OECD

THE FUTURE OF FOOD

Long-term Prospects for the Agro-food Sector
THE FUTURE OF FOOD

LONG-TERM PROSPECTS FOR THE AGRO-FOOD SECTOR

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
ORGANISATION FOR ECONOMIC CO-OPERATION
AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

– to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
– to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
– to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).
FOREWORD

The pressures for change in the OECD agro-food sector are strong and pervasive. The world’s population, although now growing more slowly, is expected to reach well over 9 billion by the middle of the next century, putting to the test the earth’s agricultural carrying capacity. Important technological innovations are coming on stream, and significant developments are unfolding in competition, market structures and industrial organisation. At the same time, globalisation and regional integration – underpinned and accompanied by trade liberalisation and the prospect of multilateral investment accords – are continuing apace. The cumulative impact of these events is likely to transform the agriculture and food sector, and alter the geographical and functional distribution of production and sales activities across countries and regions. The prospect of such deep-seated change raises a whole host of important issues for governments, industry and consumers alike.

To examine these issues, the OECD organised a Forum for the Future conference in June 1997. It brought together key players from government, business and research to identify and discuss the likely course of major changes under way or in prospect in the OECD agro-food sector, and to reflect on the policy consequences for food and agriculture, and the agro-food chain more generally, over the next twenty years. The conference was also intended to provide part of the context for the discussion of emerging policy issues at the OECD Meeting of Agriculture Ministers in 1998.

The conference consisted of three sessions. The first reviewed longer-term scenarios for global food demand and supply, with particular consideration of the broad economic and social implications of new technologies. The second focused on the longer-term evolution of the agro-food industry and relevant market structures, in particular with respect to processing, distribution and retailing. The third session addressed the implications for strategic decision-making in both government and business in OECD countries.

This publication brings together the papers presented at the meeting as well as an introductory contribution by the Secretariat. The book is published on the responsibility of the Secretary-General of the OECD.
# TABLE OF CONTENTS

- The Future of Food: An Overview of Trends and Key Issues  
  by Reza Lahidji, Wolfgang Michalski and Barrie Stevens  ........................................7

- Prospects for the World Food Situation on the Threshold of the 21st Century  
  by Hartwig de Haen, Nikos Alexandratos and Jelle Bruinsma  ......................21

- Major Uncertainties and Risks Affecting Long-term Food Supply and Demand  
  by Per Pinstrup-Andersen and Rajul Pandya-Lorch  ................................53

- The Impact of Biotechnology on the Agro-food Sector  
  by Guy Paillotin  ......................................................................................................71

- Changes in Food and Drink Consumption, and the Implications for Food Marketing  
  by Alan D. Gordon  ..................................................................................................91

- Between the Farm Gate and the Dinner Plate: Motivations for Industrial Change in the Processed Food Sector  
  by Dennis R. Henderson  ..........................................................................................111

- The Future of Agricultural Production Structures  
  by Donald McGauchie  ..............................................................................................141

- Long-term Policy Issues and Challenges for Agro-food  
  by Gérard Viatte and Josef Schmidhuber  ..............................................................157

- Annex: List of Participants  ....................................................................................195
THE FUTURE OF FOOD:
AN OVERVIEW OF TRENDS AND KEY ISSUES

by
Reza Lahidji, Wolfgang Michalski and Barrie Stevens
OECD Secretariat, Advisory Unit to the Secretary-General

Twenty years from now, the way food is produced, sold and consumed in OECD countries will in all probability have drastically changed. Projections of food supply and demand, as presented in the first part of this paper, suggest substantial transformations in consumption patterns, in technologies, in policies, and in international trade. As a result, market organisation in OECD countries is likely to evolve rapidly. The second part of this introductory chapter describes some of the major trends in the future organisation of the agro-food industry, including differentiation, concentration, and vertical co-ordination. Finally, the third part of the paper investigates some domestic and international policy implications of the changes under way in the agro-food sector in OECD countries.

I. THE LONG-TERM OUTLOOK FOR GLOBAL SUPPLY AND DEMAND

World agricultural production to 2010 is expected to grow at an average rate of around 1.8 per cent a year, a slower pace than in preceding decades but fast enough to improve per capita food production as world population growth gradually loses momentum. The bulk of the expansion in production will be in developing countries, largely due to the intensification of agriculture and a widespread use of agro-chemical inputs. OECD countries, by contrast, will contribute only marginally to the rise in world production. In Russia and the Ukraine, agricultural supply is expected to recover, but slowly, from its collapse of the early 1990s.

As Hartwig de Haen et al. show in the next chapter, growth projections in global and regional food supply principally reflect the likely evolution of effective demand. Food demand is expected to increase vigorously in developing countries – with the exception of some least developed countries – at about 2.6 per cent per annum, primarily as a result of demographic changes. The population
outside the OECD is expected to increase by 80 million each year in the next two decades, pushing up food requirements and, in some regions, aggravating the risks of food shortages. Economic growth, rising incomes and urbanisation, particularly in Asia and Latin America, may also contribute to the expected surge in food demand, not least via rapid changes in diets in favour of more grain-intensive foods such as meat, and in particular red meat. In OECD countries, on the other hand, per capita food demand could gradually level off, and consumption is likely to change much more in composition and quality than in volume over the next two decades.

Trade in agricultural commodities looks set to remain at around 10 per cent of world production, although trade in processed food should grow somewhat faster. Developing countries are expected to become net agricultural importers. This will provide OECD producers with an attractive export outlet as well as considerable opportunities for foreign direct investment, as their own domestic markets gradually stagnate. The most promising markets for OECD exports are those of livestock and some processed foods, where local production is unlikely to match demand in regions such as East Asia or Eastern Europe. In this context, the United States, Australia and New Zealand might well gain substantial market shares in world exports at the expense of the European Union (at least under the assumption that present policies continue). Indeed, with their higher efficiency, lower costs and more market-oriented policies, these countries seem better prepared than Europe for new competitive conditions. Imports would nonetheless surge in all OECD countries as a result of lower protection, so that the import penetration rate for the OECD area could reach 20 per cent in 2020 compared to 7 per cent in 1992, mainly as a result of increased trade among OECD countries. In turn, increased import penetration is likely to put yet more pressure on OECD countries to pursue structural adjustment in their agriculture sectors.

A range of uncertainties is associated with this “baseline” scenario. They concern primarily demand, supply and policy.

**Demand-side uncertainties**

On the demand side, uncertainties relate, among other things, to traditional determinants of food demand – mainly population and income growth – as well as changes in food habits. With respect to population forecasts, a variety of factors, including enhanced family planning and reduction of poverty, could lead to lower demographic growth, and thus to a lower increase of food demand. Moreover, for a given level of national income, a more uneven distribution among the population might also weaken food demand. This could be the case in China, for instance, where half of the population is expected still to be located in rural areas in 2030. On
the other hand, incomes may rise more strongly than expected in several countries, including most notably China and India, pushing up food demand.

The evolution of consumer tastes and diets may gain in importance at the expense of the traditional determinants of demand, in particular in OECD countries. It is possible, for instance, that growing safety and ecological concerns may lead to a sustained demand for products with certain organic attributes ("semi-organic" produce), although it is generally assumed that the market for purely organic products will remain marginal. In developing countries, diets may change rapidly towards higher meat consumption, as a consequence of factors such as urbanisation and openness to trade.

**Supply-side uncertainties**

On the supply side, the availability of land, water, and other natural resources emerges as a matter of major concern. Water resources, which have been affected by intensive use of fertilizers and pesticides or by excessive pumping, are becoming scarce in many parts of the world, inhibiting the development of irrigation. Regarding land, it is generally acknowledged that the net expansion of cultivated area will be modest in the future, not least due to urbanisation and the need to preserve forests. Some analysts even consider there is a risk that land losses due to erosion, salinisation, waterlogging or contamination may actually outweigh new lands brought into cultivation. Finally, wild fish stocks have been decimated (in some waters perhaps beyond recovery) almost worldwide, and the further expansion of fish farming could eventually come up against environmental limitations. These issues can be at least partly addressed by better policies, including targeted measures to combat waste of water.

Another major source of uncertainty, analysed in detail by Per Pinstrup-Andersen and Rajul Pandya-Lorch in a later chapter, is the evolution of productivity. On the positive side, traditional techniques still offer the potential for major improvements in productivity, most notably in developing countries. And alongside these, a new generation of techniques is emerging. Information technology, for example, could allow more efficient management of stocks and input flows, thanks for instance to geographical positioning systems. More importantly, however, biotechnology is gradually emerging as the most promising field of research and application in various areas dealt with elsewhere in this volume by Guy Paillotin. These include yield enhancement, reduction in chemical inputs, adaptation to specific natural conditions, and disease management.

As products using genetic engineering are increasingly developed in OECD countries by private companies, the focus is expected to shift gradually from the technical feasibility of such products to competition and market conditions,
safety and environmental consequences, and the reaction of consumers. For instance, the linkage of genetic modification of plants with upstream agro-chemical activities, which may have an important contribution to make to the sustainability of agriculture in the future, could also give substantial market power to a handful of companies, at least in the early stage of development. Existing and potential safety as well as ecological side-effects will need to be cautiously and credibly assessed. Finally, labelling and more generally providing adequate information to the consumer will be essential ingredients of success for such techniques. A hasty rejection of biotechnology applications by consumers or governments, which remains possible for instance in Europe, could severely damage the development of these techniques and therefore hamper the productivity growth of agriculture in the future.

On the negative side, there is the impact of declining rates of investment. In many developing countries, investment in agricultural research as well as development has fallen to 0.5 per cent of the value of agricultural production or less, compared to 2 per cent in OECD countries. Given the fact that in some of these countries the market outlook is too uncertain – or weak – for the private sector to provide all the investment needed, public investment in research and development may have a greater role to play if the potential of domestic food supply is to be preserved and developed.

All in all, in spite of the existence of major downside risks, it is widely assumed that food supply will be highly responsive to price signals in the two next decades. An increase in world prices would trigger an intensification of production and the use of reserves of land, not least in some OECD countries where set-aside programmes could be relaxed. Large efficiency gains could also be obtained in feeding, handling, distribution, and stockholding. Though food security problems could be aggravated by short-term increases in prices, the high elasticity of supply seems to rule out the risk of a lasting global food shortage.

Local imbalances, however, cannot be excluded. For some less developed countries and transition economies, the market infrastructure is still poorly developed. Constraints on natural resources could limit the agricultural capacity of specific countries where demand is expected to surge, thus increasing their net imports. Some analysts, for instance, underline the risk of agricultural supply in China being handicapped by substantial land losses due in particular to urbanisation, and a weakening of productivity gains linked to insufficient investment in agricultural research. Were such an imbalance to appear in a specific region of the world, increased trade and investment, coming in particular from OECD countries, would seem to be the key to preventing a food crisis.
Policy uncertainties

The continuation of the reform processes under way in most countries in the fields of both domestic and trade policy appears to be one of the key elements in a positive evolution of the world food balance. Trade and investment in agro-food products are bound to play an essential role in feeding humanity in the coming decades. This will only come about, however, through further progress in reducing tariffs and export subsidies, and opening markets. In OECD countries, further liberalisation of the agricultural sector in the coming years may lead to an accelerating replacement of price support policies by direct payments and/or insurance schemes for farmers. A widespread reduction of such price supports could result in a one-off hike in commodity prices, but will probably not reverse their long-term downward trend. In countries such as China, increased reliance on food imports could be perceived by governments and public opinion as running contrary to food security goals, unless the issue of supply assurance is addressed at the international level.

Regulatory issues related to the protection of the environment and to food safety will no doubt become crucial in the coming years. There is a risk that strict regulation in these areas, under the pressure of national opinion or lobbies, may be misused for protectionist purposes, have a negative impact on production, or discourage innovation. Forbidding the use of agro-chemical inputs without having available alternative techniques of yield enhancement or disease management could for instance have severe adverse effects on agricultural production.

II. MARKET STRUCTURES IN THE OECD AGRO-FOOD SECTOR

What emerges from the preceding discussion on the long-term outlook for world food demand and supply is that an impressive range of factors are combining at world, regional and national level to transform agro-food activities in OECD countries. The repercussions on corporate strategies are already being felt, as firms adjust to new domestic market conditions and extend their reach beyond national borders to seek out new markets and new alliances. The structure of the industry, however, is being particularly affected by changes in consumer tastes, in technologies and in the underlying competitive conditions. There can be little doubt that twenty years from now, the agro-food sector will be vastly different from what is today.
New consumers and new technologies

Food consumption in OECD countries is set to stagnate or, at most, rise only modestly, so that in future years the share of food and beverages in total consumption could be substantially lower than in the mid-1990s. In Japan, for example, it is projected to fall from 19 per cent in 1995 to just over 14 per cent in 2010, and in the United Kingdom from about 18 per cent in 1994 to 15 per cent in 2005. But behind this broadly stable picture of overall food consumption, a significant diversification and fragmentation of consumer patterns is unfolding. Ageing populations and the rise in the number of single-parent families are likely to amplify the trend to smaller households, thereby affecting packaging requirements and the social circumstances of food consumption. In the European Union, the share of single-person households is projected to climb from its current level of 30 per cent to around 36 per cent in 2015, and in Japan from 23 per cent to 28 per cent in 2010. High levels of female participation in the workforce and a rising share of elderly people will augment the demand for convenience food and eating outside, as well as for services such as delivery and catering. Ethnic food demand may benefit considerably from consumers’ growing desire for greater variety and from the relative improvement in the living standards of ethnic minorities in OECD countries. Health, food safety, ethical and environmental issues are also set to become essential features of consumer behaviour, not least as breakthroughs in biotechnology applications accumulate.

With trade liberalisation and the evolution of transportation and storage, food firms will operate in a global market-place, where they will face the fragmentation of food consumption patterns and cultures. They will therefore need to adapt their products and strategies to a multitude of local conditions, accurately analyse consumption patterns, identify niche markets, and detect at an early stage any change in consumers’ demands. This evolution will accelerate, and in turn be enhanced by, the use of new technologies. New tools of information technology will be used to examine consumer behaviour, and also to provide consumers with more information on food products. With barcodes and fidelity cards for example, firms will be able to gather data on and analyse consumption patterns for ever-smaller groups of consumers, and eventually individuals. In parallel, biotechnologies will allow differentiation to extend even to the ingredients of food. The better knowledge of biological characteristics of plants and animals and how these can be modified will enable firms to customise their products, and consistently provide food with certain specific traits.

The impact on food distribution

Such changes will have far-reaching consequences for the agro-food industry, and first and foremost for food distribution. The critical economic size of retailers is
likely to rise as fixed costs grow. Retailing is already quite highly concentrated in a number of OECD countries (the top five retailers account for, e.g., 70 per cent of the market in France, 63 per cent in Germany and 47 per cent in the United Kingdom), and the signs are for further concentration in the future, essentially via acquisitions. Eventually, a few dominant players are expected to emerge on the global scene. In parallel, information networks will constitute a new vehicle for providing consumers with detailed information on products and prices, and for selling food at lower costs than through the traditional distribution chain. Electronic commerce and teleshopping should represent a large part of future distribution systems. According to one estimate, for example, teleshopping could in ten years’ time account for 10-15 per cent of packaged groceries in France, Germany and the United Kingdom.

Further concentration among large retailers and the emergence of electronic commerce will affect secondary retailers, who will have to generate additional value added – in particular in services and proximity to the consumer – in order to compete. In his chapter on this topic, Alan Gordon argues that, as a consequence, the spectrum of secondary retail outlets may well widen remarkably, ranging from traditional independent grocers, independent specialists, newsagents and local convenience stores to petrol stations, drinks stores, home delivery systems and automatic vending. Changes in food consumption patterns will probably encourage retailers to enter activities such as catering. Within the distribution industry, the lines between different activities are therefore expected increasingly to blur.

Distribution, as the link between the agro-food sector and the consumer, will have a key role to play in the future organisation of the sector. Since the sector will have to supply a myriad of small markets reliably and flexibly, co-operation could become the central feature of vertical relations. Firms at different levels of the industry may well co-operate first to organise information systems and logistics, then to adapt food products precisely to consumer demands. Co-operation is likely to be increasingly formalised in contracts, alliances and even integration. In these new relations, distribution firms will have the benefit of being close to the consumer. They will probably have access to large sources of information about consumption patterns, which they will be able to use to segment the market efficiently. They will have a strong interest in encouraging the implementation of traceability and identity preservation schemes, and will develop direct links with farmers. Eventually, they will tend to dictate trading terms – pricing, rebates, credit, even de-listing of suppliers – and direct production decisions.

**Consequences for processing**

For the processing industry, distribution may well be increasingly seen as impeding access to the consumer. The balance of power between the two levels
could further tilt in favour of distribution firms, which, in addition to being closer to the consumer, will be less specialised, have fewer fixed assets, and (therefore) be more flexible. In order to bypass this bottleneck, processing firms will likely develop direct links with consumers by using information technologies, and by entering into catering and secondary retailing activities. The risk of weakening market power will favour concentration in the processing industry. In the meantime, research and development, notably in the field of biotechnologies, will create opportunities to exploit economies of scope in other activities such as pharmaceuticals or chemistry.

The inevitable consequence of such transformations is a deep-seated change in the foundations on which competition operates. Evidence is mounting that in the food sector, as in many other industries, comparative advantage is no longer based primarily on natural endowments. As Dennis Henderson shows in his contribution to this volume, the competitive position of firms in the future is likely to depend crucially on their ability – as multiplant, multiproduct operations – to generate firm-specific assets, i.e. to mobilise and efficiently use intellectual resources in activities such as research and development, advertising, and the development of partnerships and networks.

The emergence of new competitive conditions raises a number of issues about the future structure of the agro-food industry in OECD countries, relating in particular to the geographical location of production. The picture now taking shape is that those firms which respond effectively to demanding consumers, diversified consumption patterns, and intense competition in their home market are the most likely to be in a position to retain or sharpen their competitive edge globally at the outset of the next century. In terms of geographical location, it follows from this for some experts that what counts – and will continue to count in the years ahead – is the industrial clustering of large numbers of related firms, especially in combination with large, high-income markets. Hence, existing patterns of location in the food processing sector, i.e. predominantly in OECD countries, are set to persist for some time to come. Eventually, however, it is likely that in some developing countries, high concentrations of skilled personnel, R&D and other firm-specific assets – underpinned by well-functioning systems of law – will lead to the creation of agro-food industry clusters of regional or even global significance.

Implications for farming

Agriculture can be expected to become increasingly integrated with the food industry in the future. Farmers will face a demand for differentiated agricultural products, entailing the use of sophisticated technologies. For certain products, the importance of bulk commodity markets and auction systems may decline in favour
of thin market channels regulated by contracts. In such cases, auction prices may gradually become irrelevant references for contract prices. As agriculture becomes more specialised, risks will increase, and thus create the need for new insurance mechanisms. These risks are likely to be augmented by more pronounced price fluctuations in those OECD countries that were insulated from international markets in the past. All these changes could well widen disparities among farmers. The more innovative among them will be able to hedge risks and retain more value added – for instance, as Donald McGauchie explains in his chapter, with identity preservation and quality assurance. Traditional farmers operating in bulk commodity markets will face declining market power, and will probably see the sharing of risks and profits shift at their expense.

With the drive for lower costs and improvements in service quality in the downstream activities of the agro-food chain, important risks are being transferred to upstream operators. In the case of the fruit and vegetable sector, for example, the pressures are mounting on intermediate firms in the filière – e.g. packers, brokers, and especially traders – to assume market risks they are often unable to bear. In view of the growing influence of retailers and processors, the agricultural producers seem destined to become an ever-weaker link in the agro-food power chain. Partly as a consequence, concentration is expected to accelerate in the farming sector. Co-operation, however, could be an alternative means of exploiting economies of scale, building market power, and creating more value added, in particular through quality assurance. Modern co-operatives could also bring farmers much-needed advice in the use of technologies, in the choice of inputs, and in risk-hedging. To be able to play this role effectively, however, co-operatives will have to adapt to new, constantly changing market conditions.

III. IMPLICATIONS FOR POLICY

The economic case for further domestic reforms in the OECD agricultural sector is compelling. Against the background of economic and social changes unfolding on the world scene, a common mover behind the pressures for reform is competition. In agriculture as well as in other industries, it is apparent in various forms. At the individual sector level, agriculture in OECD countries is faced with mounting pressure from global markets, making it imperative that it move into the next century on a sound competitive footing. Greater efficiency (including lower costs) and more flexibility in the agricultural sector are, in turn, essential for the competitiveness of the downstream activities in the agro-food industry, which themselves face ever-fiercer rivalry on domestic and international markets. There is also increasing competition for ever-scarcer government resources, making it all the more difficult to justify vis-à-vis consumers and taxpayers what are perceived to be costly and
inefficient policies that benefit farmers. And finally, in the trade field, price support and other market-distorting subsidies generate perceptions of unfair competition for key agricultural commodity markets, and therefore lead to trade tensions.

Policy-makers will thus face some difficult choices. They need to forge ahead with the process of trade liberalisation while promoting a market environment in which price signals will be reliable in guiding production, investment and use of resources. At the same time, a balance will need to be found for each country between, on the one hand, introducing more competition and, on the other, ensuring social acceptability. Moreover, an additional concern for many countries will be to take the multi-functionality of agriculture – *i.e.* the economic, social, environmental and other facets of its role – properly into consideration by shifting policy from a narrow perspective of agricultural viability to a broader concept of rural development. Equally important, an adequate response will need to be found to the continuing blurring of the traditional line between agriculture and the food processing and distribution sector in coming years. The way forward, as Gérard Viatte and Josef Schmidhuber underline in their chapter, must be to ensure that food-related policy issues are considered from the perspective of the entire agro-food sector, and not from that of agriculture alone.

As tariff and non-tariff barriers to trade diminish and the state withdraws further from its direct involvement in agricultural markets, an increasingly prominent role in policy-making in the agro-food sector will fall to regulatory reform. In part, this will inevitably involve the review and reduction of regulations, especially where outdated rules and provisions stand in the way of the agro-food sector's adjustment to new opportunities, or where there are distortions and impediments (*e.g.* restrictive business practices and legal constraints) to international trade and investment flows. But it will also involve the design and implementation of new rules, most notably perhaps in the fields of competition policy, food safety and the environment.

**Competition policy**

In the field of competition policy, the next decades promise to confront decision-makers with some uncomfortable trade-offs. As was noted earlier, in most OECD countries there has been a noticeable rise in the level of market concentration in food retailing and also in food processing, which in most cases has not been matched by comparable developments in primary production. As a result, there is concern not only that oligopolistic retailing and processing structures will lead to abuse of market power, but that the lion's share of the benefits of any future reforms in the farming sector may be captured by the processors and retailers. In many OECD countries producers have formed co-operatives as a countervailing
force against powerful groups of processing and retailing companies. But in some
sectors in some countries (e.g., dairy produce in Denmark, the Netherlands, Sweden
and the United Kingdom), the market power of such co-ops is causing concern to
the processors, and also posing a dilemma for the competition authorities. These
authorities are acutely aware of the shifting balance of power across the agro-food
industry as a whole, as reflected in the changing relationships between farmers and
the downstream businesses, as well as between processors and retailers.

However, the perspective of competition authorities in OECD countries is also
shifting. It is becoming increasingly clear that in the new business context of the
twenty-first century, the yardstick for evaluating takeovers and mergers is no longer
the domestic but the international market, and that economies of scale and scope
as well as the synergies generated by the integration of related activities will be
crucial for international competitiveness. There may also be efficiency gains related
to the mergers or acquisitions which could eventually be passed on to the con-
sumer. But competition authorities will have to weigh these arguments against the
risks of exacerbating the potential for abuse of dominance and anticompetitive hor-
zontal and vertical agreements on the domestic market. Not only might such devel-
opments work to the detriment of farm producers; they might also undermine the
very foundations on which the international competitiveness of agro-food firms is
built – vigorous competition on the home market.

Food safety

In the context of rapidly emerging new technologies, the recent multiplica-
tion of cases of food-borne diseases (BSE, E. coli, salmonella, campylobacteria,
listeria) is expected to have far-reaching impacts on consumers’ preferences
and perceptions, thus placing national authorities under greater pressure to
introduce more regulation regarding food safety. Various regulatory policies can
be implemented with the aim of improving consumer safety and information,
notably via product labelling and certification, and imposing standards. The lat-
er, for instance, range from simple prohibition of supplying potentially unsafe
food (target standards) to specification of imposed rules (specification stan-
dards). Target standards, which give suppliers more freedom to choose the pre-
cise way in which they meet the standards, can minimise compliance costs, but
may also be difficult to enforce. Conversely, product and process standards
are easy to enforce but leave little room for firms to adapt their method of
compliance to their individual circumstances.

Choosing the modalities of safety regulation must thus be submitted to a
cost/benefit analysis. Inadequate regulation may generate excessive costs, dis-
courage research and development, or be quite simply ineffective. Lack of
regulation, on the other hand, can lead to a loss of consumer confidence and therefore have devastating effects on both food production and the development of new techniques. Moreover, food safety regulations will have to be regularly adapted to rapidly changing scientific evidence, technical abilities and market conditions. Public regulation is likely to be increasingly complemented, rather than replaced, by private regulation defining additional requirements (e.g. industry-developed organic certification).

