriculture and Food Security Programme. National policies are also evolving fast. Recent initiatives by the governments of large countries such as China, the Russian Federation, India and Indonesia indicate a shift of emphasis from emergency measures, such as export restrictions, towards increasing productivity and improving risk management, which are becoming prominent medium- to long-term objectives. Translating this renewed attention to agriculture into increased income opportunities for poor farmers and increased participation of smallholders in national and global production chains in developing countries is a major challenge. This depends on how specific policies are shaped, and where resources are invested. This chapter's section on Policy directions provides some insights on this.

The fourth part of the volume deals with the more specific and technical aspect of what the research system can do to foster productivity in world agriculture. Research capacity is increasingly concentrated in a few countries, and efforts to build collaboration at the global, regional and national levels still appear insufficient. Investment in public agricultural research declined globally during the 1990s, especially in the regions where it may have had the strongest impact on poverty, such as sub-Saharan Africa. However, the challenges are increasing, owing to climate change and possible increase in weather variability and water scarcity. It is not easy for governments to increase expenditure, because of fiscal constraint and the fact that benefits from investment in agricultural research materialize only in the long term: hence the condition of generalized underinvestment.

In Chapter 9, Beintema and Elliot show that the share of expenditure on agricultural research in total expenditure devoted to agriculture is fairly similar across national income levels, and that while total expenditures on agriculture are low in absolute terms, they represent a higher share of total public expenditure in low-income agriculture-based economies than in wealthier countries. It therefore appears that low-income countries as a group are not underspending on agriculture compared with higher-income countries. However, the share of agricultural research expenditure in agricultural GDP, which the authors call the “agricultural research intensity”, is lower in developing countries. There does not appear to be any useful benchmark in this domain, although the International Food Policy Research Institute (IFPRI) suggests that research is still the most productive investment for supporting agriculture, followed by education, infrastructure and input credits. Moreover, research would imply a larger impact on productivity than non-research spending (Fan and Rao, 2003). An interesting development of this analysis could be the comparison with alternative policies, in terms of cost, feasibility and coverage. This would provide insights into the costs and benefits of more than one alternative.

In fact, yield increases are slowing down in developing countries, despite the existing potential. In Chapter 10, Fischer, Byerlee and Edmeades analyse this point in detail. They show that wheat has an average yield gap of about 40 percent, while for rice the gap averages 75 percent, and for maize it ranges from 30 to more than 200 percent. Reducing these gaps, especially that for maize in sub-Saharan Africa, is a primary goal. Chapter 10 also reveals that there is considerable scope for pushing the agricultural technology frontier outwards in the short to medium term, as many new technologies at an early stage of adoption promise to enhance productivity sustainably. These include conservation farming approaches and biotechnology – each still used on less than 10 percent of the world’s cropland – and information and communication technology, which is at an even earlier adoption phase and seems to be particularly promising in terms of efficient inputs management. Plant breeders continue to make steady gains in potential yields and water-limited potential yields, more slowly than in the past for wheat and rice, but with little slowdown in the case of maize. New opportunities are also presented by genomics and molecular techniques, which are now regularly applied to speed up breeding processes in seed companies.

It takes considerable time and resources to develop new technologies and bring them to the field. Despite the increase in private sector research and development (R&D), most of the world’s resources devoted to agricultural research are still public. A few large countries account for the bulk of agricultural R&D spending, but the social returns on such spending have been and still are

quite high. Some of the large countries that have invested heavily in agricultural research, such as China and India, have experienced rapid yield and general productivity growth, with subsequent general income growth. However, the rate of growth in agricultural research investment has been declining globally, and a large number of developing countries experienced negative growth rates during the 1990s, especially in sub-Saharan Africa. In the last decade, while a number of mostly larger African countries have increased their commitments to agriculture and agricultural research, many countries still experience declining agricultural spending.

Existing synergies among technologies should be taken into account and enhanced. Reducing yield gaps is likely to require improved efficiency throughout entire production processes, including better information and skills for input use. In other words, TFP – which measures the value of output over and above what can be accounted for by physical inputs – needs to improve. R&D appears to be one of the major drivers of TFP; other factors that contribute significantly to enhancing TFP are extension services and education, which allow farmers to close gaps between farm and attainable yields. Improved infrastructure is also important for reducing yield gaps, especially those between attainable yields at undistorted prices and attainable yields.

Can data and analyses be improved?

In recent decades, the technical possibilities for researchers to exchange and share data and resources have improved significantly. However, comparisons of projection exercises in similar subject areas highlight basic controversies, if not inconsistencies. Starting points, such as historical information, can be different, and account for many of the differences in results. Such differences may also prevent comparison of the impacts of the different theoretical assumptions that inform different projections. For example, this is the case of demand and supply projections to 2050, and of the use of feedstock in biofuel production, as shown by Alexandratos in Chapter 11.

The tools now available for analysing long-term developments of world agriculture are extremely wide-ranging and complex. To mention just a few, general equilibrium models, integrated assessment models including climate and economic variables, and geo-referenced databases are today relatively accessible. This richness is an advantage in terms of the potential information that can be produced, but it also requires that analysts maintain access to and knowledge of several large data sets, and make assumptions that range over a large number of subjects, encompassing both natural and social sciences. This is seldom feasible for individual researchers or even research groups.

Communication, networking and exchange of data and analytical tools among concerned institutions, working groups and individual analysts are among the most promising ways of addressing such complexity and the need to integrate several subject areas, and of improving the transparency and comparability of results. A methodological discussion of the land market – land is just one aspect of global agriculture, and encompasses biophysical, social and economic information and analysis – concludes that “there remain significant barriers to entry in this field of study. ... [and] ... there could be tremendous returns to public investments in open-source, publicly available data base infrastructure for explicitly spatial, global analysis of long-run issues related to agriculture and its links with the environment” (Hertel, 2010: 46). Similar considerations apply to more complex phenomena, such as climate change, the interaction between agricultural and energy markets, and development of the biofuel industry.