Environment

A substantial share of the negative effects of agricultural activities on the environment is due to past policies of price support and underpricing of inputs. Reforming current policies, in particular decoupling subsidies from output and purchased input, will therefore greatly help to reduce the negative impacts of agriculture on the environment. However, environmental damage of agro-food activities is also partly due to market failures in farming, processing and distribution, including issues related to packaging and waste disposal. Providing they can be identified and measured, environmental costs should be further internalised by applying the polluter-pays principle.

New technologies used in agriculture are likely to be more environment-friendly, notably with an improvement of inputs and land management thanks to information technologies and reduced use of chemical inputs thanks to biotechnology applications. Biotechnology, however, also bears the risk of insufficient control over the spread of genetically modified organisms, which has to be addressed through appropriate regulations. Care would need to be taken to ensure that over-regulation does not blunt the incentives for research and development.

New generation of issues on the international front

Many of the developments described above in competition, biotechnology, ethics, food safety and food standards, and ecological sustainability increasingly tend to spill over onto the international stage, creating a new generation of issues. The complexity of these issues will prove especially challenging in the context of international trade and investment, where inadequate national policies could have market-distorting effects far beyond national boundaries.

Competition policy, for example, has to be viewed in the context of trade policy. As an illustration, trade liberalisation does not guarantee market access when restrictive business practices are in place. Conversely, trade liberalisation can contribute to a competitive environment by preventing domestic oligopolies from abusing market power on their home market, thereby easing the task of
competition authorities. By the same token, it has to be ensured that new technical
regulations in the fields of food safety and protection of the environment will not
result in the emergence of unjustified non-tariff barriers. New regulations therefore
need to be accompanied by international efforts in mutual recognition and, where
appropriate, harmonization of standards. For OECD countries in particular, there
will be a quest for balance between high national standards and the implications of
internationalisation of standards.

However, national regulations may change rapidly as a result of a variety of
factors – evolving technologies and practices, the growing share of processed
products (to the detriment of bulk produce) in agro-food trade, deliberate
attempts to raise non-tariff barriers to trade – any of which would tend to neu-
tralise the positive effects of harmonization on international trade. The imple-
mentation of international standards therefore seems the most effective way of
improving market access, although it raises the issue of the control of national
authorities on food safety regulations. Finally, as proven by recent trade fric-
tions resulting from biotechnology regulations, the international rules of the
game and dispute settlements need to be based on internationally accepted
scientific methods.

As subsidies are removed in the course of trade liberalisation and domestic
reforms, the international food market could enter a new paradigm character-
ised by complementarity and competition based on comparative advantage.
However, one key determinant of trade liberalisation and of domestic reforms
in many countries is the confidence of governments and public opinion in
the international trade system’s capacity to assure supply. Hence, issues of
self-sufficiency and export restrictions might be important areas for multilateral
discussions in the future.

Finally, the development of agriculture in least developed countries will be an
important element for the balance between food demand and supply in coming
years. In this context, food aid will need to be restricted to emergency cases, and
re-situated in the general framework of development policy.

**General framework conditions**

Above and beyond these areas of policy-making specifically related to the
agro-food industry, considerable importance will be attached in the future to
the general framework conditions in which this sector’s business is conducted,
in particular those conditions that pertain to the general investment climate,
R&D and communications. Developments in information technology hold the
promise of substantial gains in efficiency for the agro-food sector as a whole,
notably on the logistical side; of greatly improved transparency (in prices,
sources of supply, quality characteristics, etc.); and of vast new business opportunities at home and abroad, for retailers, food processors and, not least, farmers. The task ahead for policy-makers is to create an environment that is conducive to investment and innovation and the smooth adaptation of the agro-food sector to the rapidly changing political, economic, social and technological context of the coming decades.
I. INTRODUCTION

In contemplating the prospects for the agro-food sector, it may be useful to ask questions within a wider context: what kind of world lies beyond the doorway to the next century? Will the new building be very different from the old one to which we had grown accustomed, though with considerable pain and effort? Will it have the space to house the growing family? Will it provide the same mix of enjoyment and discomfort for its inhabitants? Will its windows provide the same outlook, its walls establish the same limitations?

While the long-term prospects for world food and agriculture remain uncertain, there can be little doubt that a number of agro-food features in the new house will be familiar: the demand for food is likely to grow further; with continuing income growth and rapid urbanisation the entire agro-industry will face the need for drastic adjustments; the access to food is likely to remain scandalously uneven for quite some time; and the pressure on natural resources as well as changing cost ratios between capital and labour will necessitate continued technological change towards sustainable intensification of land use, and investment. While the new building may hold many other surprises that could be relevant for the global agro-food sector, three new features are already in view. The most important is that in all likelihood this twenty-first century will witness a complete stabilization of the world population.
some time in the second fifty years – welcome relief for the needed equilibrium between humankind and the natural resource base. The second positive feature that can be expected is the “graduation” of quite a number of countries to the status of developed – i.e. high-income and industrial – countries. The third aspect is the most pronounced: the increasing attention consumers pay to the quality and (in particular) the safety of food, a concern that extends to the environmental friendliness of the entire production and transformation process.

Of course, in surveying this new house, we are never far from the old Malthusian worry: will the world have enough resources to feed all of its inhabitants? In fact, that particular danger to humankind is only partly due to physical limitations of the resource base; it very often has more to do with inappropriate policies and institutions that fail to induce adjustments and innovations towards more sustainable patterns of resource use when the technical solutions already exist.

This paper reviews developments to the early 1990s and offers prospects for the coming two decades as seen by FAO. It concludes with a short discussion of a number of developments that could cause the growth path of world food and agriculture to be different from the one seen by FAO from the perspective of the early nineties.

II. HISTORICAL DEVELOPMENTS AND ISSUES IN THE EARLY 1990s

Food and nutrition: progress and failures in the historical period

World per capita supplies of food for direct human consumption are today (average 1992/94) some 19 per cent above what they were thirty years ago (in 1961/63). The majority of the developing countries participated in this progress and improved nutrition. Their per capita food supplies grew by 32 per cent over the same period. Another way of viewing that progress is to note that today (in 1992/94), 10 per cent of the world population lives in countries with “very low” per capita food supplies (under 2 200 calories/day), down from 56 per cent in 1969/71 (see Table 1). At the other extreme, 55 per cent of the world population is in countries with “medium-high” food supplies (over 2 700 calories), up from 30 per cent in 1969/71. The great strides made by China have been a significant component of this progress.

Impressive as this progress has been, however, it has bypassed a large number of countries and population groups. Many countries continue to have very low per capita food supplies and have hardly made any progress. Indeed, Sub-Saharan Africa is today no better off nutritionally than it was twenty years ago; and South Asia is still in a mid-low position as regards per capita food supplies (Table 1). In parallel, continuous population growth has meant that the declines in the percentage of those
undernourished – which accompanied the increases in apparent food consumption per capita – did not lead to commensurate declines in the absolute numbers affected. The latter have fallen only modestly and remain stubbornly high at more than 800 million persons. Moreover, several hundred million people, including children, suffer from various forms of malnutrition.

It is now well recognised that failure to alleviate poverty is the main reason undernutrition persists. Therefore it is appropriate to focus attention on ways and means to alleviate poverty and improve the “food entitlements” of the poor. However, this conclusion should not undermine the importance of increasing per capita food supplies. At the same time, a clear distinction is necessary between the global and local supply situations. Globally there is evidence that on average the world faced no major constraints in increasing food production by the amount required to meet the growth of effective demand. This is shown by the long-term downward slope of the trends, until quite recently, of real food prices. However, in the majority of the developing countries, the increase of food production is one of the principal means for combating poverty. This follows from the fact that the majority of the poor depend on agriculture, and on the related sectors upstream and downstream, for employment and incomes. While this

Table 1. Population and per capita food supplies

<table>
<thead>
<tr>
<th>Calories/capita/day in 1970</th>
<th>Population (million) in 1970</th>
<th>Per capita food supplies (calories/day) in 1970</th>
</tr>
</thead>
<tbody>
<tr>
<td>69/71</td>
<td>79/81</td>
<td>92/94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A. Population living in countries with given per capita food supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 2 000</td>
</tr>
<tr>
<td>2 000-2 200</td>
</tr>
<tr>
<td>2 200-2 500</td>
</tr>
<tr>
<td>2 500-2 700</td>
</tr>
<tr>
<td>Sub-Total</td>
</tr>
<tr>
<td>2 700-3 000</td>
</tr>
<tr>
<td>Over 3 000</td>
</tr>
<tr>
<td>World total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Population and food supplies by developing region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing countries</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
</tr>
<tr>
<td>Near East/North Africa</td>
</tr>
<tr>
<td>South Asia</td>
</tr>
<tr>
<td>East Asia</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
</tr>
<tr>
<td>Rest of world</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

1. Data from UN (1994) for population and from the FAO Food Balance Sheets data of 1996.
2. Countries for which Food Balance Sheets are available (99.7 per cent of world population in 1993).
3. 93 Developing countries (98.5 per cent of the population of all developing countries).

Source: FAO.
dependence continues to be high, the growth of food production and of agricultural productivity in the countries with high concentrations of rural poverty will continue to be among the principal means for alleviating poverty and improving nutrition.

The role of world food markets

In a number of countries, success in improving food consumption and nutrition was based on rapidly growing food imports, particularly in the 1970s following the growth of export earnings from the oil boom and easy access to external finance; that gives some idea of the importance of world food markets in building up nutrition in the developing countries. While in the early 1960s cereal production in the developing countries covered 97 per cent of those countries’ needs (demand for all purposes), at present that figure is only 91 per cent; the difference is made up by imports from the world market.

The behaviour of world food markets in the past was influenced by the agricultural support policies of major food-exporting countries. This led to surplus production, stock accumulation, subsidised exports and depressed world market prices. Policy reforms under way and planned would diminish the force of these phenomena in increasing supplies to world markets. Already such policy changes, together with a slowdown in world demand for cereal imports, have led to a decline in recent years in the cereal production of the main exporting countries; world per capita production is today below its peak of the mid-1980s. The other major factor has been the drastic decline of both production and consumption in the formerly Centrally Planned Economies (ex-CPEs, i.e. Eastern Europe and ex-USSR) in the course of the systemic reforms in their economies.

III. PROJECTIONS TO THE YEAR 2010

The FAO undertakes at regular intervals prospective studies of world agriculture, the latest of which was published in 1995 under the title World Agriculture: Towards 2010. The main objective of the FAO study (as it will be referred to here) is to provide a long-term perspective on world agricultural development, with the emphasis on developing countries. The FAO study endeavours to sketch the “most likely” development path for food and agriculture (“positive” approach) but not developments judged desirable from a normative point of view. The study draws heavily on contributions from numerous experts in the FAO from various disciplines (agronomists, economists, etc.), and takes into account policy changes expected to be implemented over the projection period as known at the time of preparation of the study. The projections in the study are, therefore, definitely not trend extrapolations.
Continuing – but slower – growth in world population

The growth rate of the world’s population has been on the decline since the second half of the 1960s, in the developing countries as elsewhere. But the absolute annual increments are currently at their highest level, with 85-90 million persons added to the world population every year. Increments of over 80 million may persist for about another twenty years, after which the annual growth of world population may decline in absolute terms as well to reach some 40 million persons by 2050, according to the Medium Variant projections of the UN (1996).

The period to 2010 is therefore at the peak of the historical evolution of world population in terms of absolute annual increments. By the year 2010 world population is projected to grow to 6.9 billion (of which 53 per cent will be located in urban areas), up from the 5.3 billion of 1990 (with 43 per cent in urban areas) and the 3.7 billion of only twenty years earlier. Ninety-six per cent – or 1.6 billion – of the total increment in world population between 1900 and 2010 will be in the developing countries. Moreover, the regional patterns of population growth are very disparate, e.g. 2.9 per cent p.a. in Sub-Saharan Africa and 1.1 per cent p.a. in East Asia. These demographic trends in the developing countries, in combination with their still-low levels of per capita food consumption, would require continued strong growth in their food supplies. Not all these additional needs will be expressed as effective market demand. The aggregate increase in the food availabilities of the developing countries is likely to be less than required to raise average per capita supplies to levels compatible with food security for all. This is because the general development scene is likely to leave many developing countries and population groups with per capita incomes and potential for access to food not much above present levels.

<table>
<thead>
<tr>
<th>Year</th>
<th>World Total (mil.)</th>
<th>World Annual increment (mil.)</th>
<th>World Annual growth (%)</th>
<th>Developed countries Total (mil.)</th>
<th>Developed countries Annual increment (mil.)</th>
<th>Developed countries Annual growth (%)</th>
<th>Developing countries Total (mil.)</th>
<th>Developing countries Annual increment (mil.)</th>
<th>Developing countries Annual growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>2 524</td>
<td>813</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>3 702</td>
<td>1 008</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>5 282</td>
<td>1 148</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>6 891</td>
<td>1 206</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>8 372</td>
<td>1 212</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td>9 367</td>
<td>1 162</td>
<td>0.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: UN 1996 population assessment (medium variant).
Better prospects for overall economic growth in the developing countries, but with significant exceptions

The prospects for overall economic growth, a major determinant of demand for food, have not changed much from the time the FAO projections were made. In the crisis decade of the 1980s, all developing regions experienced declines in per capita incomes (with the important exception of Asia, both East and South). It is likely that this trend will be reversed in the future. The latest World Bank assessment (World Bank, 1996) indicates that Asia would continue to perform at fairly high rates of economic growth, and that there are prospects for a modest recovery in the Near East/North Africa and for a somewhat more substantial one in the Latin American/Caribbean countries. Sub-Saharan Africa would also shift to higher economic growth rates compared with the disastrous 1980s, but its per capita income would grow only slightly. These developments in the overall economy already suggest that some regions will continue to make progress towards food security while others may not make much progress.

The OECD countries are likely to continue to perform as in the past. The prospects for the ex-CPEs of Europe are shrouded in uncertainty. Their combined GDP is thought to be at present (mid-1990s) about 40 per cent below that of the pre-reform period. Although the decline is bottoming out, it may take a long time before sustained growth re-establishes per capita incomes of the entire region at the pre-reform levels; and, of course, there are drastic structural changes under way affecting the distribution of income, food trade and modalities of access to food. These changes were already anticipated in the FAO study.

World agricultural growth will continue to slow down

The detailed assessments indicate that the projected growth rate of world agricultural production in the period 1988/90-2010 will be lower – at 1.8 per cent p.a. – than in the past (see Table 3). This slowdown is largely a continuation of long-term historical trends. World production (gross) grew at 3.0 per cent p.a. in the 1960s, 2.3 per cent p.a. in the 1970s and 2.2 per cent p.a. in the 1980s. There has been further deceleration in the first half of the 1990s (mainly due to the collapse of production in the ex-CPEs), so that the growth rate of world production measured over 1985-95 was only 1.6 per cent p.a. – nearly zero in per capita terms. Some slowdown in world production is not a negative outcome per se to the extent that it reflects a slower world population growth and a growing share of people who have reached a certain saturation of their per capita food consumption levels. The negative aspect of the slowdown has to do with the fact that it has been happening at all and will continue to happen because people who would consume more do not have sufficient incomes to demand more food. World output could expand at higher rates than envisaged in this study if effective demand of these poor population groups were to grow faster.
Progress in food and nutrition, but not for all

The implications of the demographic and overall development prospects, together with the assessments of the FAO study for production, consumption and trade, are that per capita food supplies for direct human consumption (as measured by the food balance sheets) in the developing countries as a whole will continue to grow, from the nearly 2,500 calories of 1988/90 and the 2,550 calories of 1992/94 to about 2,770 calories by the year 2010 (Table 4). It is likely that by the year 2010 the Near East/North Africa, East Asia (including China) and Latin America/Caribbean regions will be at or above the 3,000 calories mark – significant progress, particularly for East Asia. South Asia may also make significant progress, although in 2010 it will still be at a middling position. But the prospects are that per capita food supplies in Sub-Saharan Africa will remain at very low levels.

Table 3. Growth of total agricultural production and demand (percentage)

<table>
<thead>
<tr>
<th></th>
<th>Domestic demand</th>
<th>Production</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>2.3</td>
<td>1.4</td>
<td>1.8</td>
<td>2.3</td>
<td>1.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Developed countries</td>
<td>1.2</td>
<td>-1.4</td>
<td>0.5</td>
<td>1.4</td>
<td>-1.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Developing countries</td>
<td>3.6</td>
<td>3.7</td>
<td>2.8</td>
<td>3.3</td>
<td>3.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Africa (Sub-Saharan)</td>
<td>2.6</td>
<td>3.4</td>
<td>3.3</td>
<td>1.9</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Near East/North Africa</td>
<td>4.5</td>
<td>2.3</td>
<td>2.8</td>
<td>3.1</td>
<td>2.0</td>
<td>2.7</td>
</tr>
<tr>
<td>East Asia</td>
<td>4.1</td>
<td>4.6</td>
<td>2.8</td>
<td>4.1</td>
<td>4.3</td>
<td>2.7</td>
</tr>
<tr>
<td>South Asia</td>
<td>3.1</td>
<td>3.1</td>
<td>2.8</td>
<td>3.1</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>2.9</td>
<td>3.3</td>
<td>2.4</td>
<td>2.9</td>
<td>2.6</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Source: FAO.

Table 4. Food supplies and incidence of chronic undernutrition

<table>
<thead>
<tr>
<th></th>
<th>Food supplies calories/day</th>
<th>Chronic undernutrition</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>2,720</td>
<td>2,900</td>
<td>21</td>
<td>12</td>
<td>839</td>
</tr>
<tr>
<td>Developed countries</td>
<td>3,350</td>
<td>3,390</td>
<td>24</td>
<td>30</td>
<td>215</td>
</tr>
<tr>
<td>Developing countries</td>
<td>2,520</td>
<td>2,770</td>
<td>16</td>
<td>6</td>
<td>268</td>
</tr>
<tr>
<td>Africa (Sub-Saharan)</td>
<td>2,040</td>
<td>2,280</td>
<td>22</td>
<td>12</td>
<td>295</td>
</tr>
<tr>
<td>Near East/North Africa</td>
<td>2,960</td>
<td>3,010</td>
<td>16</td>
<td>6</td>
<td>268</td>
</tr>
<tr>
<td>East Asia</td>
<td>2,670</td>
<td>3,030</td>
<td>15</td>
<td>7</td>
<td>64</td>
</tr>
<tr>
<td>South Asia</td>
<td>2,290</td>
<td>2,520</td>
<td>15</td>
<td>7</td>
<td>64</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>2,740</td>
<td>3,090</td>
<td>15</td>
<td>7</td>
<td>64</td>
</tr>
</tbody>
</table>

Source: FAO.
Under the circumstances, the incidence of undernutrition would decline further in the regions with better prospects. However, there could still be 200 million people undernourished in South Asia by the year 2010, while undernutrition is likely to remain rampant in Sub-Saharan Africa, with about 30 per cent of the population (some 260 million) affected. Thus, the scourge of undernutrition in terms of absolute numbers affected will tend to shift from South Asia to Sub-Saharan Africa. These estimates are broad orders of magnitude and relative trends rather than precise predictions of what may happen, subject to the necessary caveats (FAO, 1996a). They indicate that, in terms of population share, it is likely that undernutrition in the developing countries as a whole will continue to decline until 2010, but will persist at only slightly lower absolute levels than at present. Therefore, there will be no respite from the need for interventions to cope with the problem – to eradicate poverty, the root cause of undernutrition.

**World production of cereals will continue to grow, but not in per capita terms**

In the past twenty-five years, per capita production of cereals for the world as a whole grew from 303 kg in 1969/71 to a peak of 342 kg in 1984/86, but then it declined to 327 kg in 1989/91, and to 307 kg in 1993/95 (Table 5). The projected world production of cereals of 2 334 million tons for 2010 translates into 327 kg per capita. The implied increase from the depressed levels of the mid-1990s includes a strong element of recovery, but even so per capita production in 2010 would still be below the peak of the mid-1980s. This projected lack of strong growth in world per capita production of cereals is, however, no cause for general alarm, for the reasons discussed earlier in connection with the progressive slowdown in world agricultural growth. In particular, the consumption requirements for all uses in the developed countries (1990/92: 624 kg per capita, 45 per cent of world consumption) will grow only slowly and may fall in per capita terms. These countries produce collectively as much as needed for their own consumption and to meet the increase in net exports to the developing countries. Within limits they could produce more, if more is demanded. These prospects are heavily influenced by possible developments in the ex-CPEs of Europe, whose total domestic use of cereals would not only stop increasing rapidly as in the past but actually fall.

Per capita production of cereals in the developing countries is projected to continue growing, from 214 kg in 1989/91 to 230 kg in 2010. But their per capita consumption for all uses may grow faster than production, from 237 kg in 1989/91 to 258 kg in 2010; a good portion of production could go to feed to support the rapidly growing livestock sector. This will require further growth of net imports from the developed countries, which may grow from the 90 million tons of 1988/90 and an average of 107 million tons during the last three years, to about 160 million tons in 2010.
Table 5  Cereals: historical data and projections to 2010  
(million tons; rice included in milled form)*

<table>
<thead>
<tr>
<th>Production</th>
<th>Developed countries</th>
<th>Developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>World</td>
<td>Ex-CPEs Other</td>
</tr>
<tr>
<td>Actual 1969/71</td>
<td>1 117 (303)</td>
<td>213 (642) 422 (568)</td>
</tr>
<tr>
<td>Actual 1989/91</td>
<td>1 727 (327)</td>
<td>266 (685) 598 (692)</td>
</tr>
<tr>
<td>Actual 1993/95</td>
<td>1 729 (307)</td>
<td>219 (561) 582 (656)</td>
</tr>
<tr>
<td>Projected 2010</td>
<td>2 334 (327)</td>
<td>306 (707) 710 (730)</td>
</tr>
<tr>
<td>Total Use</td>
<td>Actual 1969/71</td>
<td>1 115 (302)</td>
</tr>
<tr>
<td>Actual 1990/92</td>
<td>1 758 (327)</td>
<td>302 (774) 484 (556) 786 (624)</td>
</tr>
<tr>
<td>Projected 2010</td>
<td>2 334 (327)</td>
<td>301 (696) 553 (569) 854 (608)</td>
</tr>
<tr>
<td>Food Use</td>
<td>Actual 1969/71</td>
<td>541 (147)</td>
</tr>
<tr>
<td>Actual 1990/92</td>
<td>887 (165)</td>
<td>68 (174) 116 (134) 184 (146)</td>
</tr>
<tr>
<td>Projected 2010</td>
<td>1 189 (165)</td>
<td>73 (169) 120 (128) 194 (141)</td>
</tr>
<tr>
<td>Feed use</td>
<td>Actual 1969/71</td>
<td>439 (119)</td>
</tr>
<tr>
<td>Actual 1990/92</td>
<td>647 (121)</td>
<td>178 (456) 303 (348) 481 (382)</td>
</tr>
<tr>
<td>Projected 2010</td>
<td>855 (119)</td>
<td>172 (397) 355 (379) 527 (365)</td>
</tr>
<tr>
<td>Net Trade</td>
<td>Actual 1969/71</td>
<td>2.3</td>
</tr>
<tr>
<td>Actual 1992/94</td>
<td>24.1</td>
<td>111.2 89.1</td>
</tr>
<tr>
<td>Projected 2010</td>
<td>5.0</td>
<td>157.0 162.0</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are kg per capita.

Source: FAO
Modest growth in the demand for exports of cereals from the major exporting developed regions

Although there are prospects for further growth of cereal exports from the major exporting developed countries to the developing countries and thus for further growth of production, the former’s aggregate net exports to the rest of the world are projected to grow by much less. This is because some of the increments in the net imports of the developing countries will be offset by declines in those of the ex-CPEs of Europe. That region would cease to be a large net importer in the future, and there is a possibility that it could turn into a modest net exporter of cereals by 2010. Its net imports had fallen from roughly 35 million tons in the pre-reform period (1979-81) to insignificant levels by the mid-1990s.

There might be some changes in the market shares for the total net exports of the three major exporting OECD areas, Western Europe, North America and Oceania. The policy reforms under way and planned, in particular in the context of the provisions of the Final Act of the Uruguay Round, should probably lead to Western Europe having a smaller share in total exports in the future compared with its share in the late 1980s. These are the findings of most analyses; they are, of course, subject to many caveats attached to the assumptions and models on which the analyses are based. Indeed, more recent studies indicate that, under further policy reforms, the European Union could increase further its net exports of cereals, some of them without export subsidies, after the year 2000 (Folmer et al., 1995; CARD, 1996).

Continuing strong growth in the livestock sector

Past trends for the livestock sector in developing countries to grow at a relatively high rate are set to continue, though in attenuated form. However, the consumption of livestock products in the developing countries will still be well below that of the developed countries in per capita terms in the year 2010 (Table 6). These averages for the developing countries mask wide regional and country diversities, with East Asia, – particularly China – surging ahead (see Alexandratos, 1996a) while in both South Asia and Sub-Saharan Africa consumption will generally remain at very low levels. The disparities reflect those in incomes as well as production constraints. The latter are a factor in the unfavourable nutritional prospects of some countries in which livestock products, particularly milk, are a major staple food, e.g. in the pastoral societies.

The livestock sector of the developed countries may also grow, but at much slower rates than in the past, with per capita consumption growing only for poultry meat. The implication is twofold: a) in the ex-CPEs it may take some time before the growth of production and per capita consumption of livestock products recover
from the low levels after the sharp initial declines, and b) the other developed countries will have generally high levels of per capita consumption.

With the continued growth of the livestock sector in the developing countries, the use of cereals as feed will continue to grow quickly, perhaps doubling by the year 2010 to some 330 million tons, about 22 per cent of those countries’ total use. This increasing proportion of total cereal supplies used to feed animals in the developing countries may give rise to concern given the persistence of undernutrition. The concern would be well founded if the use of cereals for feed-diverted supplies would otherwise be available for use by the poor as direct food. That could happen, but only in situations where the additional demand for feed would raise prices rather than supplies (whether from domestic production or imports) and price the poor out of the market. There are reasons to believe that such a scenario is unlikely.

The developing countries are likely to turn from net agricultural exporters to net importers

Projections for the major commodity sectors indicate that the developing countries’ current or eventual net imports of agricultural commodities will grow faster than those countries’ net exports of their major export commodities. This is a firm indication that the developing countries’ combined agricultural trade account will switch from surplus to deficit. The movement in this direction has been evident for some time. The positive net balance of trade on agricultural account shrunk rapidly in the 1970s when food imports from the developed countries exploded. Although the trend was somewhat reversed in the 1980s, the overall surplus was only a fraction of what it had been two decades before. These trends may be attenuated with the exporting by the developing countries of more dynamic agricultural
products with significant market potential in the developed countries, e.g. cut flowers and tropical fruit.

The welfare implications of the developing countries' possible transformation into net agricultural importers are not clear. It is certain that the turnaround will have a negative impact on the welfare of those countries that continue to depend heavily on slowly growing agricultural exports to finance their imports of food and other commodities. Many low-income countries are in that situation; however, for other countries these prospects are part and parcel of the development process. Those are the countries whose increased imports or reduced exports of agricultural raw materials are more than compensated by growing exports of the related manufactures; the increased food imports reflect their growing incomes and food consumption, and are financed from export earnings of other sectors. In fact, several countries in this latter group will "graduate" to the status of developed country in the next twenty years.³

IV. FACTORS IN THE GROWTH OF AGRICULTURE IN DEVELOPING COUNTRIES

Further intensification projected, with yield growth the mainstay of production increases

The production outcomes presented earlier will depend on further intensification of agriculture in the developing countries: yields would be higher, more land would be brought into cultivation and irrigated, and the existing land would be used more frequently (multiple cropping and reduced fallow periods).

Yield growth has been the mainstay of production increases in the past. That will be even more the case in the future, particularly in the land-scarce regions of Asia and the Near East/North Africa. At present, average yields differ widely among countries. However, comparisons convey only limited information about the potential for lagging countries to catch up with the ones achieving higher yields. This is because agro-ecological conditions differ widely among countries and farming environments. For example, the 5.0 tons/ha average wheat yield of Egypt reflects the fact that wheat is irrigated. This yield is not achievable by countries in which wheat is (and will continue to be) predominantly rainfed in adverse agro-ecological conditions.

Therefore, agro-ecological differences among countries must be taken into account before any judgement can be passed as to the potential for yield growth. It is for this reason that a painstaking collation of data on yields achieved within the different countries in six agro-ecological environments (five rainfed and one
irrigated, hereafter referred to as “land classes” – see below) for the FAO study. The resulting data are not perfect, and it has not been possible to assemble sufficient information for China. But for the other developing countries these imperfect data can go a long way towards permitting an assessment of yield growth potential that is far superior to the estimation based solely on average yields.

With these caveats in mind, the dependence of the production outcomes presented earlier on yield growth, as well as the credibility of the yield projections, can be illustrated as follows. The average irrigated rice yield in the developing countries is today 3.7 tons/ha, but some countries achieve under 2.0 tons and others 10.0 tons. The countries with the highest yields – roughly one in five – together achieve an average of 6.7 tons. The country-by-country assessment of prospects for irrigated rice indicates that the average irrigated rice yield of all countries could be 5.2 tons/ha in year 2010. This means that in twenty years’ time the average irrigated rice yield for all countries may still be below that achieved today by the top fifth. This may appear conservative, but it is a “best guess” outcome of the judgements made for individual countries taking into account differences among countries both in the quality of irrigated lands and in the socio-economic environments

Table 7. Cereal yields in major agro-ecological land classes and inter-country differences, developing countries (excluding China)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (paddy), all land classes</td>
<td>100</td>
<td>2.8</td>
<td>3.8</td>
<td>0.9-4.6</td>
<td>0.9-6.6</td>
<td>1.5-7.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated</td>
<td>58</td>
<td>3.7</td>
<td>5.2</td>
<td>1.7-7.2</td>
<td>3.4-8.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluvisols and Gleysols</td>
<td>24</td>
<td>1.9</td>
<td>2.7</td>
<td>0.5-2.7</td>
<td>0.6-3.1</td>
<td>1.2-6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat, all land classes</td>
<td>100</td>
<td>2.4</td>
<td>3.3</td>
<td>1.1-5.4</td>
<td>1.9-6.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated</td>
<td>60</td>
<td>1.7</td>
<td>2.1</td>
<td>0.9-2.9</td>
<td>1.2-4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, sub-humid</td>
<td>21</td>
<td>1.8</td>
<td>2.5</td>
<td>0.6-4.9</td>
<td>1.1-6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize, all land classes</td>
<td>100</td>
<td>1.7</td>
<td>2.6</td>
<td>0.6-4.1</td>
<td>1.2-4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated</td>
<td>24</td>
<td>3.8</td>
<td>4.6</td>
<td>1.6-7.8</td>
<td>2.2-8.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, sub-humid</td>
<td>49</td>
<td>1.8</td>
<td>2.6</td>
<td>0.6-3.7</td>
<td>1.2-4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, humid</td>
<td>17</td>
<td>1.3</td>
<td>1.7</td>
<td>0.4-2.8</td>
<td>0.8-3.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millet, all land classes</td>
<td>100</td>
<td>0.7</td>
<td>0.8</td>
<td>0.4-1.3</td>
<td>0.3-1.4</td>
<td>0.6-1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, dry semi-arid</td>
<td>18</td>
<td>0.4</td>
<td>0.5</td>
<td>0.1-0.6</td>
<td>0.3-0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, sub-humid</td>
<td>27</td>
<td>0.9</td>
<td>1.1</td>
<td>0.6-1.8</td>
<td>0.7-2.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum, all land classes</td>
<td>100</td>
<td>0.7</td>
<td>1.2</td>
<td>0.3-2.8</td>
<td>0.4-3.4</td>
<td>0.6-3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, dry semi-arid</td>
<td>11</td>
<td>0.5</td>
<td>0.6</td>
<td>0.3-1.0</td>
<td>0.4-1.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed, sub-humid</td>
<td>32</td>
<td>1.3</td>
<td>1.7</td>
<td>0.6-3.5</td>
<td>0.9-3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Yields of countries with at least 50,000 ha in the land class and crop and year shown.
2. Simple averages of the yields of the bottom 10 per cent and top 10 per cent of the countries ranked by yield level (not always the same countries in the top or bottom deciles in each year).
Source: FAO.
conditioning the pace of adoption of yield-increasing technologies. Data and projections for cereal yields are shown in Table 7.

Naturally, further growth in yields, even at the rates projected here – lower than in the past – will not come about unless the research effort continues unabated, both in crops and in animal production. The effects of research on yield growth may manifest themselves in ways different from those of the past. Emphasis is already shifting towards yield stability, stress tolerance and disease resistance. Moreover, continuing research efforts are needed for the crops in unfavourable environments which had been neglected in the past, as well as for preventing declines and maintaining – perhaps increasing – yields in those farming conditions where the amount of produce nearly matches the ceiling yields of experiment stations.

**Land in crop production to be expanded and used more frequently**

The developing countries (excluding China) have about 2.5 billion ha of land on which rainfed crops could achieve reasonable yields, depending on the technology used (see Table 8). Over 80 per cent lies in the two land-abundant regions, Sub-Saharan Africa and Latin America/Caribbean. The differences in land/person ratios among regions are enormous, with Asia and the Near East/North Africa region having particularly low land availabilities per capita. Of this total land with rainfed production potential, about 720 million ha are currently used in crop production. Another 36 million ha of land used for crop production comes from desert land that has been irrigated. Considering the other important ecological functions of the remaining land, in particular the forest cover, the FAO projections would imply relatively modest increases in the different countries adding up to about 90 million ha. Thus by the year 2010, the total land in crop production could be some 850 million ha. The expansion would mostly be in Sub-Saharan Africa and Latin America/the Caribbean, with some in East Asia (excluding China) and very little in the other two regions. It is foreseen that the land needs for crop production growth will come in part from further increases in cropping intensities, and the average for the developing countries as a whole could rise from 79 per cent at present to 85 per cent in the year 2010. Land cropped and harvested in an average year would therefore increase from 600 million ha at present to about 720 million ha in year 2010 – a 120 million ha increase compared with the 90 million ha of new land to be brought in crop production.

**Irrigated land to expand, but at a slower pace than in the past**

Achievement of the increased intensities and higher yields depends crucially on maintenance of irrigation and its further expansion by 23 million ha or 19 per
cent. This is a lower rate of expansion than in the past because of well-known problems: the increase in unit costs of irrigation investment, the scarcity of water resources and suitable sites, and the growing attention paid to avoiding adverse environmental impacts. Given these constraints – but also for reasons of efficiency – the emphasis in the future will be more on improving the efficiency of water use and expanding simple water conservation and water-harvesting techniques, and less on indiscriminate expansion of formal irrigation. The bulk of additional irrigation would be in South Asia, which now accounts for 52 per cent of all irrigation of the developing countries (excluding China) – a share it will maintain in the future. It should be noted that the above-mentioned 23 million ha of additional irrigation is a net increment. In practice, the gross investment requirements for irrigation will need to cover a much wider area to account for rehabilitation of existing irrigated areas and to substitute for those permanently lost because of degradation.

Would agricultural expansion encroach on the forest?

The FAO’s Forest Resources Assessment 1990 (FAO, 1993) produced data on the forest land of the tropical countries. Of the developing countries for which the data on land with crop production potential were estimated, only 69 have forest area data

---

**Table 8. Land with rainfed crop production potential, developing countries (excluding China)**

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Moisture regime (LGP in days)</th>
<th>Land quality</th>
<th>Million ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT1</td>
<td>Dry semi-arid</td>
<td>75-119</td>
<td>VS, S, MS</td>
<td>154</td>
</tr>
<tr>
<td>AT2</td>
<td>Moist semi-arid</td>
<td>120-179</td>
<td>VS, S</td>
<td>350</td>
</tr>
<tr>
<td>AT3</td>
<td>Sub-humid</td>
<td>180-269</td>
<td>VS, S</td>
<td>594</td>
</tr>
<tr>
<td>AT4</td>
<td>Humid</td>
<td>270+</td>
<td>VS, S</td>
<td>598</td>
</tr>
<tr>
<td>AT5</td>
<td>Marginally suitable land in the moist semi-arid, sub-humid, humid classes</td>
<td>120+</td>
<td>MS</td>
<td></td>
</tr>
<tr>
<td>AT6</td>
<td>Fluvisol/Gleyso</td>
<td>Naturally flooded</td>
<td>VS, S</td>
<td>518</td>
</tr>
<tr>
<td>AT7</td>
<td>Marginally suitable Fluvisol/Gleyso</td>
<td>Naturally flooded</td>
<td>MS</td>
<td></td>
</tr>
</tbody>
</table>

Total with rainfed potential (of which irrigated) 2 537 721 812 1 816 1 725

Additional irrigation on non-suitable (arid and hyperarid) land 36 36 38

Grand total 2 573 757 850 1 816 1 725

---

1. LGP = length of growing period.
2. VS = very suitable, S = suitable, MS = marginally suitable.
3. Source: FAO.
available. In addressing the extent to which agricultural expansion may encroach on the forest, this subsection refers only to the subset of the 69 countries that account for all but 4 per cent of the total tropical forest area in the Assessment. It is also speculative, because the extent of overlap between the forest and the land with regard to agricultural potential is not fully known. Only some elements of that overlap can be deduced indirectly.

Subject to the data caveats, the situation in these 69 countries is that 85 million ha are projected to be converted to agriculture in twenty years, out of a total 1 720 million ha of land with agricultural potential but not used for crop production at present. The extent to which this land overlaps with the forest area is not fully known, but a minimum estimate is about 800 million ha and the real overlap is probably much larger. Not much more can be said on this matter, except perhaps that if all the additional land for agriculture were to come from the forest areas, that would imply an annual rate of deforestation of 4.2 million ha, or 0.25 per cent p.a. of the total forest area (of these 69 countries) of 1 690 million ha. This compares with some 15 million ha (0.8 per cent p.a.) of annual deforestation estimated to have occurred in the 1980s. This latter figure, however, includes deforestation from all causes, not just from formal expansion of crop production. In particular, deforestation results from expansion of grazing (not included in the estimates of this study) and informal, unrecorded agriculture using much more land than considered necessary to achieve the crop production increases. It also includes deforestation from logging of areas not yet reforested by natural regrowth, and from fuel wood-gathering operations. To the extent that expansion of grazing, informal agriculture, overcutting for fuel wood and unsustainable logging continue in the future, it must be expected that deforestation will continue at a much greater rate than needed for expansion of formal agriculture.

Other claims on land

Land with agricultural potential is increasingly occupied by human settlements and infrastructure. Rough estimates for the developing countries (excluding China) indicate that such uses of land may be at present about 94 million ha, or 0.033 ha per capita (one square kilometre per 3 000 persons), but with this ratio varying widely among countries, depending on overall population densities. Not all human settlements are on land with agricultural potential, but those that are probably cover about 50 million ha. With population growth, more land will be diverted to human settlements and infrastructure – though perhaps not in proportion, because with increasing population densities the land so used will tend to decline to perhaps 0.03 ha per person. This means that land in human settlements may increase to 128 million ha by 2010, of which perhaps some 70 million would be land with agricultural potential – an increase of 20 million ha. This figure must be added to
the one for the expansion of crop production proper, discussed above, to obtain an idea on future claims on the land with agricultural potential.

**Further growth in fertilizer and pesticide use**

The developing countries use some 63 million tons of fertilizer (in terms of nutrients NPK). That figure represents a fourfold increase over the last twenty years, though the growth rate of the 1980s was much lower than that of the 1970s. At present, rates of use have reached 62 kg/ha of harvested area (about one-half the average of the developed countries), but with very wide regional differences, ranging from 11 kg in Sub-Saharan Africa to 90 kg in the Near East/North Africa. The scope for further increases is much more limited than in the past. This, in combination with the lower agriculture growth rate, will tend to make for further declines in the growth rate of fertilizer consumption, perhaps to 3.8 per cent p.a. in the period to 2010. Thus, projected fertilizer consumption in the developing countries may rise to some 138 million tons and the application rate to some 110 kg/ha. It is worth noting that while there are problems from excessive use in some irrigated areas of the developing countries, there are also problems from too little use in other areas, where it is used to counteract land degradation due to nutrient mining. Sub-Saharan Africa uses only 11 kg/ha. Even a doubling by 2010, as projected here, would still be too little for eliminating nutrient mining in some areas.

Traditional plant protection methods (tillage, burning, crop rotation) remain important in developing countries. However, methods based on the use of chemical pesticides have become widely used in recent decades. It is estimated that in the mid-1980s the developing countries accounted for about one-fifth of the world consumption of pesticides (active ingredient). They currently account for about 50 per cent of world use of insecticides, but for much smaller proportions of fungicides and herbicides. This reflects both agro-ecological and economic factors, e.g. a higher incidence of insects in the humid tropics and cheaper labour for weed control. With labour costs rising in some countries, it can be expected that chemical herbicides will be used more widely.

The intensification of production and the expansion of agriculture into new areas in the developing countries could translate into further growth of pesticide use. Such growth could be contained at fairly low rates, through a combination of technological change, improved management and incentives and increasing resort to methods of biological pest control in the context of integrated pest management (IPM). These prospects for the developing countries contrast with those for the developed countries, where the lower growth of agriculture and the policies for pesticides and for the further spread of IPM could eventually lead to absolute declines in total use.
V. FURTHER PRESSURES ON AGRICULTURAL RESOURCES AND THE ENVIRONMENT

The pressures to convert land with agricultural potential were dealt with in the preceding section. On the whole, such claims (110 million ha in all developing countries, excluding China) over the next twenty years would appear small when compared with about 1.8 billion ha of land with potential not occupied by either agricultural use or human settlements. However, land scarcities are very acute in some countries and regions, e.g. South Asia and the Near East/North Africa. Even the small increases foreseen for these areas are a significant part of their still unused land. For example, the increments for agricultural use and human settlements would claim about 25 per cent of the land with agricultural potential still unused in South Asia. There will be little land left for further expansion beyond the year 2010 – additional land for agriculture in South Asia will be needed even after allowing for further intensification. That region could raise cropping intensities from 112 per cent to 122 per cent, and double the fertilizer use rate per ha.

Even though land constraints are severe in some countries and regions, constraints on freshwater supplies for agriculture are even more limiting for many more countries. The increasing claims on agricultural land for non-agricultural uses are minor when compared with those placed on water resources, because the per capita non-agricultural use of water tends to rise very rapidly with urbanisation and industrialisation (Table 9). Competition between agriculture and the other sectors for dwindling per capita availabilities of freshwater will become more intense in the future, and in most cases it will only be accommodated by increasing efficiency in water use.

Degradation of soils is estimated to affect some 1.2 billion ha of land worldwide, of which about 450 million ha is in Asia. Among the causes, deforestation and overgrazing probably each contribute one-third of the effect, with the bulk of the balance due mostly to mismanagement of arable land. Soil (water and wind) erosion accounts for just over 1 billion ha of total degradation, with the balance due to chemical and physical factors. Both manmade and natural processes (e.g. upward

<table>
<thead>
<tr>
<th>Income groups</th>
<th>Annual withdrawals (m³ per capita)</th>
<th>Withdrawals by sector</th>
<th>Agriculture (%)</th>
<th>Industry (%)</th>
<th>Domestic use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>386</td>
<td></td>
<td>91</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Middle income</td>
<td>453</td>
<td></td>
<td>69</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>High income</td>
<td>1,167</td>
<td></td>
<td>39</td>
<td>47</td>
<td>14</td>
</tr>
</tbody>
</table>

Source: Reproduced from Rosegrant, 1997.
movements in the earth's crust) cause soil degradation. Some will continue to occur in the future; however, the relationship between soil erosion and productivity loss is complex, and more work is needed before firm conclusions can be drawn about the impact of soil erosion on yields.

Degradation from nutrient mining is a serious problem, particularly in the semi-arid areas of Sub-Saharan Africa where livestock manure is in short supply and the use of mineral fertilizer is seldom economic. The problem will probably continue to exist over the next twenty years. Degradation from salinisation of soils is primarily a problem of irrigated areas, but also occurs in hot dry zones. Available estimates of irrigated land losses from this cause vary widely, while 10 to 15 per cent of irrigated land is to some extent degraded through waterlogging and salinisation.

Desertification (broadly, land degradation in dryland areas) is estimated to affect some 30 per cent of the world's land surface. More recent thinking on desertification points to a growing consensus that past estimates of the area affected were greatly exaggerated. Some of the more extreme estimates were due to weaknesses in the methodology used to produce them. It is now recognised that drylands are much more resilient to drought and to man's abuse than previously thought. However, further expansion of agriculture into fragile soils in the dryland areas would add to the problem.

Water contamination of agricultural origin (salt concentrations in irrigated areas, contamination from fertilizer and pesticides as well as from effluents of intensive livestock units and fish farms) will likely continue to increase because of the long period required for appropriate corrective action.

As regards pesticides, it is assumed that greater emphasis on integrated pest management and concerns about health and ecosystem conservation will tend to reduce the growth rate of their use. But the more intensive use of land (reduced fallow land, more multiple cropping) and the higher-than-average growth of the vegetables sector will contribute to further – though modest – increases in pesticide use in the developing countries.

Further expansion and intensification of agriculture will also contribute to intensified pressures on the environment of a global nature. Deforestation will adversely affect the dual role of forests as habitats for biodiversity and as major carbon sinks. Biodiversity will also likely suffer from possible further draining of wetlands for conversion to agriculture, even though this conversion may affect only a minor proportion of total wetlands. Additionally, agriculture will continue to contribute to the growth of greenhouse gases in the atmosphere (biomass burning in the process of deforestation, and methane emissions from rice cultivation and from ruminant livestock).
VI. COMPARISON WITH OTHER OUTLOOK STUDIES

In spite of many differences, two other recent global outlook studies that make projections to 2010 come to broadly similar conclusions as the FAO study. Paarlberg (1996) concludes that the FAO’s projections “are not significantly different from those recently made (with different methods) by IFPRI [Agcaoili-Sombilla and Rosegrant, 1994] and by the World Bank [Mitchell and Ingco, 1993]”. Islam (1995) discusses the results of the three studies in some detail and concludes that there is “agreement that the world food supply in 2010 would probably meet global demand, but that regional problems could occur”. There is a consensus that the growth of world agricultural production will continue to slow down; that yield increases will continue to be the mainstay of production growth but that growth in yields will take place at a slower pace than in the past; that Sub-Saharan Africa and South Asia will remain problem areas; that the role of trade in food supplies will increase; and that China’s food imports will remain manageable in their proportions. The FAO study does not project prices but the IFPRI study does, and concludes that the long-term downward trend of real prices for crops will continue, which is in accordance with the findings of other studies (e.g. USDA, 1996) – even allowing for some price increases in the medium term due to the implementation of the Uruguay Round Agreement on Agriculture (FAO, 1995).

Table 10 presents selected projection results from the three studies for the cereals sector. There are considerable regional differences. Mitchell and Ingco foresee lower production and demand for Sub-Saharan Africa, the Near East/North Africa and Latin America than the FAO study but higher demand in South and East Asia, overall leading to much higher net imports for the developing countries.
(210 million tons against 162 million tons in the FAO study). Agcaoili-Sombilla and Rosegrant foresee net imports for the developing countries similar to those in the FAO study, but through a combination of much lower demand and production in the developing countries and much higher demand and production in the former centrally planned economies (CPEs) and in other developed countries.

VII. FACTORS THAT MAY INFLUENCE FUTURE DEVELOPMENTS

This section briefly discusses a number of possible developments which, were they to materialise, could cause the growth path of food and agriculture to deviate from the “consensus” scenario sketched in the preceding sections.

Changes in government policies

Implementing the target of the World Food Summit Plan of Action

The FAO’s findings leave no room for complacent views that progress – its pace and pattern – will be sufficient to eliminate or significantly reduce food insecurity problems in the foreseeable future. The assessment is pragmatic, and far from optimistic. In fact, it was this perspective of persistent undernutrition that led the Director-General of the FAO to propose convening the World Food Summit, which took place in Rome 13-17 November 1996. The Summit adopted the Rome Declaration on World Food Security and the World Food Summit Plan of Action. The Plan of Action represents an urgent call for better government policies, and sometimes drastic changes. If implemented, the Plan of Action’s concrete objective “to reduce the number of undernourished people to half their present level no later than 2015” could be achieved, which would mean an important deviation from the “most likely” outcome sketched above.

The FAO holds the view that the Plan of Action’s objective is a realistic, feasible target. Taking the year 2010 as a target year, thus leaving a safety margin of five years, produces four important implications: 1) The target can be reached, if the 55 countries with the lowest consumption levels today (less than 2,200 calories per day and person) establish conditions for a mere 1 per cent growth per year in per capita demand. Many of them would only need to realise the same growth rates of supply that they had in the last two decades. 2) However, a small sub-group of 17 countries with the severest degree of undernutrition, mostly in Africa, would have to make greater efforts. For example, their cereal supplies would have to grow by 4 per cent annually, instead of the 2 per cent of the recent past. 3) Cereal demand in 2010 in these “lagging” countries would have to be 46 million tons higher than otherwise expected, and cereal imports would have to be 20 million
tons higher. On a global scale these are small amounts (only 2 per cent of the world use of cereals expected in 2010). 4) For the countries in question however, this would be a major achievement and require a drastic change in their priorities for agriculture and rural development.

Implementing policies to safeguard natural resources

Another area where changes in policies could have an accelerated impact on the projected development path is in natural resource conservation policies – in particular where countries are approaching their environmental carrying capacity, i.e. the natural resource constraints to further growth. The FAO’s projections are based on the expectation that public policies will be put in place to maintain the productive capacity of the natural resource base where markets fail. Examples relate to land use planning, more efficient management of water resources (through, *inter alia*, appropriate pricing), and sustainable use and conservation of genetic resources.

If agricultural resource management policies fail to establish an economic, social and legal environment that will induce the technical and institutional change needed to achieve the required agricultural growth, the environment may be subject to more degradation than foreseen in the FAO projections, and hence sustainability of the projected production growth may be limited. There are by now enough success stories to underline the feasibility of such change, and also sufficient concrete practical examples of how appropriate policies can ease the resource constraints (de Haen, 1997).