Equally important, and related to this issue, is the need to establish better dialogue between scientists dealing with the natural environment and social scientists, such as economists. Analyses in Chapters 2 and 3 – where Msangi, Rosegrant and Fischer study climate change and biofuel development scenarios – demonstrate how results are driven, *inter alia*, by how the interaction between biophysical and economic variables is modelled. In this area, biophysical analyses seem mainly to emphasize the limitations imposed by expected changes in the natural environment, and the finite dimension of resources. Economists, on the other hand, may emphasize more how agents can adapt to changes in the natural environment, and the role that incentives can play in adaptation. To date, the role of incentives seems to be less clearly identified – at least in analyses of the prospects for global agriculture. A lot of emphasis is placed on mitigation and adaptation, and on what could be promoted by policies, but projections for global agriculture seem to make less effort to model technology adoption and the latent demand for innovation. The expected changes in the natural environment may well affect these mechanisms, and this aspect of adaptation to and mitigation of climate change impacts is also highlighted by the World Bank in its most recent World Development Report (World Bank, 2010: Chapter 7). Incentives for entrepreneurs to adopt innovations, as well as existing technologies, depend largely on the environment in which they operate, and the possibilities for obtaining finance for the investment and risk management involved in more efficient technologies are key elements of this environment. Adaptation to changes in the production potential of different areas is included in Chapter 2, through the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) and a wide survey of crop models; in the Agro-Ecological Zone (AEZ) model, which is behind Fischer’s work in Chapter 3; and in the ENVironmental Impact

and Sustainability Applied General Equilibrium (ENVISAGE) in Chapter 5. These seem to be based on a wealth of engineering parameters, but seem less equipped to represent explicitly the economics of technology adoption. Given the size of the gaps between potential and actual yields, this seems to be an area where additional efforts could be useful. More needs to be understood about the reasons for technical inefficiencies, if any, and also the reasons for wide discrepancies between economic and technical efficiency, which may explain yield gaps. This point is further explored by Fischer, Byerlee and Edmeades in Chapter 10.

Other areas that could generate useful results are the sensitivity of projections to assumptions regarding income and population. The analyses presented in this volume typically assume population as an exogenous influence, with data sourced from the UN. The evolution of population, as noted in Chapter 11, is among the major drivers of several projections. Population is one of the few variables for which projections are available for distant years into the future, given that its dynamic is considered relatively predictable. In fact, most results presented in the volume are sensitive to population assumptions. One interesting topic, which seems not to have been explored in depth at the global level and in connection with agriculture, is migration. As well as the sensitivity to assumptions about the overall global population level – the 9.2 billion people expected in 2050, according to the 2008 UN medium variant – it would be interesting to study the long-run impact that potential changes in the distribution of population across regions could have on agricultural and food demand and supply. Qualitatively, the migrations observed today come from some of the regions where the ratio of population to resources is reported to be high, or where per capita incomes are low. For instance, results in Chapter 6 indicate that the ratio of population to resources is already high in the Near East and North Africa and in South Asia, and is expected to increase further in the future. It would probably be worth exploring how assumptions about migration affect projections and analysing scenarios in which population is endogenous with respect to economic variables or changes in climate variables.

Nutrition is another area where projections of global agriculture could benefit from more information. Projections of changes in the number of undernourished people undertaken by FAO and IFPRI – and referred to in Chapters 1, 2 and 3 – are computed mostly on the basis of total available calories, albeit using different methodologies. Calories are an efficient proxy of the overall nutrition status, especially when the focus is on undernutrition. However, nutrition and its adequacy are typically multidimensional: proteins, fats and micronutrients are of great importance in determining an adequate nutrition status, at all income levels. Furthermore, health and nutrition status interact with the ability to absorb

and use foods correctly. Malnutrition is notoriously a growing phenomenon in many countries, including many developing ones, especially where calorie intake is increasing rapidly. Evidence from large long-term surveys shows that obesity has increased substantially over the past decades (Finucane *et al.*, 2011) and is mounting in developing countries, following fast population growth (Shetty and Schmidhuber, 2006). Recent provisional projections from FAO – not included in this volume – show that obesity may become an even more pressing issue than undernourishment in the coming decades. The interactions among quality of nutrition, poverty and agriculture are attracting increasing attention. Imbalances in diets associated with poverty in developing countries may in some cases be as problematic as insufficient amounts of calories. It is well known that nutritional imbalances may be a cause of low labour productivity on the one hand, and a consequence of limited production possibilities within subsistence agriculture on the other. Associated with this is another important information gap, on food waste. Food consumption data are still largely computed from total availability (production + net trade + stock changes) in the food balance sheets, after deductions are made for non-food uses (industrial non-food use, seed and waste). Estimates of waste rates are in great need of improvement, but can only be assessed through costly sample-based statistical analysis.

More detailed information on nutrition – based on multiple parameters and more accurate food composition data – and consumption may contribute to improving the projections for food insecurity and malnourishment. These are areas where substantive benefits may arise from the type of collective efforts described for geo-referenced data: sharing resources across the key national and international institutions that produce, maintain and use them can improve data quality.

Two additional areas should be considered as potential generators of interesting scenario analyses on global agriculture: international political economy, and gender analysis. The way in which nation states and firms shape their relations interacts with markets and, more generally, contributes to determining economic outcomes. International trade is one area that can be directly affected by international relations, through both rules, such as trade agreements, and transaction costs. Foreign investments and financial flows can also play a role in shaping economic perspectives. Some contributions in the area of international political economy produce scenario analyses (e.g., Patomäki, 2008) that could be introduced into projection exercises. Regarding gender analysis, the economic impact of existing gaps in opportunities between men and women is attracting increasing attention. A recent comprehensive analysis of the available evidence on this subject (FAO, 2011) shows that this economic impact may be substantive

in agriculture. Changes in productivity brought about by increased gender equality could also be factored into future scenario analyses, to gain relevant policy indications.

Policy directions

This section is divided into three subsections devoted to policies directed towards addressing market failures in demand, supply and global public goods.