Further reform of international agricultural trade rules

Implementation of the measures contained in the Agreement on Agriculture of the Uruguay Round should (at least for developed countries) be complete by 2000. It is commonly accepted that the agricultural reforms of the Uruguay Round were more successful in changing the rules than in liberalising trade. Protection in many markets still remains very high, and it has even been suggested that “it is as if the agricultural sector still has pre-Kennedy Round tariff protection” (Josling, 1997). One of the reasons for this is that main reforms in the EU and the United States had already been undertaken in the early 1990s during the negotiating process leading to the Uruguay Round Agreement. The only commitment that has created some “difficulty” so far is the minimum access under tariff quotas (TRQs), as this required opening up markets where they had not existed. The mechanisms of implementing these TRQs have also created some “difficulties”, especially concerning the issue of licensing. Increasingly, the gradually tighter commitments will begin to be felt, export subsidies especially but also specific domestic support policies. (At least there will be more scrutiny of such policies.)
The Agreement calls for further trade talks to be initiated by 1999. It is rather early to predict the areas on which discussions in a new round could focus, assuming that it is agreed to start then. It seems possible, however, that the package could include further reductions of tariffs and export subsidies (across the board or product-specific), a further opening of markets, and more progress in decoupling national income support and agriculture. Other areas that have been mentioned include a change in rules on tariff quotas and trade and environment (see also de Zeeuw, 1996).

In general, further implementation of the current Agreement and the further reforms should have positive effects on the world market of agricultural commodities, in the sense of facilitating trade and shifting production to more efficient producers. Prices of basic food commodities would not necessarily increase further, as greater transmission of the already higher world market prices to domestic markets should stimulate increased production. Higher, longer-run price response elasticities and dynamic effects could also contribute.

What if world cereal stocks declined further?

Generally, these projections of production, supply and demand have been made assuming a level of food stocks adequate to cover normal fluctuations in supply and demand. Until recently these stocks, mainly in cereals, were more than sufficient to perform this function. The main reasons for the large build-up of stock in the past (particularly in the 1980s) were production policies in major exporting countries which boosted grain output beyond absorptive capacities in domestic and international markets. Recent changes in such policies have been responsible for the reduction in grain surpluses in these countries – and consequently, in the size of stocks. This may have contributed to a higher degree of short-term price volatility at the international level over the past two seasons; changes in the location of stocks may also have played a role. While stocks held by major exporters have been declining, those held by the rest of the world (ROW) have actually gone up in recent years. The likelihood of this process continuing into the future will depend greatly on farm policies in the United States and the EU, and to a lesser extent in Canada. Given the recent changes in their policies, it seems unlikely that stocks in these major exporting countries will increase; in fact, they may even decrease further although the outlook for the EU is clouded in uncertainty.

The issue of changing ownership, public versus private holding, would in the future involve more the ROW countries than those that have already reduced their public holding to a considerable degree – currently classified as major exporters. The path towards more market-oriented economies in ROW countries, characterised by greater domestic liberalisation and reduced government intervention, has
also resulted in a greater share of private stockholding. Obviously, private sector behaviour regarding stocks (basically reflecting profit motives) will be different from public sector behaviour (reflecting social objectives); there is a concomitant negative impact on food security. The issue of strategic reserves for food security purposes administered by government agencies may therefore gain greater importance in the future.

**Changes in meat consumption and production**

The future evolution of the meat sector is particularly uncertain; there are a number of developments that could lead to a situation in 2010 (and beyond) somewhat different than what is foreseen in the FAO study.

Fast economic growth in East Asia has had a particularly strong impact on the demand for meat products over the past decade, especially as most countries in the region had had rather low meat consumption levels. Particularly striking is the rise in reported per capita meat consumption in China, from an annual average of 20 kg in 1986-88 to 38 kg in 1993-95 (although these data are shrouded in uncertainty and many analysts hold them to be exaggerated). Other countries such as Cambodia, the Republic of Korea, Indonesia and Malaysia at least doubled per capita meat consumption over the same period. The strong rise in demand has mainly spurred domestic production in these countries, but it has also had a strong impact on meat imports. In 1996, meat purchases by the developing countries in the Far East accounted for over 20 per cent of globally traded volumes. These tendencies are likely to continue over the medium term.

Concerns over animal disease and health-related issues will play a growing role in the coming years, as already evidenced by the strong impact of the BSE scare on beef demand last year. In 1997 that impact seems to have faded somewhat, especially as the number of new cases has fallen significantly. A major consequence of the crisis was a rebuilding of large stocks of beef within the EU, which had been nearly eliminated at the end of 1995. The BSE crisis and the ongoing debate over the use of hormone growth promoters may contribute to the decline of beef consumption in some countries, and highlight the need for scientifically sound standards.

A major development in recent years has been the emergence of the CIS countries as major markets for livestock products. The contraction in animal numbers in those countries has continued unabated since the onset of reforms in the early 1990s – reforms which, coupled with the opening to international trade, have bolstered meat imports. As a result, the CIS has emerged as the second most important destination for traded meat products, after Japan, since 1995. While these countries may see their production stabilize in the early 2000s, it is not likely
to reach the pre-reform levels, which would mean they will continue to account for a large share of global meat imports (USDA, 1997).

Accelerated recovery in Eastern Europe and the CIS

Recovery in Eastern Europe (EE) and the CIS could drastically change the role of these countries in the world market. Many believe that their farm industries are potentially highly competitive (see for example Dyson, 1997), much more so than large portions of the agriculture sector in the EU-15. Integration of the EE countries into the EU could result in even greater surpluses in these countries, unless in the meantime the EU reforms its CAP. Reform may indeed be inevitable and it is likely to happen before any EU expansion as otherwise the potentially large response of EE agriculture would make the CAP unsustainable. In conclusion, serious consideration should be given to the possibility that the EE/CIS area could become a sizeable net cereal exporter by 2010 or shortly afterwards.

Technological developments

The FAO study took into account technological progress as foreseen at the time it was being prepared. In general, modern biotechnologies are not expected to influence crop production greatly before 2010. However, a number of possible developments could have a sizeable impact around or immediately after 2010. In rice production, considerable progress is being made in research on two-line hybrid varieties, the first of which are now being planted (about 100 000 ha in China). The two-line system yields 1 to 2 tons/ha more than the three-line system now in use (which itself already raised yields by 15 to 30 per cent – to 6 to 8 tons/ha – over the best-yielding pure line varieties). Research has started on creating apomictic rice which could, by 2010, lead to considerable yield (15 tons/ha are mentioned) and efficiency gains (less costly seeds, reduced input use). Similar research is under way for other crops. Recently, for example, patent applications have been submitted for genes conditioning apomictic reproduction of hybrid maize. This, too, could lead to considerable efficiency gains. In another branch of research, molecular-marker techniques are being developed which would make possible gene recombinations from wide-crossing (i.e. crossing among distant plant relatives) to exploit potential heterosis and at the same time broaden the genetic base.

Developments in information technology have the potential of revolutionising many aspects of agricultural production well before 2010, although for many developing countries much of this implementation would probably come at a later date since applications of information technology require costly infrastructure to be in place and make a high demand on human skills (FAO, 1996b). There are numerous
areas of potential application: the use of geographical positioning systems (GPS) for micro-level application of inputs (chemicals, irrigation, etc.); better timing of input applications; more efficient feeding of livestock; better market information; improved stockholding policies of both inputs and outputs; more timely warning of upcoming hazardous natural events; and so on.

VIII. LOOKING FORWARD BEYOND THE YEAR 2010

Finally, looking forward to the longer-term future, the study offered a number of speculative estimates of agricultural growth requirements to 2025. These are meant to provide a framework for considering longer-term issues of world food-population balance. They are not projections of likely outcomes. It can be expected that the annual rate of growth of world food production required to sustain the growing population will tend to continue to decline. This is because the growth rate of world population will continue to fall, while the proportion of world population with relatively high levels of per capita food consumption will tend to increase, allowing limited scope for further increases.

Eventually, world population growth could fall to zero and total population stabilize. If by that time all people have satisfactory levels of food consumption, there will be little further pressure for increasing agricultural production. The key issue is whether the world can tread a sustainable path to an eventual situation of quasi-steady-state agriculture (of course, fluctuations due to random shocks would continue).

One aspect of this vision has to do with the capability of the world’s agricultural resources to pin production to the notional steady-state level and maintain it at that level thereafter. It is not possible to give a straightforward answer to this question, but the following considerations are relevant: a) in a world without frontiers and with free movement of people and/or conditions for greatly expanded food trade, the binding character of natural resource constraints, if they exist, will be greatly diminished; and b) there are many countries in which both food supplies and an overwhelming part of the economy depend on local agriculture. As already noted, if their agricultural resources are poor, it is entirely appropriate to speak of agricultural resource constraints standing in the way of achieving food security for all – even if it were known for certain that the world had sufficient resources to grow, in sustainable ways, as much food as required to meet the needs of a much larger world population.

On the subject of longer-term prospects, the issue of climate change and its impact on the prospects for achieving a situation of food security for all will grow in importance. The scientific uncertainties surrounding the extent of climate change
and effects on the production environment of agriculture are well known. What needs to be emphasized here is that eventual adverse effects will not be confined to the countries and regions in which they occur. Impacts will be diffused throughout the world through trade and the consequent inter-regional adjustments, a factor that will play an expanding role in the future. The effect on food security and general welfare of individual countries and population groups will depend on the stage of development they have reached by then, which will determine their ability to take corrective action. Clearly, any climate change that would cause the production potential of agricultural resources to deteriorate in the countries with both food security problems and a high dependence on agriculture could prove catastrophic.

Resource constraints impinging on agriculture and food production are only part of the issue of whether the world can tread a sustainable path to food security. Such a world must be virtually free of poverty. The issue then becomes one of sustainable paths to poverty elimination. Economic growth must be rapid in the regions with high poverty concentrations. But rapid growth will also be required elsewhere. This is because pressures on the wider ecosystem would increase, e.g., through the generation of waste from greatly increased use of energy; and if the wider ecosystem had only limited capacity to absorb the impact, it is possible that this sort of environmental constraint – not those arising from agricultural resources – would condition the pace at which the world can pursue a sustainable path to food security for all. (For contrasting views see Daly, 1992; Beckerman, 1995).

IX. CONCLUDING REMARKS

There emerges a mixed picture about the future of world food and agriculture. Overall, the world appears to be set on a path of declining growth rates of agriculture, whereby as population growth slows down, more and more countries reach medium-high or high levels of per capita food supplies, while the basic food needs of hundreds of millions of poor remain partly unfulfilled. The trend could be halted or even reversed, and growth accelerated for some time, if the significant portion of the world’s population with still-unsatisfied food consumption needs were to be in a position to demand and/or produce food at higher rates than estimated from now to 2010.

There appear to be no insurmountable resource or technology constraints at the global level that would stand in the way of achieving at least the target of the World Food Summit, i.e. reducing the number of hungry people to half the current level by no later than by the year 2015. It should be possible technically to increase world food supplies by as much as required by the growth of effective demand. The constraints to achieving food security for significantly more people are in many cases due to inappropriate policies and institutions that fail to induce adjustments
and innovations towards patterns of resource use – patterns which combine better productivity with efficiency, environmental friendliness and social equity, throughout the entire food chain. Today there are already a great number of success stories and promising technological developments to indicate that sustainable food security for all is a real possibility if the political will exists. On balance, there is scope for the necessary growth in production to be achieved while measures are taken to shift agriculture onto a more sustainable production path.

The FAO’s “normal scenario” projections imply that many countries and population groups will not be able to benefit in per capita terms more than marginally from the growth in world food production, nor from the potential for this growth to be even higher than projected here. Only a combination of faster, poverty-reducing development and public policy, both national and international, will ultimately improve the poor’s access to food and eliminate chronic undernutrition. In the countries with high concentrations of poverty and high dependence on agriculture, success in this area will often require priority to be placed on agriculture for increasing both incomes and food supplies locally. If local agricultural resource endowments are unfavourable, the task of bringing about development can prove very arduous indeed. It is in such contexts that one can speak of resource constraints proving real obstacles to solving food and nutrition problems, although as obstacles to increasing food production on a global level they may appear far less daunting.

Any vision of food security obviously implies self-reliance – but not self-sufficiency at the level of each country. Agricultural trade will play an increasing role in balancing demand and supply between food deficit and food surplus countries. The projections for cereal trade lead to a rather striking conclusion in this context. Even if the developing countries realise the projected production growth, their import demand is likely to increase further, from just over 100 million tons currently to 160 million tons in 2010, and possibly to more than 250 million tons in 2020. How is this to be paid for? While many countries have non-agricultural export earnings, agricultural export earnings will necessarily play an important role.

In the early nineties the overall agricultural trade balance of developing countries was positive, amounting to $3 billion. However, more than twenty years ago it was five times higher. By the year 2020 it is likely to be negative. This perspective may seem paradoxical, but it is not at all unrealistic in view of the fact that among the high-income countries several also have a comparative advantage in agriculture, and that a considerable share of the agricultural imports of the developing countries is generated by the more industrially advanced economies among them. Developing countries will therefore have to finance their increasing food import bills through increasing exports of manufactures and services. Of course, this perspective implies that the developed countries should keep their markets accessible for those non-agricultural exports from the developing countries.
NOTES

1. Parts of the text are widely based on Alexandratos, 1996b, an updated and somewhat expanded version of Chapter 1 of Alexandratos, 1995.

2. Although the FAO study covers nearly all agricultural products, cereals are dealt with more extensively here because of their overriding importance in food and agriculture: they account for over 60 per cent of land harvested and over 50 per cent of calories supplied (over 60 per cent in developing countries). Other crops are not discussed in this paper for lack of space, but a discussion can be found in Alexandratos, 1995.

3. The statements in this section refer to the group of developing countries as defined at present in UN parlance. It could well be that in the not-too-distant future a number of them (e.g. some East Asian countries) would need to be classified as developed countries.

4. China is excluded because of lack of relevant data, i.e. the crop production patterns and land with agricultural potential, both of which are required by agro-ecological zone for the analysis. In addition, it is now widely accepted that the existing data understate the land in agricultural use and overstate yields. A recent Chinese publication (State Land Administration of the PRC, 1994) seems to confirm what other sources had indicated, namely that under-reporting amounts to about 30 per cent. According to this publication, cultivated area in 1989 amounted to 125 million ha instead of the official figure of 96 million, and sown area to 192 million ha compared with the official figure of 147 million. This implies that there is apparently more potential for (further) growth of agricultural production than commonly thought.

5. If it is assumed that 2.5 per cent of existing irrigation must be rehabilitated or substituted by new irrigation each year (that is, if the average life of irrigation schemes is forty years), then the total irrigation investment activity over the period of the study in the developing countries must encompass some 85 million ha, of which over 70 per cent would be for rehabilitation or substitution and the balance for net expansion.

6. It should be noted that data on protected areas for 63 out of these 69 countries indicate that some 380 million ha are in this class, of which some 200 million are on land with agricultural potential but not in agricultural use.
7. The existing hybrids are three-line ones consisting of three crops needed in parallel: the male sterile line, the maintainer line and the restorer line. The two-line system dispenses of the maintainer line, making reproduction simpler and less costly.

8. Apomictic rice would have cells genetically altered to build in heterosis and would reduce the system to one line, again, with considerable efficiency gains and reduction in the costs of seed production. Heterosis refers to the quality and quantity gains obtained by crossing two genetically dissimilar parents.

CROSSON, P. and J. ANDERSON (1992), Resources and Global Food Prospects, Supply and Demand for Cereals to 2030, World Bank, Washington DC.


FAO (1996a), The Sixth World Food Survey, Rome.


MAJOR UNCERTAINTIES AND RISKS
AFFECTING LONG-TERM FOOD SUPPLY AND DEMAND

by
Per Pinstrup-Andersen and Rajul Pandya-Lorch*
IFPRI, United States

This contribution addresses some of the major uncertainties and risks affecting long-term food supply and demand, identifying the key factors for which incorrect assumptions may cause major deviations to occur between projections and reality. Before proceeding with a discussion of these factors, the most likely scenario for the future global and regional food supply and demand situation is summarised on the basis of results from IFPRI projections (Rosegrant, Agcaoili-Sombilla and Perez, 1995; Rosegrant et al., 1997).

I. THE MOST LIKELY FUTURE FOOD SUPPLY AND DEMAND SITUATION

Growth in global food production between now and 2020 is expected to exceed growth in economic demand for food at current real prices. Thus, it is projected that the real prices of all major food commodities will decrease between now and 2020. The projected decreases in food prices range from 4 per cent for maize and poultry to 13.5 per cent for wheat, with overall cereal prices dropping by 10.9 per cent and meat prices by 6.1 per cent (Table 1). These projected price decreases are much smaller than the decreases that occurred during the last twenty-five years.

Under the most likely scenario, developing countries as a group will not be able to increase their food production at the same rate as the increase in economic demand (Tables 2, 3, 4). Therefore, they are projected to increase their food

* The authors are, respectively, Director General and Special Assistant, International Food Policy Research Institute (IFPRI).
imports during this period: their net cereal imports are expected to increase from the current 90 million tons to 220 million tons by 2020, while net imports of meat products are expected to increase 20 times to about 12 million tons.

About 60 per cent of the net cereal imports by developing countries will consist of wheat, with maize occupying an additional 25 per cent. The Far East will account for about 40 per cent of the net cereal imports from industrialised nations, the Middle East and North Africa for 30 per cent, and Sub-Saharan Africa for slightly more than 10 per cent. The United States will continue to be the largest cereal exporter to developing countries, providing about 60 per cent of the net exports by industrialised countries. Western Europe, including the European Union, is

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1993-2010</th>
<th>2010-2020</th>
<th>1993-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>-4.65</td>
<td>-0.52</td>
<td>-5.14</td>
</tr>
<tr>
<td>Pigmeat</td>
<td>-2.64</td>
<td>-3.95</td>
<td>-5.71</td>
</tr>
<tr>
<td>Poultry</td>
<td>-5.23</td>
<td>1.30</td>
<td>-4.00</td>
</tr>
<tr>
<td>All meat</td>
<td>-4.63</td>
<td>-1.53</td>
<td>-6.09</td>
</tr>
<tr>
<td>Wheat</td>
<td>-2.03</td>
<td>-11.72</td>
<td>-13.51</td>
</tr>
<tr>
<td>Maize</td>
<td>0.00</td>
<td>-3.97</td>
<td>-3.97</td>
</tr>
<tr>
<td>Rice</td>
<td>6.64</td>
<td>-14.75</td>
<td>-9.09</td>
</tr>
<tr>
<td>All cereals</td>
<td>0.61</td>
<td>-11.45</td>
<td>-10.91</td>
</tr>
<tr>
<td>Soybeans</td>
<td>-3.04</td>
<td>-1.96</td>
<td>-4.94</td>
</tr>
<tr>
<td>Roots and tubers</td>
<td>2.13</td>
<td>-6.25</td>
<td>-4.26</td>
</tr>
</tbody>
</table>

Source: Rosegrant et al., 1997.

<table>
<thead>
<tr>
<th>Country/region</th>
<th>Wheat</th>
<th>Maize</th>
<th>Rice</th>
<th>All cereals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demand</td>
<td>Supply</td>
<td>Demand</td>
<td>Supply</td>
</tr>
<tr>
<td>China</td>
<td>1.15</td>
<td>0.86</td>
<td>2.34</td>
<td>1.67</td>
</tr>
<tr>
<td>India</td>
<td>1.96</td>
<td>1.71</td>
<td>1.07</td>
<td>1.81</td>
</tr>
<tr>
<td>Other East Asia</td>
<td>1.47</td>
<td>1.49</td>
<td>2.15</td>
<td>2.19</td>
</tr>
<tr>
<td>Other South Asia</td>
<td>2.96</td>
<td>1.62</td>
<td>2.27</td>
<td>2.08</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>2.78</td>
<td>0.91</td>
<td>2.47</td>
<td>1.93</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.43</td>
<td>2.21</td>
<td>1.72</td>
<td>1.69</td>
</tr>
<tr>
<td>West Africa and North Africa</td>
<td>1.98</td>
<td>1.79</td>
<td>1.82</td>
<td>1.83</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>3.45</td>
<td>2.50</td>
<td>2.73</td>
<td>2.89</td>
</tr>
<tr>
<td>Developing countries</td>
<td>1.79</td>
<td>1.44</td>
<td>2.14</td>
<td>1.86</td>
</tr>
<tr>
<td>Developed countries</td>
<td>0.44</td>
<td>1.11</td>
<td>0.68</td>
<td>1.08</td>
</tr>
<tr>
<td>World</td>
<td>1.26</td>
<td>1.26</td>
<td>1.44</td>
<td>1.44</td>
</tr>
</tbody>
</table>

Source: Rosegrant et al., 1997.
expected to contribute about 15 per cent of the net cereal exports from industrialised nations to the developing countries by 2020. Eastern Europe and the former Soviet Union are projected to switch from being major net importers of cereals to being significant net exporters by 2020.

II. MAJOR UNCERTAINTIES AND RISKS

The results from the IFPRI projections are similar to those from food demand and supply projections undertaken by the FAO. That the two projection
efforts produce similar results is, of course, no guarantee that the projections will turn out to be correct. What are some of the principal reasons why the projections may be wrong? In this chapter, these factors are divided into three sets: demand-side factors, supply-side factors, and finally the uncertainties and risks related to policies and developments in China, Eastern Europe and the former Soviet Union.

Demand-side factors

There are essentially four demand-side factors that may cause major uncertainties and risks in long-term projections of food supply and demand: i) population growth and demographic changes; ii) income growth and income distribution; iii) dietary changes; and iv) changes in consumer preferences. The first two sets of factors are more relevant for low-income developing countries, while the last two are likely to be more important in higher-income developing and industrialised countries. These four sets of factors are briefly discussed below.

Demographic factors

In low-income countries, high population growth rates and income growth are usually the overriding determinants of food demand. The United Nations provides the most reliable projections of population growth. Recently, the UN concluded that its previous projections had overestimated: the actual annual population growth rate between 1990 and 1995 was 1.4 per cent, rather than the 1.57 per cent projected earlier (UN, 1995; UN, 1996). In light of this development, the UN revised its projections for population growth in the next century, continuing to base them on three different assumptions about the fertility of the world's women. The medium-fertility model, the one considered most likely, projects the world population at 9.4 billion by 2050 (UN, 1996). This is half a billion less than the earlier UN projections (UN, 1995). Clearly, should these new projections turn out to be true, the pressure on the world's food supplies will be reduced. If, instead of the medium-fertility assumption, the low-fertility scenario turns out to be true, the world's population would stabilize at 7.7 billion by 2200 instead of 10.7 billion suggested by the medium-fertility model (IFPRI, 1997). Similarly, higher fertility rates among the world's women would result in larger populations.

The rate of economic development and poverty alleviation, the ease of access to reproductive health care and family planning services, and the prevalence of health problems, including AIDS, can severely affect fertility rates in developing countries. Furthermore, government policies, including policies in the most populated countries – China and India – can play decisive roles in overall population trends. Promoting efforts to alleviate poverty and supporting families who wish to
reduce their size are of critical importance, and will have a significant impact on the future food situation.

As an illustration of the effect of reduced population growth on the future food situation, the population growth rates used in IFPRI projections were changed from the UN medium-fertility rates to the UN low-fertility rates (Rosegrant, Agcaoili-Sombilla and Perez, 1995). Under the low-fertility scenario, the world population will grow to about 7.2 billion by 2020, about half a billion less than the projected population in the medium-fertility scenario. The results are reduced food demand and greater price declines. Cereal is projected to decline by 5 per cent and meat demand by 2 per cent relative to the most likely scenario. The volume of cereal trade would increase due to higher per capita incomes in low-income developing countries. Higher per capita incomes in Asia would cause significant increases in import demand for meat. Most importantly, reduced population growth would result in major improvements in food security and child nutrition.

**Income factors**

Poor people spend a large share of additional incomes on food; 50-80 per cent is not unusual for persons with low-income. Income changes among higher-income groups, on the other hand, tend to have very limited impact on the demand for basic foods. Instead, income increases among these groups tend to influence the services demanded along with the food, such as processing and packaging. Therefore, successful poverty alleviation and improved income distribution in the low-income countries is likely to have a significant effect on future food demand. Most projections are based on the assumption that the relative income distribution will remain constant over time.

**Dietary changes and changes in consumer preferences**

As incomes increase, consumers will change their dietary composition towards more expensive calories and protein. The exact nature of these dietary changes depends on income levels and cultural backgrounds but, as a general rule, the dietary changes likely to occur as incomes rise include shifts from inexpensive food staples such as roots and tubers through coarse grains followed by rice and wheat and foods of animal origin. As mentioned earlier, income increases also expand the demand for food marketing and processing services. A very rapid increase in the consumption of foods of animal origin is currently under way among middle- and high-income consumers in developing countries. The demand for meat and the derived demand for feed grain are increasing very rapidly in countries such as China, Thailand, Indonesia and Korea (Huang and Bouis, 1996). These trends towards higher-value food commodities such as meats and processed foods are further accelerated by rapid urbanisation in middle-income
developing countries. While both the FAO and IFPRI projections take these dietary shifts into account, it is very difficult to predict the magnitude of such shifts, partly because they are influenced by a number of economic policies which are themselves difficult to predict.

Changes in consumer preferences are, of course, embodied in the dietary changes discussed above. There is one other risk factor associated with consumer preference changes that is particularly pronounced in the industrialised countries; this is the movement towards increasing food safety and consuming organic foods produced without the use of chemical inputs such as fertilizers, pesticides and herbicides. Related to this movement is the possibility of rapid increases in the desire for purely vegetarian diets, instead of a mixed diet consisting of vegetables and foods of animal origin. The IFPRI projections do not effectively take into account an accelerated movement towards organic food. In the short run, such a movement would result in sharp reductions in agricultural productivity and food production. In the longer run, some of the negative productivity effects could be dealt with through accelerated agricultural research aimed at such issues as resistance to pests, nitrogen fixation from the air, and plants that are more efficient in extracting and utilising plant nutrients. An accelerated movement towards vegetarian diets would, on the other hand, reduce the demand for feedgrain and thereby reduce the pressure on future grain supplies.

Our assessment is that the current rate of increase in the demand for organic food in Europe and North America is likely to slow down in response to higher prices for such foods, and, while we believe the demand will increase, we do not believe that organic food will become a major portion of total food consumed in those regions within the next twenty-five years. There are indications, however, that public pressure in Western Europe is likely to move governments to introduce legislation that will constrain or prohibit full utilisation of the opportunities offered by genetic engineering and other tools of modern science to be applied to food production and processing. Should such legislation spread within Western Europe and to the rest of the world, including the developing countries, the consequences for food security and nutrition could be severe. Modern scientific methods, including molecular biology-based methods, offer tremendous opportunities for expanding food production while reducing the risks, for environmental protection, and for marketing in developing countries (Pinstrup-Andersen and Pandya-Lorch, 1996). Tolerance to drought in selected staple foods as well as resistance to other adverse conditions such as insects, diseases and other pests could greatly increase and stabilize food production and incomes among small farmers in developing countries. Should such modern scientific methods be withheld from application toward solving the problems of poor people, opportunities for assuring food security for all will be greatly reduced.
Supply-side factors

While the above-mentioned demand-side factors offer considerable uncertainty regarding future food supply and demand projections, the most important risks and uncertainties are found on the supply side. Rapidly decreasing real food prices during the 1980s and early 1990s were an outcome of large productivity increases in the agricultural sectors of Western Europe, North America, Asia, and parts of Latin America; another factor was the inability by a large share of consumers in many developing countries to convert food needs into effective economic demand because of widespread poverty. However, the annual rate of productivity increase in food production has slowed dramatically during the late 1980s and the first half of the 1990s (Rosegrant et al., 1997).

The major share of future increases in food production must come from new productivity increases on existing land. Although the required rate of increase in food production to meet future demand is considerably lower than the rates of productivity increases since the early 1960s, the additional quantity of food needed to be produced every year for the next twenty-five years is higher than ever. Failure to achieve productivity increases on existing lands will result in farmers and governments pushing agriculture into lands that are less suited for the purpose, including forested areas (Pinstrup-Andersen and Pandya-Lorch, 1996). The result will be rapidly increasing land degradation and deforestation. This is currently taking place in large parts of Africa and Latin America, as a means of survival for poor farmers who do not have access to productivity-increasing technology.

There are at least five sets of factors that cause major uncertainty and risk in long-term projections of food supply. These are: i) government action, including policies and legislative government behaviour; ii) the extent of investment in agricultural research aimed at the production of appropriate technology for farmers in both developing and industrialised nations; iii) availability and use of natural and synthetic resources in agriculture, and the productivity effect of natural resource management; iv) changes in domestic agricultural markets; and v) the productivity and sustainability impact of climatic changes. Each of these five sets of factors will be briefly discussed below.

Government action

While the behaviour of farmers is well understood and can be predicted with a high degree of certainty, the behaviour of the public sector, including governments and parliaments, is much more difficult to predict. Furthermore, government policy and legislation may place severe constraints on the ability of farmers to function in a socially and economically optimal fashion. Therefore, future government action is one of the major uncertainties associated with long-term projections for food supply.
demand and supply. Its influence can have many effects; only a few of the ones expected to be most critical are mentioned here.

Protection of agriculture in the European Union, the United States, Japan, Korea, and a few other countries and regions has been and continues to be an important determinant of food production and trade. Changes have been made in agricultural protection in all of these countries and regions, partly in response to domestic policy changes such as the major reform of the Common Agricultural Policy in 1992, and partly in response to the recent GATT Agreement. Further changes in these protection policies, whether through new GATT negotiations or otherwise, could significantly influence both global food supplies and regional balances. According to recent estimates by the EU Secretariat (EU, 1997), continuation of current farm policies in the EU will result in the rebuilding of large grain stocks, beginning in a few years (Figure 1). The re-emergence of such large grain stocks would have significant implications not only for the cost of European agricultural subsidies, but also for the availability of food aid – and pressures would mount to make further changes in policies in order to reduce these stocks, either by expanding trade or reducing production. Should the EU be enlarged beyond the current 15 member countries by including countries from Eastern Europe, grain stocks might grow even faster if the new members are permitted to obtain the benefits from the existing common agricultural policy.

Figure 1. Total cereal stocks in EU-15 (actual and projected), 1994-2005

Simulation analysis by IFPRI illustrates the effects of further trade liberalisation (Rosegrant, Agcaoili-Sombilla and Perez, 1995). If agricultural protection policies, trade subsidies and taxes are fully removed, real world prices of most food commodities will be slightly higher. Wheat and maize prices will be virtually the same as in the case of no further trade liberalisation, while rice prices will be 10 per cent higher.

A second important set of policies relates to the protection of natural resources, biosafety in agriculture, and the above-mentioned food safety issues. Several European countries have already implemented legislation that will curb the use of chemicals in agriculture, including chemical fertilizers and pesticides. Environmental protection legislation is also being introduced to regulate and curb animal production to avoid or reduce air pollution, CO₂ buildup in the atmosphere, and pollution of groundwater and streams due to excessive or inappropriate use of animal manure on the land. While much of this legislation can be justified on environmental grounds, the short-run effect is likely to be reduced food production. In the somewhat longer run, the negative productivity effects could be partially or totally eliminated through agricultural research aimed at host-plant resistance to pests, better utilisation of plant nutrients, use of animal manure for bio-gas, and a number of other opportunities.

Unfortunately, there is also a trend in several European societies to begin to consider that the application of science to agriculture may be part of the problem rather than part of the solution. Failure to understand that productivity increases in food production are an essential component of a future with food security for all has moved powerful societal groups to push for severely constraining legislation on agriculture research. While the application of modern science, including genetic engineering and other biotechnology research, to solving human health problems is being applauded and encouraged, there is an increasing suspicion that the application of such scientific methods to food production and processing will compromise agricultural production systems, food safety, and the health of current and future generations.

While it is of critical importance that society establishes ethics and social norms for the use of results from scientific endeavour, it is important that governments not be pushed by vocal minorities and widespread misinformation into taking the easy way out and simply outlawing all research results with unknown side-effects. A more enlightened approach will assess the risks and opportunities by establishing sound biosafety rules based on the best available scientific knowledge. As part of such an enlightened biosafety policy, societies should decide on the extent to which consumers should be permitted to make their own judgement based on the best available relevant information, as opposed to the state making such judgements. Genetically modified maize, soybean and tomatoes, as well as livestock products produced with the use of synthetic growth hormones, are cases
where society must determine whether it wants state judgement for all, or individual consumer judgements based on the best available information.

These policy considerations, along with the extent to which consumers accelerate their demand for organically produced food, are major uncertainties in the long-term projections for food supply and demand. The issues are far from resolved, as shown by the recent conclusion of the World Trade Organisation (WTO) that livestock products produced with the use of synthetic growth hormones in the United States could not be excluded from the EU market on health grounds. It is our understanding that this decision is being appealed, and that the EU is not currently prepared to conform to a decision which would permit free import of such livestock products.

Legislation in Europe, North America and/or Japan that would place severe constraints on the use of modern science to improve productivity and food production and processing could also have severe implications on long-term food supplies in developing countries, because these policies might be adopted in those countries as well. Several developing countries are currently reviewing their biosafety legislation as well as legislation related to the use of biotechnology in food production and processing, and the outcome of these deliberations is far from clear. Misinformation and lack of information on the potential environmental effects from the use of chemicals in agriculture and on the health effects from the use of genetically engineered foods could significantly affect food supply and demand, and therefore food security for many millions of people in developing countries. For example, failure to assist African farmers in getting access to economically viable plant nutrients, including organic materials and inorganic fertilizers, because of a perceived negative environmental effect would make it almost impossible for them to expand productivity on the lands currently in production to the level needed to assure food security in Africa. On the other hand, with the right policies for plant nutrients, agricultural research, rural infrastructure and agricultural markets, African agriculture could accelerate its annual growth rate from the current 2 per cent to at least 4 per cent, while assuring sustainability in the management of natural resources. The inability to predict which of the two growth rates would actually materialise places considerable uncertainty on long-term projections for food supply.

Access to water in agriculture is taking on increasing importance. Many societies still treat water as a free good rather than the scarce resource that it is. The extent to which enlightened government policies are designed and implemented to assure increasing efficiency in water use and more appropriate water allocation will be an important factor in long-term food supplies.
Agricultural research and technology

Future food needs cannot be met with existing technology. The creation of appropriate technology must come primarily from agricultural research and farmer experimentation. While the private sector has expanded agricultural research using biotechnology methods when appropriate, it will not undertake much of the research needed by small farmers in developing countries because it cannot expect to recuperate sufficient economic gains to cover costs. Benefits to society from such research can be extremely large, but will be obtained only if the public sector makes the research investments. Currently, low-income developing countries grossly underinvest in agriculture research aimed at solving small farmers’ problems. These countries invest less than half of 1 per cent of the value of their agricultural production, as compared to 2 per cent by higher-income countries (Pardey and Alston, 1996). While both the international development assistance community and the governments of many low-income developing countries have failed to place sufficient emphasis on such agricultural research during the last ten to fifteen years, there are now signs that the international community and some developing-country governments are recognizing the importance of expanded investment in agricultural development in general, and agricultural research in particular. Should these signs turn out to be correct, long-term food supplies could expand considerably faster than what is currently projected.

IFPRI research shows that even minor increases in international assistance for agricultural research for developing countries could significantly accelerate food supplies, while relatively small cuts could have very serious negative effects (Rosegrant, Agcaoili-Sombilla and Perez, 1995). Expanded financial support of both the international agricultural research system (Consultative Group on International Agricultural Research) and national agricultural research systems in developing countries is urgently needed, and it is of critical importance that information based on sound scientific evidence be used to counter the great deal of misinformation that is currently pushing the governments of several countries to question public-sector investments in research for agricultural productivity increases.

Use of natural and synthetic resources

The future food supply will depend on the amount of inputs farmers use as well as on the extent to which degradation of natural resources affects productivity. Availability of sufficient plant nutrients in the soil is a critical determinant of crop yields. While some of the plant nutrient requirements can be met through the application of organic materials available on the farm or in the community, such materials are insufficient to replenish the plant nutrients removed from the soils – and will therefore also be insufficient to further expand crop yields. The
use of chemical fertilizers has decreased worldwide during the last few years (Bumb and Baanante, 1996). The decrease has been particularly pronounced in the industrialised countries and parts of Asia. While some decreases in the use of fertilizers are warranted because of negative environmental effects, it is critical that fertilizer use be expanded in those countries where a large share of the population is food-insecure. Fertilizer consumption in these countries is generally low. For example, on average, fertilizer consumption in Sub-Saharan Africa is about 10 kilograms per hectare, as opposed to 300-400 kilograms per hectare in certain parts of Europe, North America and Asia. Expanded use of fertilizers in Sub-Saharan Africa will help alleviate current production shortfalls as well as serious land degradation resulting from soil mining. One of the largest environmental problems in Africa today is the gradual decline in the fertility of much of the soils. Failure to deal with this problem will reduce future food supplies and accelerate soil degradation.

Farmers' access to improved crop varieties and animal stock is also an important variable influencing future food supply. Rapid expansions in agricultural research to design appropriate technology for small farmers, combined with policies that facilitate the use of such technology as well as effective markets for agricultural inputs and outputs, could expand future food supplies considerably above current projections. On the other hand, failure to recognise the importance of these factors may result in further reductions in the rate of growth in food supplies, globally as well as regionally.

Access to water could be a major limiting factor in future food supplies, particularly if governments and local communities do not devise and implement more appropriate water allocation mechanisms that assure increased water use efficiency and protection of groundwater reservoirs, in turn to assure sustainability.

Losses in crop and animal production, both during the production period and after harvesting, are large. Successful efforts to protect crops and livestock from pests and diseases could accelerate the growth in food supply significantly above current projections. Such efforts could be based on expanded research to develop tolerance or resistance to pests and diseases as well as integrated pest management, including biological control. Failure to invest in such measures, combined with legislation to reduce or eliminate the use of chemical pesticides, could have devastating effects on future food supplies.

**Land use**

Long-term projections for food supply are based on certain assumptions regarding the future use of land, not only for food production but also for alternative uses such as urban development, roads and other infrastructure, and nonfood agricultural commodities including traditional nonfood commodities such as coffee,
rubber and tea as well as production of raw materials for biofuel. Should the relative prices of food versus nonfood commodities change significantly – for example, through rapid increases in energy prices – the proportion of land available for food production could change, thereby affecting future food supply. Furthermore, food supply projections are based on certain assumptions regarding the amount of additional land currently not used in agricultural production being brought into food production. Agriculture currently occupies a very small share of the total land area (FAO, 1997). However, efforts to bring additional land under agricultural cultivation would, in most cases, imply large economic and environmental costs. Except for a relatively small area in Africa, most of the land not currently used for agriculture is either under forests or unsuited for sustainable agricultural production because of soil, water or climatic conditions.

**Markets and information**

While markets for agricultural inputs and outputs operate effectively in most industrialised countries and in many Latin American and Asian countries, they still function poorly in most countries of Africa. Unless markets are made more effective in Africa, the opportunities for expanded food supply through technological change at the farm level will not be fully realised. Lack of market information at the farm, community, and national levels is a major hindrance for effective market development. Concerted efforts to utilise modern information technology in developing countries could greatly accelerate the market transformation and thereby have a significant positive effect on both food supplies and farmer incomes.

**Climatic change**

While the trend of global warming is becoming increasingly clear, there is still a great deal of uncertainty about the effect of that warming on food supplies. Indications are that growing conditions will deteriorate in the current tropical regions, while they will improve in the temperate zones. However, the productivity effects will occur over a long period, with very small effects for any given year. Therefore, it is reasonable to believe that policies and technologies can be developed to effectively prevent or counter any negative productivity effects. Obviously, failure by the public sector to act, and failure by the market and the private sector to respond, could result in significant long-term effects on food supply. Such a scenario might include reduced food production in tropical and subtropical countries, and increased production in temperate-zone countries. Whether these opposing effects will cancel each other out, resulting in expanded trade with little or no effect on global food supplies, is yet to be determined.
China, Eastern Europe and the former Soviet Union

The future food supply and demand situation is likely to be particularly sensitive to policy changes and other developments in China, Eastern Europe, and the former Soviet Union. With a population of over 1.2 billion people (one-fifth of the world population), national policy changes in China can obviously have very significant effects on the rest of the world. Recent IFPRI research (Huang, Rozelle and Rosegrant, 1997) estimates the demand, production and net imports of cereals for each of a number of scenarios regarding China’s population and income growth, as well as the rate of growth in China’s investment in agricultural research and irrigation. As shown in Table 5, the most likely scenario is that China will increase its net imports of cereals; these will reach about 24 million tons by year 2000 and stay more or less constant for the subsequent twenty years. However, lower-than-expected rates of growth in population or income could turn China into a net exporter of cereals by 2020. A similar effect is expected from an increased rate of investment in agricultural research and irrigation. On the other hand, low rates of such investment or higher-than-expected growth in income or population could greatly expand China’s net imports of cereals. While each of these scenarios is unlikely to result in dramatic changes in international food prices, a combination of high population growth, high income growth, and failure to invest in agricultural

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>450</td>
<td>426</td>
<td>24</td>
<td>513</td>
<td>486</td>
<td>27</td>
<td>594</td>
<td>570</td>
<td>25</td>
</tr>
<tr>
<td>Baseline with low population growth</td>
<td>445</td>
<td>426</td>
<td>19</td>
<td>496</td>
<td>486</td>
<td>11</td>
<td>561</td>
<td>570</td>
<td>–8</td>
</tr>
<tr>
<td>Baseline with high population growth</td>
<td>454</td>
<td>426</td>
<td>29</td>
<td>527</td>
<td>486</td>
<td>42</td>
<td>621</td>
<td>570</td>
<td>52</td>
</tr>
<tr>
<td>Baseline with low income growth</td>
<td>440</td>
<td>426</td>
<td>15</td>
<td>489</td>
<td>486</td>
<td>4</td>
<td>549</td>
<td>570</td>
<td>–20</td>
</tr>
<tr>
<td>Baseline with high income growth</td>
<td>459</td>
<td>426</td>
<td>34</td>
<td>537</td>
<td>486</td>
<td>51</td>
<td>647</td>
<td>570</td>
<td>78</td>
</tr>
<tr>
<td>Baseline with low rate of investment in agricultural research and irrigation</td>
<td>450</td>
<td>418</td>
<td>32</td>
<td>512</td>
<td>462</td>
<td>49</td>
<td>593</td>
<td>517</td>
<td>76</td>
</tr>
<tr>
<td>Baseline with high rate of investment in agricultural research and irrigation</td>
<td>450</td>
<td>429</td>
<td>21</td>
<td>514</td>
<td>507</td>
<td>7</td>
<td>597</td>
<td>606</td>
<td>–10</td>
</tr>
</tbody>
</table>

Source: Huang, Rozelle and Rosegrant, 1997.
research and irrigation could put significant pressures on future food supplies, resulting in increasing real food prices. As further discussed in Huang, Rozelle and Rosegrant (1997), we do not believe such a scenario is likely.

The fall of the Berlin Wall and all of the associated political changes in the former Soviet Union and Eastern Europe brought great promise for rapid economic growth in that part of the world. Many projected that food production in a number of the countries affected, including the Ukraine and the Russian Federation, would expand rapidly and significantly, causing the former Soviet Union and Eastern Europe to switch from being net importers of grain to being significant net exporters over a short period of time. Such a scenario has not yet materialised, and there is still a great deal of uncertainty regarding the future food production and demand in those countries. While changes in relative prices, subsidies and incomes resulted in dramatic reductions in the demand for livestock products, production of both livestock and crops also suffered very significantly. While most long-term projections for food supply and demand show the region to eventually become a major grain exporter, there is considerable disagreement as to the period of time it will take for this to happen. Many of the countries of Eastern Europe and the former Soviet Union have tremendous agricultural potential that is as yet underutilised. Appropriate changes in policies and institutions – including property rights, rural infrastructure, and related institutions – could result in rapid production increases. It is extremely difficult to predict the speed of such changes. Similarly, European Union membership by some of the countries of Eastern Europe could accelerate agricultural transformation in these countries, with resulting expansions in food production.

III. CONCLUSION

The long-term food supply and demand situation will be influenced by a number of factors. On the demand side, the key factors include i) population growth and demographic changes; ii) income growth and income distribution; iii) dietary changes; and iv) changes in consumer preferences. Among the key factors influencing the supply side are: i) government action, including policies and legislative government behaviour; ii) the extent of investment in agricultural research aimed at the production of appropriate technology for farmers in both developing and industrialised countries; iii) availability and use of natural and synthetic resources in agriculture, and the productivity effect of natural resource management; iv) changes in domestic agricultural markets; and v) the productivity and sustainability impact of climatic changes. And, of course, there are some regions of the world, such as China or Eastern Europe and the former Soviet Union, that – by their very size or behaviour – can drastically alter the world food supply and demand situation.
Cutting across all of these factors and adding uncertainty to the final food demand and supply outcome is the role of human behaviour. What the situation will look like in coming years depends very much on how we, the global community, respond and adapt to these factors. Depending on how pro-active we are, we can minimise food insecurity or exacerbate it. By our actions, or inaction, we can influence food security, positively or negatively. We must take human behaviour into account as we consider the long-term risks and uncertainties.
MAJOR UNCERTAINTIES AND RISKS AFFECTING LONG-TERM FOOD SUPPLY AND DEMAND

BIBLIOGRAPHY


I. INTRODUCTION

In all countries of the world where tangible and intangible investment, farm income, and soil and weather conditions have not been limiting factors, the second half of the twentieth century has brought unprecedented growth in agricultural productivity. This boom, often referred to as the “Green Revolution”, was sustained through scientific and technical advances, and showed an average growth rate of almost 2 per cent per year. Over the past five years, the pace has slightly slackened owing to the measures taken by several industrialised countries to limit their output.

The outcome of this outstanding performance is well known: although 800 million people throughout the world suffer from hunger, world agricultural output could provide 2 650 calories/day/inhabitant, i.e. higher than the minimum nutritional requirement of 2 300 calories/day/inhabitant. Such technical progress has also led to a relative decrease in consumer prices and a sharp reduction in the active agricultural population, to the advantage of industrial growth. While this may nowadays seem a shocking state of affairs, these results are precisely what was envisaged by the agricultural policies drawn up in many industrialised countries over fifty years ago.

While the success of agriculture is being called into question in countries where surpluses are developing, a long-standing question remains: can world food requirements be met? In the search for a rational answer, several institutions have drawn up models of world food supply and demand (Mitchell and Ingco, 1993; Alexandratos, 1995; Agcaoili-Sombilla and Rosegrant, 1995). Their conclusions are relatively optimistic. There is no need to look at the models in detail to understand why. It is enough to compare three statistical trends: steady growth (approximately 1.6 per cent per year) of the world population, sustained economic growth (approximately 4 per cent per year) and sustained agricultural productivity constantly backed by advances in science and techniques.
Nevertheless, the debate on agriculture is giving rise to more subtle considerations extending beyond mere comparison of global growth rates. They concern, *inter alia*, the sustainability of agriculture (water resources, soil quality, climate change), the trend in inequalities between world regions or within the same region, the differentiation of economies in the globalisation process, land planning, and adequate consideration of the demands made by consumers and the general public. It should be noted in passing that all this raises the issue widely debated within the OECD (1992) of the relationships among scientific and technical progress, economic growth and social development.

In order to take a closer look at these issues in the light of new scientific developments, a very brief overview of both the advantages and limitations of past scientific and technical advances might be useful. As for future progress, we shall focus on the specific but in no way exclusive case of biotechnology in order to identify its economic and social impacts.

II. THE BASIS OF THE GREEN REVOLUTION

The agricultural boom arose from advances in quite a few technical areas: mechanisation of agriculture, the use of inorganic plant fertilizers, crop protection, animal nutrition, animal health and finally, animal and plant genetics.

i) Mechanisation in agriculture

This was a very important factor in the modernisation of agriculture, and produced strong capital substitution of labour. However, many countries still do not have access to this modernisation means through lack of capital, or do not have machinery suited to the real prevailing economic conditions (*e.g.* the recent transition from large state farms to smaller private ones). Finally, significant progress has been made in this field through computerisation and space communications. We now have the prospect of precision agriculture that economises on inputs and is more respectful of the environment.

ii) The use of inorganic fertilizers

The use of fertilizers, especially nitrogen, and the control of water supply (irrigation, drainage) have led to higher crop yields and the exploitation of new agricultural areas. There are several problems at this level, however: excess consumption of renewable water resources which will lead to major difficulties in the future (by 2025, 12 countries with a total population of 450 million will run out of these resources); lower water and soil quality; inadequate food quality. These are the big-
gest factors that are threatening agricultural sustainability. Biotechnologies can help to solve these problems through the obtention of plants tolerating drought or lower water quality, or plants requiring less fertilizer.

iii) Crop protection

By definition, agricultural production creates ecological imbalance and is therefore open to pest damage or competition from weeds. Crop protection, mostly through chemicals, has been and remains essential for agriculture. It is still inadequate or inefficient in many developing countries. Nevertheless, crop protection entails several drawbacks: by shifting ecological balances it may lead to the onset of resistance to the chemicals used or the introduction of new pests, and the product residues may affect the environment and food quality. Advances in the chemical field have appreciably reduced these two disadvantages and here again, biotechnology may diversify the tools at the disposal of farmers, in particular through pesticide-resistant plants.

iv) Animal nutrition

Agricultural growth has proceeded side by side with urbanisation and changing consumption, which is itself connected with economic growth. For instance, the consumption of meat products has increased in the past, and is still increasing today in the new industrialised countries. Effective conversion of crops into animal products has been considerably improved through the development of animal feeding-stuffs on a scientific basis, which discriminates between energy and protein supply depending on the species concerned. This is why animal nutrition remains a strategic aspect of world agriculture, whether for the supply of countries with shortages in cereals or oil and seed products, or on quality grounds, as starkly highlighted by the outbreak of bovine spongiform encephalopathy and the development of transgenic plants. The search for efficient and low-cost animal feedingstuffs ensuring production autonomy and meeting quality and consumer safety requirements is a major research issue. The impact of intensive stockbreeding on the environment is also a cause for increasing concern, and certain types of nutrition are being reconsidered.

v) Animal health

In the same way as plants, animals are exposed to health risks – whether under extensive production systems (risk of parasites) or intensive systems (increased risk of contagion) – which need to be removed. Animal health industries have developed drugs, and also vaccines and diagnostic tests, which are ideal candidates for biotechnological advances (synthetic vaccines, immunological tests, etc.). Here again, envi-
vironmental protection (drug residues) and product quality are gaining importance among the objectives of research. Meanwhile, consumer food safety imposes ever stricter control of livestock health (listeria, salmonellae, etc.). New diagnostic tests are therefore required, which can only be developed through biotechnology. Finally, animal health is being extended nowadays in many industrialised countries to the concept of animal welfare, which needs to be defined objectively.

vi) Genetics

The role of genetics in agricultural progress is both central and highly specific. It is generally considered to be the starting point for 50 per cent of the productivity gains achieved during the Green Revolution. Its impact is felt across the board, as it can potentially contribute to all the fields just mentioned. For the user, in other words the farmer, it provides an improvement embedded in a straightforward commodity. Furthermore, the improvement is self-replicating in accordance with the laws of life. Genetics therefore play a strategic role from a scientific and technical standpoint, especially in the use of biotechnologies, but also from an economic standpoint against a backdrop of difficult intellectual property and farming rights issues. On all these grounds, this field should be looked into more closely.