The demand side

In recent years, the volatility of world food prices has placed renewed emphasis on a number of phenomena that affect the global food system from the demand side. Policies affect the demand for food and agricultural products from a variety of entry points. In the coming decades, the demand for raw homogeneous agricultural products is expected to slow down, due to the small income elasticity of demand for these products, coupled with increasing global incomes and growing urbanization. This result is highlighted in several chapters in this volume, particularly in the first part. It suggests that the share of basic food in total food consumption is likely to decline in the coming decades, and this may result in a decline of the global price elasticity of the demand for basic food products. Under such conditions, in which demand will be relatively stable, any cause of supply disruption is likely to determine large price swings in the global food system. Hence price volatility may increase. Although this topic is not directly addressed in this volume, it is probably going to become a major concern for policy-makers, and increasingly so in the future, as the share of urbanized population potentially affected by volatility grows larger. Especially in developing countries that depend on imports, policies for dealing with unpredictable price volatility are likely to attract increasing attention.

A related development that is bound to shape demand-related policies is the degree of price transmission from international to domestic markets. Transmission is affected by policies, such as trade policies, infrastructure and their efficiency, and by the marketing system. Prices are the most important signals affecting demand and supply responses in both the short and long runs. It appears that the downwards trend in real agricultural basic commodity prices, which was a feature of the global food system for many decades, has stopped. The issue is whether policy-makers should allow the changing price signals to be reflected fully in domestic prices, and hence guide producers and consumers, or should manage domestic prices and allow imperfect pass-through, to achieve specific domestic objectives.

Deviation of domestic from global equilibrium market prices for long periods is a risky proposition, even though the latter may be influenced by policies enacted by other trading countries. As prices affect both domestic demand and domestic supply, it is always prudent to follow global price developments to project proper signals for domestic agents. However, a case could be made for preventing the full brunt of short-term unpredictable international price changes from being fully reflected in domestic prices. Whatever the domestic issues that may dictate such a policy stance, the relevant price deviations should not be allowed to persist for long periods, to avoid creating permanent distortions in domestic markets.

More than one chapter in this volume highlights the growing reliance of a number of countries on imports for the fulfilment of domestic food needs. This leaves them more exposed to global market variations, and highlights the need for them to be able to afford the necessary food imports. It also highlights a policy dilemma that many governments may contemplate: whether to increase the degree of their countries' self-sufficiency in food, to reduce their exposure to trade. The feasibility of this depends on the domestic production possibilities, supply conditions and government's ability to affect domestic demand. Policies can influence demand in a variety of ways. Irrespective of the feasibility of such a policy stance from the production perspective, however, the issue here is whether a country should use demand-side policies to change its exposure to international trade. While such policies may be feasible in the short run, for instance via trade controls, they may not be sustainable in the medium to longer run, owing to their impact on other countries and to existing international trade regulations.

As observed in Chapters 4 and 5, strong economic growth is the key to future poverty reduction. Nevertheless, poverty will remain in some parts of the world, especially sub-Saharan Africa. And, as seen, the decreasing price elasticity of demand for most agricultural products may make food price spikes more frequent. These two points highlight the importance of safety nets relating to food security for vulnerable populations, especially in the perspective of less predictable international market prices.

In Chapter 2, Msangi and Rosegrant indicate that in terms of social protection of the most vulnerable sections of the population, much can be accomplished through policy-driven strengthening of national social "safety net" programmes, which provide relief for those who are most threatened by escalating food prices, while avoiding blanket policies such as price controls, which are easier (and cheaper) for governments to enact, but which have the perverse effect of reducing the producer response that could otherwise soften the price rises through increased output. As Msangi and Rosegrant highlight, the main challenge of policy in this case is to balance the need to maintain producer incentives and avoid distorting

self-correcting signals from markets, while supporting human welfare through protecting the most vulnerable.

Major issues for such programmes are how to build on households' existing coping strategies, and how to achieve efficient targeting. Programmes need to be wide in scope, to support households beyond the short term. They may include measures to protect the short-term nutrition levels of those most in need, along with measures that can restore assets, to enable households to maintain productive capacity. Regarding targeting, although general food subsidy schemes often benefit many food-insecure households, they may also result in large leakages to the non-poor. The ideas and methods employed in recently implemented conditional cash transfer programmes provide a fertile area for adapting traditional food safety net programmes (European Commission, 2010). Food safety net programmes can also make a significant contribution to growth by partially alleviating the need to self-insure. However, these programmes may discourage poor households from investing. A large share of their savings, for instance, may be used to constitute food reserves. Social protection can also promote growth by creating physical assets through employment schemes. Public works programmes can make particularly relevant contributions – in both supporting the entitlements of the vulnerable and improving the access to markets and basic services that is essential for longer-term economic growth – through the provision of appropriate public infrastructure goods.

Another set of policy tool that may be worth exploring and enhancing is food-related global safety nets. These may assist countries that become unable to pay for increased food import bills in periods of high food prices. Global safety nets can be based on different measures, including those aimed at insuring food import bills. Countries could consider insuring their financial needs, to reduce the impact of high food import prices. Schemes may be conceived for providing relief through physical or monetary means, aimed at partially compensating for higher-than-expected costs of food imports.

In Chapter 5, van der Mensbrugghe and colleagues highlight the role of what they term the “emerging global middle class”. This is a large population group that is projected to grow to about 2.1 billion people, or 28 percent of the global population, and will be found almost totally in developing countries, especially China and India. The food needs of the global middle class will affect global food demand. Hence policies will need to anticipate its changing preferences, as well as its food demands.

A major demand-related area where policy can be influential is the demand for food commodities for biofuel production. As seen, the likely size of this market varies across the projections: Msangi and Rosegrant (Chapter 2) and Fischer

(Chapter 3) indicate that the use of agricultural feedstocks for the production of biofuels is likely to grow in the medium to long term. Alexandratos (Chapter 11), instead, argues that at least the cereals involved in this type of use are likely to remain small compared with world aggregate consumption. Large persistent increases in oil prices – arising from phenomena unrelated to agriculture – can alter the economic fundamentals and make biofuels less dependent on mandates and more on market forces. In such circumstances, intensified competition for feedstock crops (and the underlying resources) will tend to siphon off supplies and resources from the food sector, to the detriment of the food security of weaker population groups. The eventual advent of second-generation biofuels may ease the impact, but will not eliminate it. Msangi and Rosegrant make the point that it may be useful for policy interventions to limit the use of agricultural feedstocks in first-generation ethanol and biodiesel production. Direct support to biofuel producers and blenders, and blending targets are currently applied in developed countries, along with trade barriers. These measures are likely to have significant impacts on global agricultural markets. If developing countries adopt similar measures, demand-side pressure in the feedstock markets will increase. Such policies currently present challenges in terms of fiscal affordability in developing countries, and their monitoring and coordination at a global level seem to be a fertile area for future policy coordination.

A consequence of a highly interdependent world food system is the establishment of global supply chains, such as exist today. A main driving force behind this phenomenon was the development of supermarkets and large food processors. Consumers have played a willing role in this development and, with the increasing size of the global middle class, these tendencies may become more manifest. In developed countries, the successful attempt to package foodstuffs as having attributes of health and environmental responsibility, along with animal welfare and fair labour conditions in some cases, has transformed the economics of food production and trade. In developing countries, middle-income consumers have embraced the availability of non-local foods and the better reliability and quality control that can come with company size and management expertise. Most of these tendencies have given rise to private standards that are additional to or different from those applied under the Sanitary and Phytosanitary Agreement of the World Trade Organization (WTO), which sought to control governments' ability to set import standards that were not justified by risk assessment and not based on scientific evidence. The Sanitary and Phytosanitary Agreement has been useful, particularly in the area of animal and plant diseases, but it has been less effective in the area of private standards. In terms of policy, the importance attached to food safety and quality point out the need to expand the international

discussion on these topics. It would be useful to improve the regulation of non-safety-related standards in traded foods, and to review health and safety standards periodically, in light of changing scientific evidence.

In sub-Saharan Africa – as argued in Chapter 11 – food consumption is likely to be directly related to the evolution of domestic food production, more than to income growth. With limited shares of imported food in total supplies, high economic dependence on agriculture and little non-food use of food commodities, food consumption follows the evolution of production. This implies that policies for dealing with consumption in this region are largely intertwined with those for production.

Despite the slowing rate of growth in demand for cereals and meat, increases in income are still bound to lead to fast growth of meat consumption, especially in middle-income developing countries. Hence demand for feeds will also increase rapidly. This raises the issue of whether demand policies should target the dietary patterns of the growing global middle class, through nutrition education aimed at slowing the growth in demand for meat and meat products and reducing diet-related diseases. This policy issue would be more relevant in developed countries, where meat consumption and diet-related diseases are high (on a per capita basis, almost three times as high as in developing countries), but it also applies to developing countries with fast growth. The policy issue in this case is how to orient consumer behaviour towards more healthy habits. While large-scale nutrition education campaigns could assist, appropriate consumption taxes to discourage the consumption of specific types of product could also be envisioned. Mazzocchi *et al.* (2009) provide a wide discussion of these topics, mostly with reference to developed countries. The limited evidence available on campaigns shows that they may have a low impact, mainly on consumers who are already well informed. Labelling can be effective, to some extent. Taxes and subsidies for healthy foods can be effective in orienting consumers towards healthy foods to some extent; but as Schmidhuber and Traill (2006) observe, where the income elasticity of food is small, taxes can hardly affect consumers' behaviour. Hence education campaigns still need to be considered a key tool in this field.

An interesting demand-related policy direction may be the use of consumption taxes to transmit to consumers the resource and scarcity values of various raw materials that enter the food they eat. For instance, if a food product uses a water-intensive raw material and water has a high scarcity value, which is not reflected in the product's commercial price, consumption could be discouraged by the imposition of relevant resource-related consumption taxes. Such taxes could be imposed nationally or, if there are global resource sustainability issues, globally, by international agreement. The matter, however, is quite complex, as

some of these taxes may imply considerable side-effects. This would be the case, particularly, of taxes imposed on energy-intensive production.

The supply side

One major conclusion of the analyses in Chapters 1 and 6 is that the world will need to increase agricultural production by about 70 percent between 2005 and 2050, to satisfy the growing demand for food and agricultural products. About 80 percent of this increase will need to come from increases in productivity, such as higher crop yields. To ensure that production prospects materialize with minimum negative side-effects, adjustments are likely to be necessary, especially to allow the transmission of appropriate scarcity signals and to correct market failures through policy interventions.

Agriculture is a part of almost every country's economy, and is a potential contributor to growth, but countries differ in their factor endowments and institutional settings, and there are large differences in how agriculture can contribute to growth and poverty alleviation. Based on their stocks of natural and human resources, and their existing potentials for agricultural growth, countries should design policy intervention with the aim of promoting production that generates higher actual and potential comparative advantages. There are no unique recipes for agricultural development. Instead, countries could identify their specific binding constraints and market failures, and address these. Such strategies, moreover, should not be static. They should take into account past experiences, developments in technology, changes in external and internal constraints, and emerging concerns.

A major shift in the focus of agricultural policies is required, and is partly taking place, from a product production approach to a value chain approach. Supply improvements through the implementation of production-enhancing measures alone may not be sufficient. Supply depends on a variety of downstream and upstream activities. For instance, unless a fertilizer supply system is in place, enhanced technology that is based on increased fertilizer applications may not be adopted, or may be adopted inefficiently. Similarly, unless the marketing side of any new volume of production is assured, efforts to increase supply may be thwarted.

To understand the various policy issues relating to supply it is helpful to adopt the yield definitions of Fischer and colleagues in Chapter 10. The gap between yields attainable under actual conditions – i.e., economically attainable under profit-maximizing conditions – and farm yields observed under current practices is largely due to improper practices, which may be improved through extension. The second gap, between yields attainable under efficient markets and

actual yields, is due largely to factors beyond farmers' control, but within the scope of government policies. The third gap, between potential yields and yields attainable under efficient markets, is largely due to knowledge gaps. Policies can contribute to narrowing all these gaps, and this results in an increase of TFP.

Information on the size of the different yield gaps identified in Chapter 10 would assist policy-makers in prioritizing interventions. However, such information is rarely, if ever, available. What is more frequently available is information on the technical and allocative efficiencies of the agriculture sector, which relate to input use to achieve specific output levels or yields. Technical and allocative inefficiencies can be dealt with by policies relating to knowledge, through extension, and policies for removing factor distortions that prevent efficient factor use, such as inputs and credit.