Without going into excessive scientific detail, it should be recalled that the information underpinning each of the properties of a living organism is inscribed in molecular terms (genetic code) into its genome. Provided this information is available, an organism can express the function coded, but this expression is not automatic and depends on, among other things, signals from the organism’s environment. The entire information in the genome of an organism is referred to as its genotype, and the concrete expression of this information under the effect of the environment is its phenotype. Living organisms are capable of reproducing and transmitting to their descendants the genetic information they hold. Reproduction can be identical (cloning) or with minor or major variations as in the case of sexual reproduction. In the latter case, it becomes necessary to examine the heritability of the information contained in a genotype.

Conventional genetics developed on the scientific basis briefly outlined above. The starting point is the identification of the widest possible range of phenotypes identified in the genetic resources at our disposal, followed by the identification of the relationships between these phenotypes and the genotypes on which the properties of an organism are unambiguously based. Beyond the mere process of selection of good genotypes, genetic improvement in the strict sense involves cross-breeding between different individuals, either through natural processes or by using assisted hybridisation techniques, which are highly developed for crops. Once genetic improvement has been obtained for a few individuals, it
then has to be expanded on a larger scale. In plants, there are two possible ways of achieving this: through seed (sexual route) and through cuttings (vegetative route, identical reproduction as in cloning). In animals, the most economic procedure on obvious grounds is the use of sperm, leading to genetic selection on the descendants of males and considerable development of artificial insemination techniques. Recent techniques of embryo manipulation and, subsequently, cloning of embryo cells have led to a female selection procedure, while the recent discoveries concerning potentially totipotent adult cells have further broadened the means of diffusing genetic advances, theoretically at least.

That whole array of methods – all of which are fairly complex – has underpinned genetic progress; this is the field that is experiencing the most far-reaching changes with the boom in biotechnology.

Genetics is a highly potent tool of improvement; nevertheless, it is the subject of criticism which can be overstated but which must be heeded all the same. Arguments include the risk of damage to genetic diversity, although this is the basis for identifying original phenotypes; selection using excessively restricted criteria (selection of high-yield plants or animals to the detriment of environmental or product quality); lack of adaptation of genetic products to the social and economic conditions prevailing in agriculture, especially in developing countries. Genetics can cope with the new requirements implicit in such criticism; in order to do so, it must heed other disciplines and involve a broader set of criteria in its improvement plan.

In concluding this survey of the basis of the Green Revolution, several general points are worth noting:

- The progress made in agricultural production could not be sustainable today without very serious consideration of the processes of preservation and conservation of commodities, as well as the processing and distribution of foodstuffs.

- The agro-food sector cannot totally be compared to conventional manufacturing industries. Its performance is based on judicious domestication of nature rather than on total artificialisation of nature. It therefore favours continuous, multiple and small-scale innovations; there is less room than elsewhere for breakthroughs.

- Technical progress in agriculture is disseminated through a very heterogeneous system where performance gaps between farms remain large. The role of agricultural advisory institutions connected with training therefore remains essential.

- Agricultural innovation has been the outcome of strong synergy between public research bodies, private companies and farming associations, cre-
ated by carefully balancing free circulation of information (especially in the case of genetic resources), intellectual protection of private interests, and the farmers’ capacity for initiative and autonomy.

All these aspects are sharply called into question with the onset of new technologies, especially those derived from modern biology.

III. THE NEW GREEN REVOLUTION

Agriculture’s future challenge is to feed the world in volume and quality terms on a sustainable basis. It can rise to this challenge thanks to the very wide spread of new advances in science and technology, but especially thanks to biological advances.

The term “biotechnology”, now widely accepted, is a recent introduction – at any rate it arose later than the diffusion of fundamental biology advances in agriculture. Modern genetics began at the end of the nineteenth century with Mendel’s work. The use of micro-organisms in industry (yeasts, lactic ferments, etc.) has long been a practice; (again) in the nineteenth century, it benefited from Pasteur’s discoveries. Finally, the use of enzymes (e.g. rennet for cheese manufacturing) is firmly rooted in tradition.

Biology underwent a cultural revolution, however, starting with Delbruck’s intuitions in the early 1940s and culminating with the full establishment of the genetic code at the end of the 1960s. By setting the foundations of the genetic code, the fathers of molecular biology totally renewed a science which was by no means in its infancy. We now know that life is the outcome of highly structured and complex chemistry. The cells of living organisms are highly organised molecular cities containing machine tools (enzymes), means of transport and communication (hormones), defence armies and the capacity for self-reproduction.

On the basis of these new concepts, molecular biology developed new tools, which were then used to great effect in the acquisition of new knowledge. In agriculture, these tools concern in particular the biology of development and adaptation to external conditions, relationships between organisms (auxiliaries or pests), and population biology. Improved knowledge of the major biological functions in agricultural production remains a decisive factor for the future and the prime objective of public research worldwide. Without such understanding, any technical progress made elsewhere could not actually be exploited.
i) The biotechnology boom

A striking fact is that the above-mentioned advances in knowledge very soon produced many technical applications, mostly derived from the methods developed through fundamental research. In 1970, Smith, Wilcox and Kelly identified restriction enzymes, which act like precision molecular scissors capable of chopping, at specific points, the long DNA chain carrying genetic information. The first gene transfer in *Escherichia coli* was carried out in 1973 by Boyer and Cohen. Modern biotechnology is largely based on these two techniques since they enable the DNA chain to be split into elements containing one or several genes, and these fragments can be multiplied and expressed in micro-organisms. The first hybridome from cell fusion was created in 1975 by Milstein and Köhler, leading to the production of monoclonal antibodies, highly sensitive detectors of specific molecular configurations. Finally, in the early 1980s, transgenic plants and animals were obtained.

Over the past ten years this technological boom has shown no sign of receding. A highly effective method of *in vitro* production of copies of DNA fragments (PCR) has been developed, while the automation of biochemical analysis methods is continuing to improve at a steady and impressive pace.

Biotechnologies derived from molecular biology have renewed many traditional methodologies (use of monoclonal antibodies for diagnostic or even therapeutic purposes, enzyme synthesis, development of synthetic vaccines, etc.). It is undoubtedly in the genetics field, however, that they are expected to have the greatest impact, at least in the short term, especially in view of the strategic role of genetics.

Two ideas derived from the scientific breakthroughs of the 1960s form the basis for the development of genetics-related biotechnologies:

- Since the genetic code is inscribed in molecular terms on DNA, it must be possible to decipher the messages it contains through physico-chemical methods – hence the determination of genomes (genome mapping).

- Since the genetic code is universal (what are specific are the barriers between species), gene transfer (hence the transfer of DNA) can be used to introduce exogenous genetic information into an organism. This is the field of transgenesis.

**Genome mapping**

With advances in scientific instrumentation, the molecular determination of the entire genome of living organisms, including higher organisms, is now possible. Several models judged to be representative of the species have been selected for full sequencing, generally through concertation at international level. They concern
micro-organisms – in particular, yeast and bacillus subtilis – plants (arabidopsis, rice, etc.), the fruitfly, and man.

Now that those genome sequences have been established, research strategy will focus on the very broad determination of the functions coded by each of the genes identified. Some are already known, but most are not. Unlike conventional genetics, the starting point is not the phenotype and the end-point the genotype, but the reverse, starting with a fully known genome. Over the next few years, therefore, we can expect very marked improvement in our knowledge of the diversity of the characters expressed by the genomes, with major implications for agriculture and the agro-food sector.

In parallel with the full sequencing of model genomes, less exhaustive but simpler and faster methods of genome characterisation have been developed. They allow the genetic identification of individuals within the same species and the determination of gene families contributing to the same function, which often occurs in agronomic applications. The DNA sequence here is characterised at the level of some of its sites (markers), as numerous as possible and the most likely to express genetic differences from one individual to the next. The organisation of these markers in the genome forms a genetic map, a portrait of each individual in each species. Confrontation of the maps with the phenotypes allows fairly precise identification of the genome elements controlling the functions under consideration. Genome mapping is under way for most species of agronomic interest, and is already leading to faster implementation of conventional genetic improvement processes.

**Transgenesis**

Given that the genetic code is universal, theoretically it is possible to add to the genome of an organism a DNA fragment coding for a function that is not naturally present in the organism, and thus to transform the organism through means not used in nature.

To translate this into practical terms, first a gene coding for a useful function must be identified, isolated and multiplied. All the techniques involved in this first step are well established, and act as a basis for the determination of the genomes just mentioned.

The gene must then be transferred into the host organism by means of a vector. Gene vectors capable of reaching their target in the host organism have considerably diversified. They may be biological (viral, plasmidic, bacterial vectors) or physical (tungsten, gold or platinum balls). Direct transfer methods are also effective (micro-injection of DNA into the nucleus or into the cytoplasm). For many organisms of agronomic interest the second stage has now been mastered, and the most difficult cases are expected to be resolved shortly. It should be noted that
currently available transgenesis methods lead to poorly defined insertion of the transferred gene into the host genome. Very active research (homologous recombination) is being pursued, however, in order to solve this drawback.

In multicellular organisms, transgenesis – which in practice is easy to apply to one single cell – must be able to work on all the cells forming the organism. From this standpoint plants have turned out to be ideal material. In many species, it is possible to regenerate a whole plant from a single cell taken from certain adult organs. These cells are totipotent in the sense that they can initiate the entire differentiation process of a plant starting from the genetic information they contain.

Consequently, a totipotent cell which has been transformed will give rise to a transgenic plant. This capacity of cell totipotency had not been observed in animals until recently. Transgenesis techniques have therefore focused on embryo cells taken at stages of low differentiation. Recent results obtained by the Roslin Institute on sheep open up new prospects, since they postulate totipotency of certain cells in domestic animals. The same findings, of course, raise ethical issues, discussed below.

In the case of multicellular organisms, it is very important – indeed, necessary – that the genetic information introduced into the genome through transgenesis is expressed only in specific organs. To this end an additional information element (promoter) must be associated with the transgene to control its expression at the right site and at the right time. The identification and patent protection of good promoters is a key element in the strategy of biotechnology enterprises.

In 1973 transgenesis was applied to the model micro-organism Escherichia coli. It was then performed on the tobacco plant and the mouse. It now concerns tomato, soybean, rapeseed, corn, rabbits and sheep. The technical means are available for conducting transgenesis in practically all species of agronomic interest.

ii) Opportunities offered by biotechnology

When the first biotechnology tools were mastered twenty years ago, scientists foresaw a wide range of applications that would concern many economic sectors: health, agriculture and the agro-food sector, chemicals, energy, the environment. These forecasts were slightly optimistic but, above all, they underestimated the lead time from the laboratory to the market. High investments were made in small and medium-sized biotechnology enterprises, particularly in the United States and to a lesser extent in Europe. This over-optimistic commitment was nonetheless positive in the sense that it enabled many concepts and processes to be tested, so that today clearer choices have been made by industry on a more modest but
longer-term scale. Biotechnology has thus emerged from this period of feverish activity in a stronger position.

On the grounds just described, the spectrum of opportunities offered by biotechnology still largely reflects the trend in laboratory techniques:

First there is mass production of biological macromolecules of economic interest:

- Reagents such as monoclonal antibodies and nucleic probes. These are very widely applied nowadays in agriculture for animal health diagnosis or for plant protection purposes and in order to check bacteriological quality and the traceability of food products.
- Natural hormones and cell mediators (in fact identical to natural products) for which an outlet has been found in stockbreeding, e.g. ovine somatotrophin for higher milk yields.
- More effective, specific and safer synthetic vaccines. For instance, there are plans to release a synthetic antirabies vaccine into the natural environment.
- Enzymes of industrial interest. These may have a wide range of application in the agro-food industry, especially in the milk or oil and fat sectors.
- Finally, newly isolated biomacromolecules with very interesting properties: absymes can both recognise antibodies and show catalytic properties similar to that of enzymes and ribozymes, which are catalytic ribonucleic acids.

Next, a whole range of micro-organism transformation techniques were developed. These concern the agro-food industries above all, and examples of technical innovations abound: thermostability, phage resistance of lactic bacteria, flocculation capacities of yeasts for the production of natural flavours, sweeteners, etc. Limitations on the use of these techniques are clearly connected with consumer acceptance – which is why in the agro-food microbiological field more emphasis is laid on genome mapping (yeasts, bacillus subtilis, etc.), in order to identify suitable genes which would code the functions mentioned without the use of transgenesis.

There are also many different applications in soil microbiology (pesticide biodegradation, biological control, nitrogen symbiotic fixation) and in plant protection (e.g. use of bacillus thuringiensis for insect resistance). However, they must be compatible with environmental protection.

Finally, biotechnologies today concern both crops and livestock. If only on technical and economic grounds, crops are given more attention, as reflected by the appearance of various transgenic species on the mass market (tomato, soybean, corn, rapeseed, potato, etc.).
For crops, there are two kinds of objective: production improvement and product quality improvement. In the case of production, research focuses on tolerance to total herbicides and pests (insects, nematodes), leading to more selective and cheaper treatments that are potentially more environment-friendly, resistance to pathogens (viruses, bacteria, fungi), and adaptation to difficult or limiting conditions (drought, cold). As for product quality, most of the work concerns the improvement of reserve proteins for animal or human consumption, improved vegetable oils for food and non-food uses, polysaccharide modification, fruit, vegetable and flower quality, and the production of high value added substances. As may be seen, the range of the work is very broad, but from a technical standpoint it is perfectly feasible.

In the case of livestock the situation is less favourable for transgenesis – first, because totipotent cells making transgenesis easy are not yet readily available if at all, secondly because animals possess more complex but less plastic defence and control systems than plants, and finally because consumer acceptance of animal transgenesis is a long way off. Research in this field remains relatively fundamental or focuses on the production of high value added substances for pharmaceutical purposes. However, zootechnical applications are also being explored: the overexpression of growth hormones, genetic resistance to pathogens, and improved product quality, especially that of milk.

The discussion has been deliberately confined to applications derived from biology and transgenesis. But the practical consequences of genome mapping should not be overlooked, since genetic diversity in nature is often sufficient to guarantee efficient, inexpensive and more easily accepted technical solutions. Finally, chemistry is still making progress, bringing more and more active and environment-friendly products.

iii) Future difficulties

As with any other new technology, although biotechnology provides real benefits it is also hampered by a number of limitations that cannot be transgressed without risk. Outright condemnation of biotechnology is as senseless as disregarding this fact (remember, bovine spongiform encephalopathy spread through the use of a conventional technique). The limitations on the use of biotechnology concern human and animal health and environmental protection.

Human and animal health

The consequences of the genetic modification of agricultural commodities or micro-organisms and enzymes in food processing need to be evaluated. Animal
feedingstuffs are included in this analysis on ethical grounds (animal welfare) but also because of their impact on the quality of products derived from animals.

First, it is generally agreed that a product derived from biotechnology that is strictly equivalent to a traditional product does not present any more risks than the latter. It can even be obtained under safer hygiene conditions. Where there is a difference, the independent control bodies set up in all industrialised countries closely examine potential risks, however small: the presence of modified DNA, allergy risks or, as recently reported, the effect of an antibiotic resistance gene on public health. In countries where there is strict control, the best precautions are taken in the current state of the art. There is no such thing as zero risk, however, and consumer acceptance of biotechnology products largely depends on the level of trust in the control bodies and control transparency.

The environment

Unlike the pharmaceuticals industry, agriculture conducts its activities in the open environment, and therefore brings specific problems. Herbicide-tolerant or pest-resistant plants bring advantages such as the reduction in the use of pest-control products per hectare, but the existence of negative impacts cannot be excluded. Wherever a herbicide-tolerant plant can cross-breed with wild species growing next to it, the tolerance may be transferred to them. The probability of such transfer is even higher between plants of the same species – hence the need for strict crop rotation on the same land. Insect-resistance can act as a selection pressure and favour the development of insects resistant to the toxins produced by the transgenic plants. Careless application of biotechnologies may have an impact on biodiversity if a gene of economic interest were to be associated with a very small number of varieties.

To provide specific answers to these questions, which in any case also arise for certain conventional plant protection treatments, further scientific data are required even though research is now actively conducted at an international level.

An additional difficulty arises from the fact that as far as the environment is concerned, no global solution is appropriate. For instance, the usefulness of herbicide-tolerance depends on its intrinsic environmental qualities, since the exploitation of this tolerance leads to an increase in the use of the herbicide concerned as well as an increase in the surface area treated. Gene transfers depend on the existence or absence of species that can cross-breed with the transgenic plant in its ecosystem.

These difficulties can be tackled in two complementary ways: through regulation of the use of genetically modified organisms in minimum-risk situations – or at any rate, well-defined risk situations – and through further research to
broaden the fields of application along the many avenues available in biology and ecology. However, all this depends on judicious application of the principle of precaution. Midway between the hopeless search for zero risk and disregard for risk prevention there lies a common sense position consisting in the precise evaluation of potential risks and the development of reliable scenarios to overcome these risks should they arise.

IV. STRATEGIC ASPECTS OF THE DEVELOPMENT OF BIOTECHNOLOGY

Spanning the huge world of life, biotechnologies are of special strategic importance: they concern essential economic sectors such as health and the agro-food sector; they arouse much hope but also fears in the minds of the public, and raise ethical issues; the development of biotechnology requires strong links between research, industry and regulation, and also, for the agro-food sector at any rate, consumer acceptance.

In order to clarify these strategic aspects, this section briefly reviews scientific and technical capacities worldwide, and then examines industrial strategies now being developed in the agro-food sector.

i) World scientific and technical capacities

The growth of biotechnology is still highly dependent on advances in fundamental biology. The latter was supported early on in the United States, and later by most countries. The United States is still well in the lead since, according to a 1993 survey, in that year it provided 39.7 per cent of scientific papers in the field, ahead of the European Union (32.6 per cent) and Japan (9.1 per cent) (Mustar, 1997). A striking fact is that the richest countries in the world hold a higher share of papers published in fundamental biology than their share in the overall number of scientific papers. This illustrates the strategic nature of biotechnology as well as the relatively high cost of fundamental research in biology. Conversely, the developing countries are lagging further behind the leading body of the wealthiest nations.

However, it is in the development of technologies and the capacity to control them that the United States has stepped up its lead. According to Mustar, the United States filed 53.7 per cent of patents in biotechnology, again ahead of the European Union (32.6 per cent) and Japan (7.7 per cent). According to a recent European Community estimate (Economic and Social Committee of the European Communities, 1996), the United States might even supply 65 per cent of patents in the pharmaceuticals sector. This lead reflects, of course, the investment made in fundamental research, but also the outstanding synergy in the United States among
university and industrial research, private investment and regulation, which both promotes innovations and reassures consumers. There is no such synergy in the European Union concerning intellectual property. This point should be looked at more closely given the strong divergences at the international level concerning the patentability of living material, which hinder the diffusion of innovations.

Some have even spoken out against the patentability of living material, in particular in Europe, as a matter of principle, arguing that living material is a universal common good. In practice this position is untenable. Indeed, the authors of the cloning of the ewe Dolly patented their method on the grounds that they could control its use in this way and prevent any application to humans. This amounts to putting patents at the service of ethics, which is not altogether foolproof!

For practical reasons a distinction must be made to the extent possible between the case of man, which raises serious ethical problems, and that of plants, animals and micro-organisms. Apart from pharmaceutical uses of transgenic plants or animals, it is the latter case which concerns the agro-food sector.

For crops and domestic animals – micro-organisms have already long been the subject of patents – two main problems require harmonization at the international level:

- the relationship between patent law and the protection of plant varieties (already specified in 1991 during the review of the UPOV Convention) and the extension of these rules to the animal kingdom with the introduction of the concept of “animal breeds”;

- the connected problem of the “farmers’ privilege” and the extension of the latter to stockbreeders, which authorises the reproduction of a plant or animal, possibly under patent, on their farms, excluding any marketing of the plant or animal out of the farm.

Beyond these fundamental law issues – which also govern the relationship between the supplier of transgenic plants and the users – it should be noted that a good industrial property system must balance the need to protect investors and the (no less important) need for the circulation of scientific and technical information free of charge, an important factor in the endogenous growth of the world economy. From this standpoint the agro-food sector is very different from the pharmaceuticals sector, since until now it has basked in a relative freedom of information exchanges in the genetics field. The recent report by IFPRI (Pardey et al., 1996), which highlights the high investment returns of capital-providers, especially the United States, for the international system of development research, illustrates this point very clearly. In this connection the conclusions of the Rio Summit may turn out to be negative for developing countries by restricting free access to the technology of industrialised countries. In the agro-food sector it therefore seems preferable to
confine the use of patents to what should never cease to be, i.e. simultaneous rec-
ognition of a novelty, an invention and not a mere discovery, and suitably defined
industrial applications.

ii) Industrial strategy

In 1983 the first experimental gene transfer was conducted on a plant (simulta-
neously by the Monsanto and Agrigenetics teams in the United States). Another ten
years were required, which after all does not seem too long to wait, for the actual
market introduction of a transgenic plant (Calgene's FLAVR SAVR tomato, United
States). It should be noted that this tomato, which has a relatively specific market,
offers the advantage of keeping longer, which is of potential interest to agro-food
industries as well as consumers, and in most cases the food products including this
tomato have been labelled accordingly. Since then, main-crop transgenic plants
have been brought onto the market (cotton, soybean, corn, rapeseed) after modifi-
cation to acquire agronomic advantages (tolerance to total herbicides, insect
resistance). This industrial development was to be expected and had been pro-
grammed for ten years. Since the application of biotechnologies requires
large-scale investment, in the agro-food sector they were bound to attract interna-
tional major agro-suppliers foremost, and such firms were bound to try to use the
comparative advantages acquired in the past through the development of chemis-
try (e.g. control of a total herbicide). It should also be remembered that in the cur-
rent state of the art, transgenesis can only transfer one or a few genes and it is there-
fore particularly well-suited for addressing non-polygenic agronomic problems
(protection against a specific herbicide, synthesis of a toxin for a given pest).

The fact remains that this foreseeable evolution, which has become a reality on
a broad scale in practice, raises strategic problems which are discussed extensively
at the international level today. These problems concern the future of the
agro-supply sector and of farming activity, and the future of the food industry and
distribution, which is in turn connected to consumer acceptance of biotechnology.
In other words, the development of the life industries is rapidly becoming global,
bringing together agro-suppliers, producers, processors, distributors and consum-
ers. Curiously, this situation has long been the case in technologies other than those
involving living material (e.g. computers), but the agro-food sector had not
anticipated the trend. It must now do so in no uncertain terms.

However, on the grounds we have just mentioned, within the next few years
most of the innovations concerning agricultural production will be brought onto the
market. Out of 22 approved genetically modified organisms in the United States at
the end of 1996, there are six main crop plants showing pest resistance and three
herbicide tolerance. There are also 13 pesticides from genetically modified
organisms. This tendency is confirmed by the new approval applications, which also concern agricultural production auxiliaries (insects, nematodes). For a few vegetable crops, product quality has been improved through gene transfer (tomatoes, carrots, peppers) and a transgenic rapeseed has been approved for non-food uses. On the animal side, the only approval has been that of bovine somatotropine.

While all these innovations are a source of worry to the environment lobby, they are drawing the attention of farmers as a means of improving yields. If crops that required less fertilizer or were drought-tolerant were brought onto the market, the interest of farmers could be better reconciled with environmental concerns. It should also be noted that transgenic plants show many potential advantages for numerous developing countries, where agricultural production losses can be huge.

At this stage it would be useful to examine the market for biotechnologies in crop protection. According to many forecasters, this market is very likely to amount to about 20 per cent of plant protection expenditure by the year 2010. World statistics for this expenditure being highly uncertain, the analysis will be confined to France, although the results can be easily extrapolated since input expenditure varies little from one industrialised country to the next at a given level of production.

The volume of expenditure on plant protection products in France totalled FF 15 billion in 1995, or 11 per cent of agriculture’s intermediate consumption, but 20 per cent of that concerning crop production alone (Agreste, 1996). Since gross farm income is similar to that of intermediate consumption, the impact of biotechnology is not negligible for farming; it can be evaluated at about 4 per cent.

Expenditure on plant protection products, however, only represents 10 per cent of the volume of crop deliveries and 2 per cent of the household expenditure on food. The effect of agriculture-related biotechnologies is therefore considerably diluted as one moves down the agro-food chain.

These figures, which again can be extrapolated to all industrialised countries in terms of order of magnitude, suggest that firms controlling biotechnologies will look more closely at the food sector in the medium term; however, it will be necessary as of now to gain consumer trust in these new technologies – which is not the case in certain industrialised countries, especially in Europe. In the climate of uncertainty about the labelling of products derived from biotechnologies, each country – whether a big commodity or processed product exporter – and each actor in the sector – whether upstream or downstream – tends to put forward their comparative advantages. This healthy competition should not be allowed to lead to the negative outcome of increased consumer mistrust or standardization of world food, either of which would lead to a loss in wealth creation.