A major policy issue for the coming decades appears to be how many resources to devote to increasing potential yields, and how many to closing the various yield gaps. For individual countries too, the major policy issue concerning agricultural supply – apart from expanding the resource supply – seems to be whether to emphasize the increase of potential yields or the closing of yield gaps. This must be decided at the country level, as the policies needed for each sphere are different. Unfortunately, some gaps may be easier to close than others. For instance, increases in potential yields may be derived from improved seed varieties, which may be relatively simple to distribute among and take up by farmers under existing input and market settings. Reducing factor market distortions, such as those affecting the supply of credit, may be more difficult. Given the large yield gaps in many developing countries, particularly in sub-Saharan Africa, policies aimed at closing yield gaps would seem to be preferable to policies aimed at raising potential yields, and therefore potentially making the yield gap even larger.

Governments' commitments to agriculture depend on their perceptions of the sector's potential for overall growth. In developed countries, where the yield gap is smaller, the best strategy seems to be to devote available public R&D resources to pushing the technology frontier outwards. A growing share of total agricultural R&D expenditures in these countries is financed by private companies. It is known that the private sector can capture only a share of the benefits of technology, and that some innovations produce hardly any appropriable benefit; hence the need for public-private partnerships. Concerns have been expressed because the total public resources devoted to agricultural R&D in developed countries are not increasing in line with either the likely social returns or the importance of future challenges. As indicated in Chapter 9, the private sector is unlikely to make up the difference, and the private sector also benefits from the basic research results that originate in publicly financed research. It is therefore important to keep up

the momentum of public funding for agricultural R&D in developed countries, concentrating it on more basic research with longer-term benefits.

Among developing countries, large ones such as China and India that have no option but to supply a large share of their food needs from domestic production, will need to continue devoting resources to pushing out the production frontier, and they are already doing so. For smaller countries, supply-side policy options regarding technology may be related more to the issues of closing yield gaps and improving productive efficiency than to pushing out the yield frontier. In this context, resources should be devoted to maintaining the capacity to assess a country's potential in terms of water resources, soils and climate; where to obtain the necessary knowledge, science and technology to realize its potential; and where partnerships need to be negotiated and technology needs to be purchased.

R&D needs to become more responsive to farmers' needs, and one way of achieving this is via partnerships with farmers' organizations. Such partnerships can take many forms, ranging from simple consultation, to formal representation in research bodies, and financing via levies on specific products. More farmer participation in extension services can also be envisioned, and is crucial in bringing new technologies to the production level. Extension governance can be decentralized to the regional and local levels, with farmers' representatives being directly involved in the decentralized governance of technology and extension agencies.

A major policy issue for most developing countries is the private sector's role in providing some of the services that are traditionally deemed as being in the public sector's sphere. A major pathway for smallholders' integration into larger national and international markets involves contractual agreements between farmers or farmers' groups and a company with the technology and marketing network to take up production. For many developing countries, therefore, policies should be put in place to facilitate private companies' partnering or subcontracting of local producers to increase the production of certain products. Such companies can bring technical expertise, extension and ancillary services, such as credit and marketing, to increase production in specific areas and products. The environment for their operation should therefore be a focus for policy in many developing countries. Technology adaptation can also be enhanced by partnerships between the public and private sectors.

In Chapter 10, Fischer and colleagues point out that a key agricultural technology is irrigation, which is drastically underinvested in some regions, including sub-Saharan Africa. Chapter 6 shows that the global area equipped for irrigation in developing countries could expand by 32 million ha by 2050, especially in land-scarce regions such as East Asia, South Asia and the Near

East and North Africa. However, as Chapter 10 highlights, increases in irrigation would have to be accompanied by corresponding investments in installing adequate drainage facilities, to avoid problems of salinity. The policy issues in this area include the types of irrigation to be promoted, the institutional setting for managing irrigation systems, and the financing of irrigation schemes. Irrigation policy also needs to focus on minimizing waste and improving water efficiency.

A major way of closing the yield gap in many developing countries, as pointed out in Chapter 10, is to improve the functioning of markets. In this context, policies may need to target the reduction of margins between prices at the farm-gate and at central market locations. Large margins lead to disincentives for farmers and other stakeholders along value chains. At the same time, supply response also depends on the availability of credit, insurance, information and inputs. If agricultural supply in developing countries is to be made more responsive to market signals, improvements will be needed in all of these areas. Of crucial importance is the supply of financial services to farmers; the range of innovations in this area has included microfinance. However, apart from policies to support such institutions, there is also large scope for policy to assist the establishment of better financial services, by reforming public agricultural banks and linking them more closely with innovative institutional arrangements.

Agricultural production depends on the availability of inputs such as seeds, fertilizers and agrochemicals. The provision of many of these involves economies of scale, and most developing countries have relied on the public sector for this. However, given the well-known inefficiencies of the public sector, the role of the private sector needs more attention.

A new area for policy is the introduction of so-called “smart subsidies” to increase the use of crucial inputs such as fertilizer. Apart from its obvious budgetary cost, the use of subsidies needs to be carefully examined, and applied when there are good reasons to believe that such subsidies can overcome substantial market failures. For instance, if there are insufficient volumes of marketed products in some parts of a country, owing to low production, this may lead to an absence of permanent private marketing networks for the provision of inputs, as well as the marketing of outputs. In such cases, the use of time-bound input subsidies may lead to the expansion of marketed production at sufficient volumes to create the scale for the private sector to enter and provide the services and products cost-effectively.

Chapters 7 and 8 highlight the crucial role of agricultural capital in the production process, and the large amounts of new and, especially, replacement capital needed to meet the 2050 global targets. Imperfect as these estimates may be, they raise three major policy issues. The first concerns the choice of

appropriate locations for new investments in agricultural production. Policies should target regions and countries where the incremental capital output ratios are relatively low, to facilitate the productive use of underutilized or unutilized resources, especially land and water.

The second policy issue, related to the result presented in Chapter 7, is that government expenditure on agriculture is correlated with capital formation and has a significant positive impact on TFP. This confirms the decisive role of public expenditure in creating an enabling environment in terms of infrastructure and sustainable access to natural resources. Adequate incentives for the private sector, particularly farmers, to invest in productive assets largely depend on the possibility of establishing such an environment. Governments in developing countries may change priorities in budget allocations and avoid, or at least reduce, discrimination against agriculture. However, it must be noted that the nature of public expenditures for agriculture is important. Expenditures on infrastructure and extension may have different effects compared with expenditures for salaries in ministries of agriculture. Foreign direct investment is also strongly correlated with productivity growth, and the presence of an efficient bureaucracy, the lack of corruption and democratic political structures; policy should focus on improving these areas.

The third policy issue concerns the source of finance. The bulk of investment finance for agricultural capital needs to come from domestic savings, and the major sources of these are lending from the domestic banking system and own savings from farmers and other stakeholders along production chains. Policy needs to make sure that these savings are mobilized and recirculated to finance capital needs directed at productive investments, rather than, for instance, keeping them at the household level to finance self-insurance against unpredictable shocks.

In Chapter 6, Bruinsma points out that arable land for agriculture in developing countries needs to expand by about 120 million ha by 2050. This expansion would benefit from policy actions ensuring that any new land is developed and cultivated sustainably and equitably. As mentioned, this volume does not emphasize this aspect; but it is clear that focus should be on preventing the conversion of forest land into arable land; policies should discourage such conversion in environmentally sensitive areas and regions, while providing alternatives for people who encroach on forests in the absence of other livelihood choices. Another area for policy focus is the adoption of conservation farming using zero tillage. Chapter 10 indicates that this is a major opportunity for reducing fuel use in agriculture and sequestering soil carbon. As conservation agriculture is knowledge- and location-specific, there is ample scope for public policy to encourage such practices via adaptive research and knowledge management.

An important potential avenue for encouraging the adoption of such practices in developing countries is payment for soil sequestration schemes – an area on which both national and international policy should focus.

One way in which land expansion can be combined with sustainable agricultural practices is through the use of a cluster approach. In this approach, certain areas or regions within a country are designated as priorities for agricultural development, and infrastructural and other facilities are built to facilitate private companies' investments in a cluster of activities related to agricultural production. The advantage of such an approach is that public investment and policy are combined with private sector capital and expertise.

Global public goods: trade policies, domestic support and the environment

It has long been recognized that agricultural policies have distorted not only the domestic agricultural markets of most countries, but also international agricultural markets. The agriculture sector was the main cause of delay in concluding the WTO Uruguay Round of trade negotiations, and is one of the main causes of delay in concluding the current Doha Round. In addition, analysis of the recent food crisis revealed that a large share of the global price rises during 2007/2008 could be attributed to short-term trade policies (Headey, 2010).

Increased investment in agriculture and adequate incentives to farmers are required to meet the global challenge to 2050, as highlighted in the third part of this volume. A key question is how to shape and design support to farmers in both developed and developing countries, while minimizing global market distortions that are potentially harmful to developing countries, and promoting global food supply adequacy, food security for the undernourished, and poverty-reducing and growth incentives for farmers in low-income, food-deficit countries.

Agricultural support in OECD countries is costly and distorts international commodity markets. It also disproportionately benefits the wealthier households that own large amounts of agricultural land, while raising food costs, which disproportionately reduces the real incomes of lower-income households. However, agricultural support is not uniformly distorting. While overall OECD support to farming has been remarkably stable over time, periodic reforms undertaken since the onset of the Uruguay Round (Skully, 2009) have resulted in declining levels of market distortion, owing to a reinstrumentation of policies. Subsidies directly attached – or “coupled” – to production have gradually been reduced and substituted by measures that support farmers' incomes and reduce their risk exposure. Among trade policies, tariffs are the predominant form of border measure. Market price support and payments based on output have decreased, and export subsidies and foreign surplus disposal are now relatively minor, having been heavily used in

OECD countries in the 1980s. Since the Uruguay Round, many OECD countries have introduced direct payments to producers as partial compensation for reduced tariff protection and lower product-specific support. One form of direct payment, decoupled support, has been prominent in the United States of America and the EU. Direct payments still distort output and trade, but to a lesser degree than tariff protection. However, estimates suggest that import tariff barriers represent 81.4 percent of total support to agriculture in all countries: tariffs accounted for USD 691 billion, direct domestic subsidies for USD 97 billion, and export subsidies for only USD 61 billion (Anderson, Martin and Valenzuela, 2006). All of the 70 countries most penalized by agricultural protectionism are developing countries (Bouët and Laborde, 2009), which suggests that the Doha negotiations' market access agenda should focus on the cutting of market access provisions.

As OECD farm support has shifted from commodity-based to decoupled measures, farm incomes have become more variable, and safety nets in the form of risk mitigation measures, such as revenue or weather insurance, are increasingly being relied on to provide protection from unpredictable income swings. Agricultural insurance has been widely subsidized in OECD countries, and legally so for WTO, which classifies it as a "green box" or "minimally distorting" policy. For instance, in the United States of America, farm insurance and payments under crop and weather insurance are projected to reach USD 22 billion in the 2008 to 2012 period, a substantial share of total United States farm support. Nevertheless, such measures tend to distort incentives, especially regarding investments, and can be a partial substitute for direct support policies. OECD (2009) reports that risk-related policies account for a significant share of the producer support estimate in OECD countries, averaging about 51 percent in the EU and 63 percent in the United States for the 2002 to 2007 period.

In developing countries, the period before the recent food crisis saw steadily reduced spending and investments in agriculture, with the latter receiving a disproportionately small allocation of public resources (Bezemer and Headey, 2006). Foreign aid to agriculture also contracted during this period. Developing countries' farm policies have been driven largely by the need to accelerate the transition from low-income agrarian structures to more developed industrialized and service-oriented economies. The overall effect of such policies has mainly been taxes on producers. In the process, the agriculture sectors in many countries have faced negative policy biases and low growth, while import dependence has increased. However, when average incomes grow (typically to levels of at least USD 8 000 per capita per year), the type of farmer support in developing countries seems to turn positive and to follow a pattern similar to that of developed countries. The results from a recent World Bank study estimating agricultural distortions for

75 developing countries from 1955 to 2007 (Anderson, 2009) bore this out, by showing that broadly developing countries taxed agriculture via price and trade policies from the early 1960s to the late 1970s/early 1980s, before gradually reducing taxation and switching to slightly positive assistance to agriculture, in aggregate, by the mid-1990s.