Assuming the opposite as hoped by all, biotechnologies have two main potential applications in the food sector: improving the quality of commodities, as
already mentioned, and the development of new products likely to be the subject of health claims (nutraceutics). It is very likely the latter niche that biotechnology firms and those with experience in the human health field are moving towards. Population ageing in the industrialised countries should encourage them to do so.

Paradoxically, biotechnologies are currently mainly directed to the production of undifferentiated commodities, whereas within the next ten years they will no doubt facilitate the development of highly specific food products.

Finally, in the medium and long terms (or for specific short-term niches), non-food mass outlets of agricultural production should not be overlooked, since we are moving into a period where fossil fuel prices are set to rise. According to an estimate by the Shell Company, almost 400 million hectares worldwide might be devoted to this type of crop, offering much scope for biotechnology innovations.

V. CONCLUSION

The mass marketing of transgenic plants is the subject of much debate among agro-food experts, scientists and the general public. Some believe that the new technologies derived from modern biology are set to solve all our social problems, from world hunger to the preservation of taste in agricultural produce, whereas others believe that the same technologies threaten the environment and public health. To quote Racine, biotechnologies do not deserve “such undue honour nor such indignity”.

It should always be borne in mind that biotechnologies are spreading over a very wide front throughout a huge, highly differentiated and already technically sophisticated economic sector. Biotechnologies constitute an added asset that may turn out to be decisive for overcoming major problems, but they will not lead to a totally artificial new order.

In this connection, scientific and technical progress offers two channels: extensive knowledge of genomes as they arise in nature, and genome modification through transgenesis. Far from being opposed, these two channels complement each other. Despite the fact that in the future a cereal will, in the main, remain a cereal and a tomato a tomato – and that our nutrition will stay much the same as it is today – the impacts of modern biology on the agro-food sector will clearly be of a strategic nature, although they should always be viewed against the backcloth of a diversified range of techniques.

Future applications of biology are not yet irrevocably set. Much progress remains to be done in fundamental research and in the acquisition of basic techniques. In order to maintain these future promises, a healthy patent policy
accepted internationally should be pursued to maintain free and gratuitous trade in these fields, upstream from research.

Several generations of biotechnologies will appear, without wiping out the achievements of the first generations. Today, in light of the techniques at our disposal, which will evolve rapidly, and of the considerable investment required in the life industries, the first biotechnology products concern agricultural production and, more specifically, crop protection. In the near future, the food sector and new food products are likely to attract investors the most.

In view of future uncertainties, which are shared by the decision-makers of the major industrial groups involved in biotechnology, the “farmer’s privilege” should be preserved and extended to stockbreeders.

With the application of biotechnology still only in its early market phase, the principle of caution should be used with discernment, and the impact of genetically modified organisms on the environment carefully analysed.

Along the same lines, fully transparent consumer information is the only way to gain acceptance of technologies that consumers do not reject a priori but whose effects they wish to ascertain.

As for inequalities between countries, the dividing line lies between those with investment capacity for basic research and the industrialisation of products derived through biotechnology, and those without. International aid for the diffusion of technical progress to the latter should be maintained, in order to ensure harmonious growth of the world economy.
THE IMPACT OF BIOTECHNOLOGY ON THE AGRO-FOOD SECTOR

BIBLIOGRAPHY


CHANGES IN FOOD AND DRINK CONSUMPTION, 
AND THE IMPLICATIONS FOR FOOD MARKETING

by
Alan D. Gordon
GIRAG S.A. (Gira Group), Switzerland

I. INTRODUCTION

This paper takes a brief look at the dynamics behind the changes in food retailing, catering and services in OECD countries: from demographics, country preferences and information freshly available to the consumer, to the striking degree of concentration in modern retailing and the potential for newer forms of secondary retailing such as “teleshopping” and home delivery.

II. DEMOGRAPHICS AND LIFESTYLE

Demographic factors

A range of demographic factors are at work in the developed countries – from population, capital and households to changes in working patterns and income distribution – which are having an important impact on the tastes, preferences and behaviour of consumers.

Population increase is very low in all the countries (0.2-0.3 per cent per annum), with the result that there is little increase in the total number of consumers. Overall food (calorie) requirements are static throughout the developed world. Meanwhile, the prolongation of the lifespan (except in Russia) is increasing the number and percentage of “senior citizens”, who have less physical activity and special nutritional needs (reducing sodium content, controlling fat and saturated fat intake because of cholesterol, etc.). They also often have the means to meet those needs (food fortification with minerals such as calcium, vitamins).
The reduction in birth rates has caused a reduction in the average size of households throughout the developed world. In France, for example, between 1960 and 1995 the average number of persons per household decreased from 3.1 to 2.5. In both France and Germany about 30 per cent of households are now one-person households. This trend will develop along with the demand for single person packaging, and products adapted to the different social circumstances of food consumption. The sharp rise in microwave household equipment is partly linked to this phenomenon – over 90 per cent in the United States and more than 50 per cent in the United Kingdom.

Another reason for the popularity of the microwave is undoubtedly the activity of working women, which is constantly on the rise. In France more than 75 per cent of women between 25 and 40 now work, compared with only 40 per cent in 1970; the same phenomenon is observable in the United States, Germany, the United Kingdom, etc. Some of these working women are also mothers, with a family to feed at the end of a working day. This has increased the demand for service products such as ready meals in frozen, chilled or shelf-stable form. Evening “meal solutions” have become a major market phenomenon in the United States. Working women may also be single parents, bringing up children on their own. It is estimated that these “household units” (in economic terms) are frequently on the poverty edge, with nutritional marginality as a consequence.

That raises the question of income disparities, another demographic factor at work. Political and socio-economic forces are creating an increase in social inequalities. There are more rich consumers but also more consumers with financial constraints, and this has implications for the quality of food/drink products bought: fruit juices versus the cheapest carbonated beverages, for example. The unemployed will never be added-value food consumers. The decrease in the percentage of household income spent on food as incomes increase still generally holds but this fact has to be nuanced by the increase in social inequalities. In Europe these have been largely caused by “economic restructuring”. In the United States – with low unemployment – the traditional capitalist spirit and the socio-economic ethnic differences (Hispanics, Blacks) have caused the same polarisation between rich and poor. Recent research in the United States has shown that white families spend 3 per cent more on food than the average for the entire population and, taking into account household size, Hispanics spent 25 per cent less and Blacks 31 per cent less. The same holds true for eating outside the home.

Eating outside the home, particularly for the midday meal (a necessity because of the distance from home to workplace, working wives/mothers, the continuous working day) has increased throughout the Western world. This trend is a function of working habits – and so may fade with the development of “home working” – but white collar/blue collar presence at the place of work for most
economic activities will ensure the eating outside the home phenomenon at mid-day. The evening allows more choice and is linked to general economic growth (and factors such as “home meal replacement”).

Lifestyle factors

1. Country differences

Until the middle of the nineteenth century, what people ate was mainly influenced by the natural endowment of their country: Mediterranean climate versus Northern Europe, types of fruit, vegetables and oils cultivated, pasture availability for cattle (beef meat, milk), appropriate conditions for wine, cider, beer or spirits, and so on. These influences remain in varying degrees, but have been attenuated by such factors as industrialisation (urban living); the development of the food processing industry to meet the needs of the city-dwellers; organised food retailing; and the intermingling of food cultures (immigration, travel and media).

The United Kingdom was the first European country to receive (or suffer) the impact of the Industrial Revolution, and “cheap food for the labouring classes” became a necessity from the mid-nineteenth century onwards. The peasant farmer had already been eliminated by the enclosures of the sixteenth, seventeenth and eighteenth centuries. The result: very little attachment to the soil, destruction of food culture, low value attachment to bread, regional cheeses and fresh fruit and vegetables. The US companies Kellogg’s and Heinz embarked for the United Kingdom in the 1920s with their breakfast cereals and canned baked beans.

The United Kingdom has traditionally had a “fuel” approach to food, currently being changed however by the remarkable culinary innovation and sales system of major retailers such as Marks & Spencer. The other “fuel” country in Europe is the Netherlands; the attitude is somewhat alleviated by the Indonesian ethnic influence. France, Spain, Italy and Belgium are firmly in the “pleasure” camp, with strong regional influences and culinary traditions passed from generation to generation. Eating well in these countries was not a function of class as it was in the United Kingdom.

Germany is part “fuel” (attachment via discount stores to best food bargains), part “pleasure” – but in that country there is a massive attachment to Reinheit (purity, cleanliness in food) which can be traced back to the Middle Ages. The reaction to nematodes in fish, adulterated wine scandals and BSE in 1996/97 have been brutal, and the Green movement in Germany is the strongest in Europe.
The United States can be characterised by:

- The “land of plenty”: enormous helpings and the most serious obesity problem in the world. (Figures released in March 1997 by the US Department of Health and Human Services show that 35 per cent of US adults are technically obese, compared with 25 per cent in 1980.) Paediatric obesity is also growing very rapidly (lack of sport in schools, TV-watching, etc.).

- The homogenisation of eating habits, with the universal hamburger (the biggest source of saturated fat in the US diet) as a typical example.

- An absence of nutritional consensus, with too many organisations issuing nutritional guidance and instructions, and inevitable consumer confusion exacerbated by the media. This is the land of nutritional fads.

- A food industry responding via new product innovations to every possible consumer fad in the search for “added value” per kg of food product sold. The situation is now more serious, with some medical claims being admitted (e.g. oat bran and cholesterol reduction). New food/drink product innovations grew from 6,107 in 1986 to 16,863 in 1995, with some decline (13,266) in 1996.

In Japan it is the traditional “seafood and rice” diet with low saturated fat consumption. There is some Westernisation of Japanese eating habits, influenced particularly by strong tourism outside Japan. The country is now the leading world importer of beef and pigmeat (of high quality) and a large importer of poultry meat. Total meat consumption is, however, only 44 kg/capita – about 54 per cent of the EU average of 82 kg/capita – and now virtually stagnant (only beef shows some growth). (The US total is currently 121 kg/capita.) Japanese seafood consumption is about 40 kg/capita.

2. Nutritional considerations

The science of human nutrition is not an exact one because of the individuality of the human metabolism. However, in the last thirty years there has been considerable progress in understanding. Governments – faced with the conflict of interest between the farming lobbies and consumer – have until recently not been very proactive. The exceptions have been Sweden (as early as the 1960s) and, more recently, the United Kingdom, with German nutritional bodies (e.g. DGE) making strong pronouncements. Consumers are increasingly aware of the correlation between the quantity and quality of their nutritional intake and their physiological well-being.

There are several main points of consensus. To begin with, calorie intake in excess of need should be avoided; obesity is now serious in the United States, with
predisposition to arterial diseases, diabetes, etc. There should be a balanced calorie contribution from protein (11/12 per cent); fats (about 30 per cent); carbohydrates (±58 per cent). In Europe and the United States, the fat/calorie contribution is 36-40 per cent. In the United States, the protein/calorie contribution is ±15 per cent due to the high meat consumption. As for meal calorie contribution, breakfast should constitute at least 25 per cent of total daily calories. There is controversy over the relative merits of “snacking” versus “3 meals per day”.

Excess consumption of saturated fats should be avoided, from sources both visible and invisible (e.g. red meat). There is still controversy about the relative virtues of polyunsaturated (e.g. sunflower) and monounsaturated (e.g. olive) oil. Also to be avoided is excessive consumption of sucrose (sugar), although the range of arguments deployed against sugar differ between Germany (wide) and the United Kingdom (limited). There is consensus only about dental caries. Sodium (common salt) intake should be reduced, in view of its impact on blood pressure.

RDA (recommended daily allowances) have been established for vitamins (A, B, C, D, etc.) and minerals (iron, calcium). Interest is increasing in trace elements such as zinc and magnesium. The role of dietary insoluble fibre in intestinal transit is generally agreed. The role of soluble fibres (possible cholesterol reduction) remains uncertain, although claims are now being admitted in the United States. The need for moderation in alcohol consumption is acknowledged, although the range between the United States (puritan) and Europe on what constitutes moderation is wide. There is now increasing evidence of the virtues of “moderate” red wine consumption. Finally, there is agreement on an overall need to increase the consumption of long-chain carbohydrates such as bread, potato, pasta, etc. and of fresh fruit and vegetables in general.

To respond to these nutritional “verities”, the food and drink manufacturer has a number of alternative product policies which can be functionally defined as follows: enrichment with fibre, protein (amino-acids), vitamins, minerals, supplements; reduction in fat and saturated fat content, in sugar, salt, alcohol; elimination of sugar, alcohol; and substitution of fats by a variety of fat replacers, of sucrose by high-intensity sweeteners, sugar alcohols and fructose, of sodium by potassium chloride, etc.

These functional modifications often imply a significant change in the manufacturing process and, in some cases, higher costs. However, the yield in terms of marketing messages in overcrowded and static food markets is very interesting, and many nutritionally adapted products are sold at a price premium on the standard product.
3. **Meal / snack situations and functions**

The pyramidal society of hierarchy, class and consumer behaviour is being progressively replaced by a matrix type of society where consumer behaviour and food/drink consumption is linked to meal/snack patterns during the weekday and again at the weekend. There are still differences, caused by age categories and income, as to the composition of these meals/snacks but the older categorisations in the developed world are being replaced by lifestyle classifications. Every major food category has now developed lifestyle descriptions concerning the intensity of usage or non-usage. This is made more complex by “attitudes to diet”, which translate into further classifications of consumer attitudes.

In recent research on the French market, GIRA used ten snacking “situations” and seventeen snacking “functions”. In all countries there is an ever-increasing variety of products which enter snacking situations and which respond to the “functions” of these situations. For example, the situation can be morning break, pre- or post main meal, children’s tea-time, watching TV, etc. The function can be conviviality, a present, slimming, pleasure, anti-boredom, etc.

These food/drink market complexities in an overall static (volume) market provide the material for the multiplicity of food product innovations which typify both the US and European market.

4. "**Safe**" food

Within Western Europe, there have been differences with regard to perception of the need for food “hygiene”. Germany has the most sensitive consumers. There have been a wave of scandals in Europe, among them: adulterated oil in Spain (high mortality); hormones in veal used for baby food in Italy; listeria in cheese (many countries); salmonella in eggs and poultry (many countries); salmonella in pigmeat; adulterated wine in Germany; “worms in fresh fish” in Germany; *E. coli* in beef (United States, Japan and the EU); and the 1996 BSE crisis (potential CJD correlation).

That last scandal sent shock waves across the EU beef market and into countries which had been traditional markets for EU beef, and also increased the demand for organically grown foods. Reactions have been varied.

a) **Meat**

Several measures have been adopted. For example, “traceability” via animal passports allows the retailer to confirm to the consumer the origin of the meat cut being sold. In Sweden there are guarantees of “salmonella free”, used as a marketing message for poultry and pigmeat. There are also guarantees that veal raised in the Netherlands is free from growth promoters. Finally, there have been efforts to reduce the stress of reared birds and animals by introducing “natural conditions”: banning of
battery cages; abolition of tethering for sows; reduction/elimination of crates for veal; and outdoor rearing of pigs. These efforts are part of “Animal Welfare”, which in the United Kingdom has begun to be associated with “Animal Rights”. (Vegetarianism is only significant in the United Kingdom – 4 per cent of the adult population.) The EU has also maintained its ban (despite scientific evidence) on imports of US beef where natural growth promoters are used as part of the beef fattening system.

b) Food hygiene

The United Kingdom established in 1991 the wide-reaching Food Safety Act, which establishes stringent controls on the maintenance of the cold chain at appropriate temperatures for perishable foods in both retail and catering markets.

c) Organically grown produce / bio products

This is partly the consumer response to pesticide/herbicide residues in fruit and vegetables. The EU Commission in Brussels allows national governments to grant subsidies to farmers for conversion to organic farming.

Legislation was introduced in the EU in 1995; producers making claims had until end-1997 to conform. It defines bio products as issue from land or cultivation which has received no synthetic chemical products for at least three years or any exposure to pesticides. In France there are different categorisations (products at least 95 per cent issue from bio culture, 70 per cent, etc.; below 50 per cent no label reference can be made to bio production). Products are mainly fruit and vegetables, but also include beef (natural pasture), dairy products, eggs, bakery products (organically grown cereals), honey, etc. Part of the motivation is to avoid too high a yield per hectare. Governments vary in the amount of farming support they provide. The UK Government grants low support (ECU 72 per hectare) whereas the German Government grants ECU 144 per hectare during conversion and ECU 122 per hectare thereafter. In Germany, organically grown produce now represents about 3.8 per cent in value of domestically grown total fresh fruit and vegetable sales, against 0.3 per cent in the United Kingdom.

In France, the market penetration is currently 1 per cent in the fruit, vegetables, cereals and eggs category. Prices in all countries are from 30-50 per cent higher than standard products.

Special retailing chains have developed (e.g. Nouveaux Robinson in France, Whole Foods Market in the United States) and some major retailing chains are now featuring bio products.

In the United States in 1995, organically grown produce represented $3 billion or about 9 per cent of the $32 billion produce retail market. Overall, bio food sales doubled in the last five years to reach about $8 billion in 1995.
There are undoubtedly growth prospects in this area, but production standards must be tightly controlled to avoid any major damage to consumer credibility.

d) Genetics

Before ending this section on "clean food", mention should be made of reactions to genetically modified (GM) crops (soya, maize, etc.). These have now been approved in the United States and imports of soya have been approved by the EU Commission. GM soya has now arrived in Europe from the United States with uncertain segregation from non-modified, even though it currently constitutes only about 2 per cent of the US soya crop. Genetic engineering makes possible the achievement of seed configurations (and plant performance) which cannot be effected by normal plant technology such as hybridisation and wide crosses. It enables crossing of species barriers, and a gene so transferred (e.g., from a Brazil nut) can function quite differently depending on the genetic background into which it is inserted. Thus there is an element of risk (unknown fallout), and opponents in Europe are insisting on labelling of GM foods so that consumers can choose whether they want to take the "risk". In the United States there has been no such consumer demand. Battle lines are drawn in Europe between the producer interests and "Green" organisations – with retailers and consumers in the middle.

III. THE CATERING / FOOD SERVICE MARKET

Food and drink consumption takes place through two circuits: outside-the-home eating ("food service" in US terminology or catering), where the food is normally presented to the consumer as meals cooked or assembled by the caterer; and in-home eating (the retail or household market), where the household occupant buys food for meal assembly or cooking and for in-home consumption. The approximate breakdown for the food manufacturer/supplier of these two circuits in Europe is 20 per cent catering/food service, 80 per cent retail. This section deals with catering/food service.

A. Main catering segments

The major breakdowns are the following:

- **Social**: education – schools, universities, higher education; health – hospitals, clinics; homes/resident care – elderly, handicapped, etc.; penal – prisons; armed forces – army, air, navy.

In social catering, menus involving various nutritional frameworks are "imposed" by the operating service. The degree of choice of the user is often limited.
• **Workplace:** office/factory catering, which is semi-social (welfare of the employee) but which also has a commercial interest for the employer (the employee might perform better). It is in this sector that the profit-oriented contract caterers are the most active.

• **Commercial:** this very large commercial segment includes bars and cafés; restaurants, both independent (various categories) and part of a chain (various categories); leisure venues; hotels and guest houses (various categories). Restaurants can be categorised by menu type, service (counter, free flow, cafeteria, full service), size/number of seats, spend per head, etc. These are innovators in the food service/catering market.

• **Transport:** a small segment involving rail – station and on-train; air – airport and airline; road – motorway and highway; sea – ferries, cruises, etc.

**B. Meal functions**

Residential establishments – hospitals, homes, hotels, etc. – serve three meals per day (breakfast, midday and evening).

The main volume catering meal is at midday – the necessity meal – when most people are outside the home for work or education. The main emphasis is on low price/value/rapidity, with competition between the subsidised company cafeteria and various commercial establishments (fast food, traditional independents, sandwich bars, etc.).

In the evening, eating out is usually discretionary and can be divided between “grab-a-bite” (cheap) dining before or after, *e.g.* a cinema excursion, and “pleasure” dining, when choice is influenced by the economic means or “situation” of the diner (from pizza to “elegant dining”). There are differences in consumer eating-out comportment between work days and the weekend.

The catering breakfast meal is only significant in countries with a breakfast tradition (*e.g.* Northern Europe) but the buffet breakfast now used by most “business” hotels has done a lot to stimulate consumer interest in a wide variety of “breakfast” products (juices, cereals, hot meats and eggs) and the importance of breakfast in the daily calorie intake.

**C. Economic weight and main actors**

Table 1 sets out the relative importance of the social (including office/factory) versus commercial catering segments for the five major EU countries (in percentage of meals served) and for the United States (in value).
These differences are explained by the long tradition of office/factory catering in the United Kingdom, Germany and France (but virtually no school meals in Germany), the late start of Spain in social (particularly office/factory) catering, and the importance of tourism in Spain and Italy. The United States has traditionally been underdeveloped in social catering (the capitalist spirit) whereas the commercial (both fast food and “dining”) has been the motor of the market.

The main actors of the food service market are:

- **Food manufacturers** (meal input suppliers): in the past these have regarded food service as a “poor cousin” alternative to the major retail market. However, the increasing pressure from modern retail (brands, pricing, de-listing) is increasing the attention given to this market.

- **Contract caterers**: these operate the catering (kitchen and service facilities) on behalf of the final customer. There are two types of contracts: “cost plus”, with a management fee; and “fixed price”, with any risk pertaining to food costs and labour taken on by the contract caterer. The penetration in social catering (still mainly office/factory) of these major companies (which include Sodexho/Gardner Merchant and Compass/Eurest) is now as follows: Italy – 37 per cent; Spain – 28 per cent; France – 25 per cent; United Kingdom – 24 per cent; Germany – 5 per cent. (The German penetration is low because for a long time large German companies kept their catering “in-house”. This is now changing rapidly.)

- **Restaurant chains**: the most significant impact has been from “fast food” establishments (McDonald’s, Burger King, KFC, etc.), which have revolutionised popular catering (price, food hygiene, rapidity of service) and impacted on eating habits, particularly among the young. Other chains offer pizza, grills, steak, seafood and ethnic cuisine. The penetration of

---

**Table 1. Relative importance of social versus commercial catering segments**

<table>
<thead>
<tr>
<th></th>
<th>Meals/year (millions)</th>
<th>Social</th>
<th>Commercial</th>
<th>Trend 1995/2000 (% yearly increase in number of meals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>7 800</td>
<td>48</td>
<td>52</td>
<td>1.4</td>
</tr>
<tr>
<td>France</td>
<td>6 625</td>
<td>56</td>
<td>44</td>
<td>0.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7 900</td>
<td>42</td>
<td>58</td>
<td>1.8</td>
</tr>
<tr>
<td>Italy</td>
<td>5 400</td>
<td>38</td>
<td>62</td>
<td>1.0</td>
</tr>
<tr>
<td>Spain</td>
<td>3 250</td>
<td>28</td>
<td>72</td>
<td>1.2</td>
</tr>
</tbody>
</table>

|                      | Turnover ($ billions) | United States (in value) |  |
|----------------------|-----------------------|--------------------------|  |
|                      |                       | 321                      | 25 |
|                      |                       | 75                       |    |

Source: GIRA Sic for Europe, Technomic for the United States.
chains (measured in turnover) in the main Western European countries in commercial catering is now as follows: France – 29 per cent; United Kingdom – 28 per cent; Germany – 24 per cent; Spain – 17 per cent; Italy – 6 per cent. (Apart from fast food, Italians still prefer to eat in traditional “individual” restaurants in the commercial sector).

In the United States, the top ten chains in terms of sales now represent 10 per cent of the total US commercial food service market.

- **Specialist wholesalers** to caterers: the catering universe is a large one (200 000-300 000 units in countries such as France and Germany) and the small will buy from cash and carry (no credit, no delivery) and even retail. For the larger caterers (worth a delivery), specialist wholesalers have emerged in frozen food and dry goods. In the United States, the 25 largest broad-line distribution companies now represent 27 per cent of all food sales to the US catering market.

### D. Influence on eating habits / food consumption

The influence is varied. For example, the United Kingdom school meal (originally “meat + 2 veg” + pudding) was designed via subsidy to combat deficiencies in the family eating habits (poor breakfast, unbalanced diet). This was imposed. In response to Thatcherite pressures, it was decided to increase the attraction of meals to children (more hamburgers, French fries and milk shakes) with reduced subsidies. During the height of the BSE crisis in Summer 1996, parents put pressure on local authorities to remove beef from school menus.

In the hospital area, the influence is strictly dietetic (patients are aware of adaptation of menus to various medical states). Contract caterers serve broad menus but can innovate by offering lighter menus (e.g. more salads, fresh fruit) and by varying the protein presence (beef, poultry, pigmeat, sheepmeat, seafood). Meanwhile, commercial caterers (both independents and chains) have the most influence. Examples include exotic/ethnic (Indian, Thai, Mexican, Cajun, Chinese, etc.), both innovating and responding to consumer requirements; the hamburger, which still dominates fast food menus in the United States and Western Europe; the salad bar (lighter eating); exotic seafood (most people prefer simply to eat fish and not cook it); super-premium ice cream (Häagen-Dazs); the hotel breakfast buffet (increasing the importance of breakfast as part of the daily calorie intake). Mention should also be made of “take out” facilities and the key role of restaurant chains in the United States in contributing to the “meal solution” problem of households for the evening meal. In 1996, according to US restaurant associations, take-out meals for the first time exceeded meals served in restaurants.
Looking ahead, it seems safe to project that there will be slow growth in Western Europe favouring the catering market over the retail market. This growth will be mainly income related, and appear in the commercial segment.