Table 12.1
Non-distorting farm support for developing countries' agriculture

<i>Policy goal</i>	<i>Interventions</i>
Maintain or improve productive capacity	R&D: new varieties Better management techniques Efficient use of inputs: water, fertilizer, pesticides Development of input market systems Improved storage, processing, product quality "Hard" infrastructure: irrigation, land restoration "Soft" infrastructure: information systems, lower transaction costs, extension of best practices
Correct market failures	Facilitation of exchange between producers and buyers Provision of credit: subsidized Technology dissemination, farmers' training Support to producers' organizations/inter-professional agreements Promotion of value chain development
Reduce income and price risks/ uncertainty	Support to information for insurance markets Market information systems for exchange Investments in post-harvest storage Veterinary services for livestock Insurance/safety nets against crop failures, droughts, etc.
Improve food security and reduce hunger	Fostering of rural employment Targeted input subsidies: fertilizer, seeds Storage/safe processing for staple foods Subsidized credit for farm and off-farm activities Promotion/creation of demand for staple food/cash crops Increased R&D in staple food varieties, improved techniques Investments/subsidies for post-harvest storage Quality control for stored grain Improved processing for perishable staples
Preserve natural resources and environment	Soil fertility management More efficient use of water: proper pricing R&D in varieties adapted to climate change Best practices for lower levels of pesticides

Source: Elbehri and Sarris, 2009.

The issue in developing countries is how to support farmers, to promote production, productivity and food security, without generating large domestic and international distortions. Elbehri and Sarris (2009) list a variety of public interventions that could serve several developing country goals and be deemed non- or minimally distorting. These are reproduced in Table 12.1. Many of these policies have already been reviewed or mentioned in various parts of the book; Table 12.1 outlines those that are not likely to raise issues with WTO. Implementing the interventions indicated would be a tall order for any developing country, but they give a menu of possible non-distorting policies.

As well as domestic policies, many other events are likely to shape future agricultural trade and trade policies. The past 30 to 35 years, since the food crisis of the mid-1970s, have seen the emergence of a more globalized food system and the shifting of national and global policy concerns to issues of growth in non-agriculture and more open trade. WTO and the debates surrounding agricultural trade have tended to neglect food security concerns. Nevertheless, the recent global food market events have refocused many policy-makers' views back on to food security. In addition, there have been a series of developments that are likely to impinge considerably on global food markets and trade.

Projections presented in the second part of this volume suggest that growth in the next few decades, whether fast or slow, will be faster in developing countries, especially in Asia. As seen, this will increase demand for the most income-elastic food products, such as livestock products, fruits and vegetables. If most of the growth in many of the faster-growing economies occurs outside agriculture, the demand for imports will increase faster than overall demand. Concerns about how to satisfy this growing domestic demand for food will be a major factor in shaping developing countries' agricultural trade policies and their attitudes towards WTO in the years to come. Fast growth in non-agricultural sectors may induce the familiar (in developed countries) political pressure to ease the adjustment via subsidies to rural areas. This will bring pressures for protection or domestic support. If WTO restricts countries' freedom to apply relevant policies, conflicts may arise between WTO commitments and domestic adjustment pressures. WTO commitments may therefore need to allow policy space for countries that are at different stages of development.

Perhaps more worrying for the world trade system as a whole is whether the aftermath of the recent financial and economic crisis and the attendant slowdown in global economic growth will create pressure for trade disruptions. Of particular concern are oil supplies, which depend on a relatively small group of countries. Periods of inflation and slow growth in the past have been associated with sharp increases in the price of crude oil. The issue is whether the global trade system as it

has emerged since the Kennedy Round can survive self-preservation policies that may destroy laboriously established mechanisms. Fortunately, the world trading system embodied in WTO agreements seems to have survived the recent financial crisis quite well, and the main consequence seems to be the further stalling of the Doha Round.

The period since 1985 has seen a paradigm shift in management of the agricultural economy in both developed and developing economies, towards deregulation and more focus on preserving market signals and incentives and promoting risk management. In light of political demands generated by the increased food price volatility observed in recent years, an issue for the coming decades is whether the reform process will continue along the same path: in other words, whether the tendency will continue to be towards less market intervention and more risk management. Such a trend would be consistent with a more open trade system and removal of the impediments that developing countries face in supplying food to industrial country markets. However, the pace of reforms could stall if the Doha negotiations are delayed, or even abandoned.

A fundamental question is whether developing countries will follow the same pattern of protection for domestic markets and producers as developed countries. Much of the impetus for public intervention in developed country agricultural markets came as a reaction to different adjustment patterns in agriculture and non-agriculture sectors, and these pressures are already apparent in several developing countries that are going through a process of transition. Pressures from developing countries for relaxation of WTO rules pertaining to protection and domestic support to agriculture could become an issue in the next few decades.

The historical pattern of agricultural protection suggests that agriculture is first unprotected or even taxed at early stages of development, then goes through a cycle of protection and support while the country achieves middle-income status, when it is liberalized. If developing countries follow this pattern in the future, attempts to bind in WTO the current levels of protection and support may deny some developing and least-developed countries the policy flexibility needed to pass through the middle-income phase of their development. It is not clear whether developing countries will need to follow the historically traditional pattern and rate of protection of agriculture. However, if they do, and if the new WTO rules on agriculture do not allow it, pressures may be created for other types of support that are deemed compatible with WTO; in the worst case, this may threaten WTO itself. To prevent this, it may be appropriate to allow policy space for developing countries' agricultural trade-related policies.

Recent research has demonstrated that world trade in most products, including food products, is dominated by a few large multinational firms. Although this has resulted in more diverse and cheaper food and provided more

consumer choice, especially in developed countries, a side-effect is that corporate decisions can affect millions of farmers and consumers. Concern has grown that the concentration of economic power could, at some stage, constrain rather than empower farmers and consumers.

In manufactures, much trade moves within the same firm, as supply chains lengthen. The same trend is noticeable in the food trade. While many countries, especially developed ones, apply anti-monopoly and anti-trust laws within national borders, such rules are non-existent in international trade. Competition issues are among the so-called “Singapore issues” that many countries deemed undesirable as part of the current Doha agenda. One of the main problems that hamper developments in this area is the lack of appropriate information, as well as the legal vacuum. For instance, if a multinational company is monopolizing a market, which national or international authority should be responsible for disciplining it? Whether and when global competition policy will re-emerge remains to be seen.

Will the global food market begin to fragment as more regional and bilateral trade agreements are concluded? Or will these regional and bilateral agreements effectively merge to create global free trade? Large countries and trading blocs such as the EU, the United States of America and Japan have already concluded many bilateral and regional trade agreements, and more are under negotiation. Agriculture is usually included cautiously, if at all, to avoid upsetting the status quo, and its inclusion entails many exemptions. There is an inherent asymmetry in such agreements, as the larger country with a larger market has an advantage over the smaller one. Preferential access to the larger market is usually bought at the cost of freer entry of the developed country partner’s product into the smaller country’s market. A major obstacle to taking advantage of such agreements is adherence to the rules of origin, which can place undue costs and other burdens on many administratively weaker economies, with the consequence that the agreements’ potential benefits are not realized.

Finally, both the expansion of cultivated areas and the agricultural intensification indicated by projections to 2050 (particularly those by Bruinsma in Chapter 6) have significant implications in terms of global environmental policy. As mentioned, these are not emphasized in this volume, but it is worth recalling that agriculture emits about 30 percent of all greenhouse gases in the atmosphere (including through deforestation), and can therefore contribute to a reduction of such gases through environmentally friendly production practices. Key questions in the current debate are: How can society motivate farmers to reduce the negative environmental side-effects of agricultural production, while continuing to meet the increasing demand for farm products and enhancing the positive environmental

impacts? and How can countries agree on common policies to address global externalities?

Areas for future policy and analytical focus

Previous chapters, as well as the discussion in this one, have highlighted a very wide set of subject matters, policies and actions that will need to be explored to promote the global agrifood system's ability to respond to the needs of a growing and wealthier population, such as that expected in the 2050 perspective. Bearing in mind that there are still more questions than answers in each of these areas, this last section proposes a list of points that seem to follow from the analyses conducted in other chapters, and on which analysts and policy-makers may focus their attention. The following six such areas seem to follow from the analyses conducted in the rest of the volume.

- *Growing consideration of the demand side along with supply policies:* Until the end of the 1970s, the main focus of agricultural and food policies was production and the supply side. From the mid-1980s to more recent years, the emphasis was mostly on reducing distortions in world markets. The recent food crises have brought a renewed emphasis on the need to invest in agriculture and increase productivity. In the coming decades, the demand side is also likely to require an increased policy focus, to provide the proper signals for the supply side, and also to anticipate and even influence patterns of global food needs and the use of agricultural products. Increasing attention will likely need to be devoted to food-related policies aimed at orienting and informing consumers, to prevent malnutrition, reduce the incidence of diet-related diseases and ensure food safety. The outlook exercises suggest that poverty and undernourishment may become smaller problems compared with their current levels. However, food-related safety nets aimed at improving food access are likely to continue to play a key role, at both the national and international levels, at least in areas such as sub-Saharan Africa.
- *Production chains rather than individual producers should become the target and the focus of analysis and policy-making on the supply side:* Relations along production chains tend increasingly to shape incentives and outcomes for individual stakeholders, especially for poor farmers, whose ability to participate in this type of setting should be enhanced. Policies should increasingly focus on market failures that prevent production chains from working effectively, by simultaneously considering input and output markets, from the farmer to the final consumer.

- *Agricultural production expansion will need to rely on new technologies, but a lot can be achieved by simply promoting the adoption and adaptation of existing technologies:* As seen in several chapters of this volume, there are large gaps in productivity between developed and developing countries. This is clearly a major area for policy focus, and will necessitate major adaptations to existing institutional and incentive environments in many countries. However, it has also been pointed out that closing yield gaps alone will not be sufficient for meeting the 2050 production challenges. New technologies will most probably be required, and it appears that several R&D directions already promise to expand the production frontier considerably.
- *More sustainable production systems need to be promoted:* Current agricultural production practices in both developed and developing countries seem to have created a growing burden on the world's resources, such as land, water and the environment. While different conclusions may be drawn about the probability of a global Malthusian scenario, it is clear that the resource basis will undergo significant stress in some of the countries that are already more sensitive in terms of poverty and food insecurity. The thrust of agriculture in the future will need to be oriented towards far more resource-sustainable practices and technologies.
- *Climate change will need to be an integral part of agriculture and food policies:* It has become clearer in recent years that agriculture is both part of the climate change problem and a potential part of the solution. It will require a major shift of current policy thinking to acknowledge this in many countries, and to shape policies to make agriculture an integral part of the climate change adaptation and mitigation landscape. As seen in this volume, opportunities exist, and policies should assist in involving agriculture more in the overall international climate change debate and policy arena. Once more, emphasis should mostly be on those areas that are already more sensitive in terms of potential impacts on poverty and food insecurity.
- *The world trading system will need to be flexible to accommodate both old and new agricultural concerns:* The outlook exercises presented indicate a likely perspective of growing interaction among countries through trade in the coming decades. WTO has proved remarkably resilient and accommodating to changes in policies and views among its growing number of members. However, as the now developing countries become a larger part of the international trade sphere, rules related to

agriculture will have to be adapted to meet their concerns, and give them some policy space in the period of transition to a more developed status. As part of the future global trading system, a global mechanism should be considered for addressing competition issues at the international level. Although this is an overly ambitious proposition, the growing influence of multinational companies and the diffusion of international production chains seem to call for more attention in this area.

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