IV. THE RETAIL MARKET

In Western Europe, as mentioned above, retail sales of food to the final consumer in volume terms represent about 80 per cent of total food sales.

There are two main circuits: the “modern”: hypermarkets and supermarkets mainly operated by “groupings” of various kinds; and the “secondary”: a mixed range covering traditional independent grocers, the specialists (butchers, bakers, greengrocers, fishmongers), “CTN” (confectionery, tobacconists, newsagents with some food sales), drinks stores, convenience (C) stores, petrol filling stations with increasingly specialist shops and kiosks, refreshment vending and various forms of home delivery.

In Western Europe, modern retailing represented in value terms about 70 per cent of total food/drink sales and its share is increasing; the secondary circuits represent about 30 per cent. In the United States, the secondary share is lower (about 10-15 per cent) due to the reduced presence of independent grocers and traditional specialists. In that country, however, the distinction between food service and retailing is increasingly blurred, with both competing for the “in-home meal solutions”.

A. Modern retailing

This section highlights the major features of modern retailing in Western Europe and the United States.

1. Western Europe

   a) Concentration

   The most striking feature in modern retailing is the degree of concentration that has taken place – and that will increase in the future, essentially by acquisition.

   The current concentration (in percentage of market shares) of the top five retailers is as follows: France – 70; Germany – 62; United Kingdom – 47; Spain – 17; Italy – 16. The situation is the same or even more pronounced in the smaller EU countries such as the Netherlands, Belgium, Sweden, Denmark and Austria. Even Greece and Portugal are witnessing this phenomenon. (In the rapidly developing economies of Central Europe – Poland, Hungary and the Czech Republic –
80 per cent of the recently developed hypermarkets and supermarkets are owned by West European operators.)

The concentration in the EU is essentially taking the form of mergers inside countries, but there are some examples of cross-border acquisitions or “invasion” (Tesco, Metro, Tengelmann, Carrefour, Auchan, Promodes are examples). This concentration means massive buying power.

However, the structure of retailer ownership differs considerably between countries. In the United Kingdom, the top five are all multiples – they own their outlets – and in a position to impose system throughout their store networks. In France, the two top retailers, Intermarché and Leclerc, are essentially groupings of independents; the result is less uniformity in terms of assortment and buying. In Italy, the largest retailer is the Coop. (Italy has also successfully kept out the invasion of foreign chains, which is not the case in Spain.)

There are also considerable differences between countries with regard to average size of supermarkets and in the number of hypermarkets. Here, France – the “inventor” of the hypermarket – has by far the highest number of hypermarkets (1,100 to Italy’s 220).

Retailers have also increased their power with producers by forming “alliances” (e.g. AMS) with other major retailers from different European countries. These alliances have concentrated, inter alia, on trading conditions with producers, thus eliminating the big differences in producer pricing between countries.

In future, concentration is likely to increase in each of the big five EU countries to roughly the French levels; the momentum will be slowest in Italy, as foreign “predators” have been kept out of the concentration process there – it is concentration “à l’Italienne”. In Spain the ambitions of the big three French retailers (Carrefour, Auchan, Promodes) are countered by the powers of the Autonomous Regions (and protection of the smaller retailer).

It should be emphasized that the United Kingdom’s type of concentration (by sophisticated multiples with control on logistics and store configurations) is more constraining for the brand-name food and drink producer than the French or German “systems”. German food retailing in terms of system and sophistication is at least ten years behind the United Kingdom.

b) Private label

The shares of private label (PL) vary from country to country and by chain. The most developed country in Europe in terms of commercial sophistication is the United Kingdom, and it is here that PL is the most developed. Some major UK food manufacturers have become dedicated private label suppliers to the major chains.
such as Tesco, Sainsbury and, of course, Marks & Spencer, which is 100 per cent PL in its stores. PL is still embryonic in Italy and Spain due to the much lower degree of sophistication or integration of the major retailers. The overall position of PL across the main Western European countries is summarised in Table 2.

c) Balance of power

This is now firmly with modern retailers – as opposed to food/drink producers – across Western Europe. The manifestations are imposition of trading terms – pricing, rebates, credit, special payment for access to retailers’ shelves – and de-listing if a supplier does not meet the trading terms or the retailer decides to limit the range of producer brands which are referenced.

The growing concentration and power of modern retail is the number one preoccupation of all the major food producers. The situation is only partly mitigated by a number of restrictions imposed on the opening of new large stores (essentially hypermarkets). These are in force in France, Italy and Spain, and planning permission for new large stores is more difficult throughout Western Europe. This limitation on new store openings (e.g. in France) is increasing cannibalisation among the major retailers, and therefore the pace of concentration. Store opening hours were very reduced in Germany, but have recently been extended.

d) The discount phenomenon

Discounting can be defined as “relatively low prices for quality comparable to the mainstream market”. The discount market is serviced by a number of retail formats. Discounting has always been present in food retailing and was the original main positioning of the French hypermarket groups and some UK retailers such as Tesco (“pile high and sell cheap”).

A significant retailing phenomenon in Western Europe of the last six or seven years has been the emergence of the “hard discount” venue, which was originally developed by Aldi in Germany. The essential features of units are as follows: 250-750 m² (maximum) with a high street/neighbourhood location, low-cost premises; 500-800 lines (maximum 1 000) compared with the 20 000 of a hypermarket; very limited choice (mainly generic retailer brands with a brand name sometimes added);

| Percentage of private label products in packaged retail food sales, 1996 |
|-----------------|-----------------|
| United Kingdom  | 25              |
| Germany         | 21              |
| France          | 19              |
| Spain           | 9               |
| Italy           | 4               |

Source: Trade estimates.
chiefly packaged grocery items that can remain in stock (limited chilled and frozen); minimal service; prices about 40-50 per cent below an equivalent quality manufacturer brand product, and 20-30 per cent below a high-quality retailer brand.

Aldi moved from Germany into the Netherlands, Belgium, the United Kingdom and France. Imitations have emerged, both from other specialist hard discount chains and in defence by mainline retailers. The biggest shock has been in countries such as the United Kingdom, where the highly profitable major British retailers had tended to stress the quality of their products, ignoring the price message.

There are now some 11 000 hard discount stores in the main Western European countries; Germany still has more than half the total. The current hard discount penetration in retail grocery markets varies from 15 per cent in Germany to 1 per cent in Italy, with France at about 4 per cent and the United Kingdom 3 per cent. Mainline retailers have counter-attacked by developing a special discounted range of products, or by setting up hard discount formulae themselves.

2. United States

The key features of the US food retailing scene can be summarised as follows.

a) Concentration

The top five supermarket chains in 1996 had combined sales of $92.3 billion or about 23 per cent of total supermarket sales of ±$400 billion. The top ten accounted for $147 billion, or about 37 per cent.

There is less concentration, therefore, than in some European countries; the United States is vast, however, and many of the chains concentrate on certain regions. For example, Ahold, the leading Dutch retailer, has now reached the rank of fifth-largest supermarket retailer in the United States, but with all its acquisitions concentrated for critical mass in the East of the country. The US operating environment is attractive to European groups, with no restrictions on opening hours (many supermarkets are open seven days a week, 24 hours a day) and very few planning restrictions for store openings. The concentration process is increasing by acquisitions among the American retailers and by foreign retailers (mainly European).

b) Private label

Retailer private label (store brand products) in supermarkets represented in 1996 about 20 per cent of total grocery sales; of the 1996 supermarket sales increase over 1995 of $8.9 billion, $3.3 billion were made by store brands.

The pressure on producer brands is therefore increasing, but not yet as severe as in Western Europe. It should not be forgotten that of total supermarket food
sales in 1996, only 38 per cent were in groceries; 62 per cent were in perishables (meat, seafood, produce, etc.), where branding is less easy.

c) Innovation/competition

The most significant development at the moment is the competition between retailers and caterers (food service) for the “home meal replacement”. The US consumer is increasingly “starved of time” for meal preparation, and a growing number of consumers lack skills or interest in cooking. There is, however, desire to spend more time at home. These trends have created a home meal replacement market now approaching $100 billion per year. About half of this is taken by fast food restaurants and by specialist chains such as Boston Market which, while restaurants, feature take-away meals for home consumption.

The supermarket chains are responding by building meal replacement centres, and some offer home meal delivery or Internet shopping. Others are focusing on a combination of recipes and fast check-out (“save time, eat well”). The blurring between retail and food service (catering) is increasing in the competition to supply the convenient, rapid, “no cooking” requirements of the US consumer.

3. Responding to the consumer

Modern retail is using flexible assets to pull together and present in its stores the range of food and drink products which – judging from experience and previous sales – are demanded by consumers. Retailers have, therefore, a direct contact with the consumer, which the food/drink manufacturers do not. (The latter are also being increasingly kept out of any direct merchandising in the retailers’ stores.)

Innovation is therefore cautious but constant in response to perceived needs of convenience, packaging, variety, nutrition (the wave of “light” products in the 1980s), exoticism, etc. Major retailers watch their national competition very closely; there is considerable imitation and cross-fertilization via international alliances and the increasing sophistication of the food trade press. Marks & Spencer in the United Kingdom is probably the most innovative food retailer in the world, offering ever-changing recipe dishes (mostly chilled), pre-packed salads, convenience fresh meats, sandwiches, fresh juices, etc. In general, margins – and risks – are higher with the more complex fresh counter foods such as red meats, seafood, fruit and vegetables than in dry groceries and frozen foods, and there is constant experimentation in linear allocation.

Modern retail has also made “affordable” many products which were previously in very high luxury price categories.
B. Secondary retailing

The increasing “squeeze” from modern retailing is causing food and drink producers in Western Europe to take more seriously the possibilities offered by secondary retailing. This is not an alternative to mainstream retailing but a useful adjunct.

1. Western Europe

GIRA's research across the United Kingdom, France, Germany and Italy in 1995 and 1996 showed that secondary retailing held about 28-33 per cent of all food and drink sales in these countries. There are more than 200 000 outlets per country (very similar to food service/catering). Among these are two types of “independents”: the traditional independent grocers (who are being steadily eliminated unless they move to a convenience format); and the independent “specialists” – bakers, butchers, greengrocers, fishmongers – who are all losing ground to modern retail although some resist well. Other outlets include: CTN, where food sales are usually not the main activity; proximity convenience stores (often part of a chain); drinks stores (alcoholic drinks); petrol station kiosk/store networks – a dynamic sector, as the major oil companies realise the non-gasoline sales potential of their outlets (and counter-attack against major food retailers' inroads into the gasoline market); various home-delivery systems; and automatic refreshment vending.

There are several characteristics common among secondary retailing units: a small surface area (40-80 sq. m) and low annual sales; supplies essentially from the wholesaler due to the number of units and low unit buying power; high usage of top producer brands (to reassure the consumer); and high prices and margins.

Major food producers are trying to prolong the survival of some sectors by supplying equipment (e.g. freezers) but often with “strings” attached: special packaging, point of sale display and, where there is direct producer delivery, credit terms. The “specialists” such as butchers and bakers are widening their range by retailing other food categories.

Most sectors are in long slow decline under the pressure of modern retail (lower prices, one-stop shopping). The most dynamic segment is that of the petrol station store networks, even though the total number of petrol stations is declining.

Another interesting segment is that of refreshment vending: this had concentrated on drinks vending (hot and cold cup, can/bottle soft drinks); over the past five years, however, it has been widening into snack vending in a variety of locations. Vending used to be called “non-manual catering” but is now becoming another “retailing shelf”.
It would seem safe to project that in Western Europe, the concentration in modern retail will continue and more share will be taken from secondary. The latter will survive through service and neighbourhood proximity.

2. United States

The United States – except in cities such as New York – does not have the legacy of the traditional specialists found in Western Europe (independent butchers, bakers, greengrocers, etc.).

The major secondary retailing segment in the United States is made up of 93,000 convenience store units with total sales of $144 billion in 1995. These are mainly linked to petrol stations; in 1995 petrol (gasoline) sales represented 52 per cent of the total. “Merchandise” represented the other 48 per cent – essentially tobacco, beer, soft drinks, milk and fast food items. Total food sales through this channel represented about $30 billion in 1995, or about 7.5 per cent of total retail food sales.

The blurring between retail food sales and food service/catering sales is increasing as the “fast food” sales of the convenience stores (retail) are categorised under “food service” catering sales in the statistics put out by the food service industry in the United States.

Home shopping/delivery

Home delivery, via the grocer’s “errand boy”, was a significant part of retail sales in the 1930s in the United States (13.8 per cent in 1930) and Western Europe. In the United States, it dropped to 1.2 per cent in 1986 and has started to climb back (2.6 per cent in 1995).

In Western Europe, it has been significant in the areas of milk and frozen food. In the United Kingdom, the home delivery system for milk was as high as 90 per cent of all milk sales; it is now below 40 per cent in volume (but still 65 per cent in value). In Germany, about 30 per cent of frozen food retail sales are made by home delivery (Bo-Frost and Eismann are the two big operators), with the selling argument of “no break in the cold chain”. In France, home delivery in frozen food is still about 15 per cent of retail sales.

Home delivery requires a “system”. There needs to be an “integrator” who determines: the range of products, the pricing, the suppliers; the display (catalogue, TV, Internet, etc.); the ordering system (catalogue, telephone, minitel, Internet, etc.); the distribution system (delivery); the payment system. And, of course, there need to be sufficient customers with income, time pressures and the ordering know-how/equipment to provide adequate demand.
The “integrator” can be a major grocery retailer who has mastered the logistics of food and drink assembly and is in a position to add a customer delivery service. There are many trials under way, e.g., in the United Kingdom, by the large retailers. There are, however, doubts about taking consumers away from the expensive fixed assets which the retailers have built. The “integrator” could also be a wholesaler working for food and drink producers who thus find a way of avoiding the “squeeze” force of modern retail. The growing awareness of Internet is also stimulating a lot of interest, but PC home ownership needs also to be equipped with modems. There is also much speculation on the development of interactive media in the home and their impact on home shopping among other activities.

In Germany, a large mail order company such as Quelle has taken a share in HOT (Home Order Television) and thus uses the public television service – but there are restrictions to one hour per day on home teleshopping programmes. HOT imitates US networks such as QVC and Home Shopping Network, and already reaches 6.5 million households. QVC has now moved into the UK market.

As for trends in the future, home shopping in food will certainly develop over the next ten years, but is probably more suitable for standard bulk grocery products than for “fresh”, such as meat, seafood, and products where there is a sensory role in product choice. Shopping also has a social contact role that is particularly important in Latin cultures.

Many experts also see “teleshopping” for retail sales in general and for food sales in particular rising in importance. Teleshopping in food and drink is certainly a window of opportunity for major food and drink producers seeking a way to bypass modern retailers. However, the latter have all the cards on their side with consumer understanding gained through their current operations and their retailing assets. For the United Kingdom, France and Germany, it would be reasonable to project 10-15 per cent of packaged groceries purchased via teleshopping over the next ten years.

V. CONCLUSION

This chapter has tried to show the increasing complexity of food and drink markets: growing segmentation inside each major category in response to consumer perceptions of convenience, nutrition, etc.; the ever-widening range of “situations” and “functions” for meals and snacks; “inside home” (retail) and “outside home” (catering) consumption, and the blurring taking place in the United States in the competition for “home meal replacement”; the differences in food culture and lifestyles between the United States and Western Europe and between major Western European countries.
This vast spectrum of diverse and constantly shifting factors makes forecasting an extremely difficult exercise. While it has been possible in this chapter to indicate some broad overall trends – the continuing concentration in modern retail, the diminishing share of secondary retail, the rise of home shopping and teleshopping, etc. – projections cannot be offered for individual categories of food. The growing complexity of consumer and lifestyle patterns and the rapidly changing range of food situations make it increasingly meaningless to forecast changes at the macro levels of “meat”, “cereals”, “dairy”, “fruit”, etc. Any macro level is, after all, the sum of many different movements at the micro level within it (e.g. poultry and beef and pigmeat inside the category “meat”). Micro movements are the real terrain of food marketing; one should be wary of any macro forecasting not built “from the ground up”.
The purpose of this contribution is to present a framework within which evolutionary change in the structure and behaviour of firms in the processed food sector can be assessed. It is organised into three major sections, each dealing with a set of factors or conditions for change. Part I addresses factors that affect the competitiveness of firms, i.e. the key sources of competitive advantage in the processed food industries. Part II deals with factors that affect the location of production, i.e. what determines where firms choose to do business. Part III is concerned with factors that affect how firms organise their business activities, i.e. what motivates them to internalise some business activities and rely on outside firms for others. Part IV briefly concludes.

The paper is set in the context of globalisation. That is, it is predicated on the assumption that firms in the processed food sector compete globally; their structure and behaviour are not limited by (or constrained to be within) national boundaries. There is no suggestion that globalisation is some destination at which the sector will someday arrive. Rather, globalisation is understood to be a process that leads firms toward seamless international commerce. As such, firms compete with and co-operate with other firms from around the world. Given this perspective, the concept of a firm's nationality is largely vacuous; nations are considered primarily as sources of competitive advantage and as locations within which to do business.

I. COMPETITIVE ADVANTAGE

In his widely received work on competitiveness among nations, Porter (1990) delineated four sets of conditions that individually are necessary and collectively
are sufficient for a firm to gain strategic advantage in the market-place. To paraphrase Porter's descriptions, these conditions are 1) the quality and availability of inputs to an industrial process, 2) the nature of consumer demand faced by a firm in its primary market, 3) the intensity of rivalry in the operating and marketing orientation of the firm, and 4) the presence of efficient and competitive firms in related industries.

Using a variety of analytical approaches that are generally consistent with Porter's framework, numerous studies have been conducted that examine antecedents for firm success in the global market-place. A number of these have addressed the processed food sector specifically (see, for example, Bredahl et al., 1994; Henderson et al., 1996; Sheldon and Abbott, 1996; Henneberry, 1997; and Pick et al., 1997). These studies have revealed a number of generally consistent findings that can be drawn together into "stylised facts" regarding the determinants of competitive success in the sector. The stylised facts in turn become primary considerations in forming expectations regarding the structure of the sector in the years ahead. That is, factors that are associated with competitive success are taken as indicators of the character of the sector in the future.

Inputs

This set of conditions begins with what economists term factors of production. Indeed, a nation's relative endowment of land, labour and capital forms the starting point for the theory of comparative advantage, which is the foundation for the standard, neoclassical theory of international trade. According to that theory, to the extent that nations are endowed with different ratios of these factors of production, international trade will occur with a nation exporting those products that require large input of its relatively abundant factor(s) while importing products that require large input of its relatively scarce factor(s). Thus, based on this neoclassical theory, it is predicted that nations (and the firms therein) under a free trade regime will specialise in industries that produce the first class of products, and that trade between nations will be inter-industry in nature. That is, firms in one nation specialise in the production and export of one class of products (e.g., labour-intensive goods) and import another class (e.g., capital-intensive goods) from specialised firms in another nation. It is obvious under this scenario that a nation's natural endowment of factors of production will affect what types of firms and industries appear to have competitive advantage in international markets.

Empirical observation of patterns of international commerce in processed foods, however, reveals that a considerable amount of trade is intra-industry – that is, simultaneous import and export of similar goods (Tables 1, 2 and 3). Further, the
value of production by foreign affiliates of processed food firms often exceeds the value of processed foods entered into international trade, sometimes by several magnitudes (Tables 4 and 5, Figure 1). Firms with foreign affiliates are considered to be multinational firms. Multinational firms arise from foreign direct investment (FDI). FDI refers to the direct involvement by a firm in the operating decisions of a foreign affiliate. Often, this is associated with a majority investment position in the affiliate. But, majority investment is not essential. The important characteristic distinguishing FDI from the passive form of international investment (called foreign portfolio investment) is managerial input into the foreign operation. For the purposes of both convenience and consistency, FDI is stated in terms of sales by foreign affiliates throughout this paper.

Neoclassical theory can explain neither the presence of intra-industry trade nor that of multinational firms. Therefore, the conventional view of land, labour and

<table>
<thead>
<tr>
<th>Table 1. US intra-industry trade in processed foods, 1994 (Grubel-Lloyd Index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>Soft drinks</td>
</tr>
<tr>
<td>Prepared meats</td>
</tr>
<tr>
<td>Frozen fruit and vegetables</td>
</tr>
<tr>
<td>Canned fruit and vegetables</td>
</tr>
<tr>
<td>Roasted coffee</td>
</tr>
<tr>
<td>Ready-to-eat cereals</td>
</tr>
<tr>
<td>Cooking oils</td>
</tr>
<tr>
<td>Roasted nuts</td>
</tr>
</tbody>
</table>

1. The Grubel-Lloyd Index is defined as \( \frac{|X + M - |X - M||}{X + M} \) where \( X = \text{exports and } M = \text{imports of similar products}. \) The index has the characteristic \( 1 \geq \text{GL Index} \geq 0; 1 = \text{all trade is intra-industry}; 0 = \text{all trade is inter-industry} \).

Source: Henderson, Handy and Neff, 1996.

<table>
<thead>
<tr>
<th>Table 2. US intra-industry trade with others, 1994 (Grubel-Lloyd Index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>Chocolate</td>
</tr>
<tr>
<td>Frozen baked goods</td>
</tr>
<tr>
<td>Crackers</td>
</tr>
<tr>
<td>RTE cereals</td>
</tr>
<tr>
<td>Fresh meat</td>
</tr>
<tr>
<td>Chewing gum</td>
</tr>
<tr>
<td>Canned seafood</td>
</tr>
<tr>
<td>Refined sugar</td>
</tr>
<tr>
<td>Pickles</td>
</tr>
</tbody>
</table>

1. See footnote in Table 1.

Source: Henderson, Handy and Neff, 1996.
Table 3. Intra-industry trade in food and beverages, European Union
(GL Index1)

<table>
<thead>
<tr>
<th>Country</th>
<th>1980</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.57</td>
<td>0.62</td>
</tr>
<tr>
<td>Germany</td>
<td>0.53</td>
<td>0.58</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.70</td>
<td>0.39</td>
</tr>
<tr>
<td>France</td>
<td>0.49</td>
<td>0.54</td>
</tr>
<tr>
<td>Greece</td>
<td>0.13</td>
<td>0.24</td>
</tr>
<tr>
<td>Italy</td>
<td>0.32</td>
<td>0.38</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.36</td>
<td>0.45</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.54</td>
<td>0.56</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.19</td>
<td>0.28</td>
</tr>
<tr>
<td>Spain</td>
<td>0.27</td>
<td>0.47</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td>EU-12</td>
<td>0.38</td>
<td>0.45</td>
</tr>
</tbody>
</table>

1. See footnote in Table 1.
Source: Traill, 1996.

Table 4. Foreign sales of leading US multinational food firms, 1992-93
($ million)

<table>
<thead>
<tr>
<th>Firm</th>
<th>Sales from foreign affiliates</th>
<th>Exports from the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philip Morris/Kraft</td>
<td>11 945</td>
<td>1 340</td>
</tr>
<tr>
<td>Coca-Cola Co.</td>
<td>9 351</td>
<td>207</td>
</tr>
<tr>
<td>PepsiCo Inc.</td>
<td>5 382</td>
<td>248</td>
</tr>
<tr>
<td>CPC International</td>
<td>4 326</td>
<td>71</td>
</tr>
<tr>
<td>MM/Mars</td>
<td>4 000</td>
<td>120</td>
</tr>
<tr>
<td>H.J. Heinz Co.</td>
<td>3 053</td>
<td>106</td>
</tr>
<tr>
<td>Kellogg Co.</td>
<td>2 512</td>
<td>97</td>
</tr>
<tr>
<td>Sara Lee Corp.</td>
<td>2 344</td>
<td>184</td>
</tr>
<tr>
<td>Archer Daniels Midland Co.</td>
<td>2 232</td>
<td>937</td>
</tr>
<tr>
<td>Quaker Oats Co.</td>
<td>2 025</td>
<td>120</td>
</tr>
<tr>
<td>Campbell Soup</td>
<td>1 930</td>
<td>94</td>
</tr>
<tr>
<td>Dole Foods Co.</td>
<td>1 657</td>
<td>66</td>
</tr>
</tbody>
</table>

Source: Henderson, Handy and Neff, 1996.

Table 5. Trade and foreign production of processed foods
($ billion, annual average 1988-91)

<table>
<thead>
<tr>
<th>Country</th>
<th>Out-bound sales</th>
<th>In-bound sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foreign affiliates</td>
<td>Exports</td>
</tr>
<tr>
<td>France</td>
<td>30.6</td>
<td>19.8</td>
</tr>
<tr>
<td>Germany</td>
<td>2.9</td>
<td>15.9</td>
</tr>
<tr>
<td>Italy</td>
<td>3.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>21.8</td>
<td>19.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>43.8</td>
<td>9.4</td>
</tr>
<tr>
<td>United States</td>
<td>40.4</td>
<td>19.1</td>
</tr>
</tbody>
</table>

capital as the determining factors in the location of production, and thus international competitive advantage, appears to be short-sighted. Porter’s concept broadens the scope of factor (or input) conditions to include a nation’s infrastructure, including such things as systems for transportation, communications, funds transfer, and mail and parcel delivery, as well as amenities that make for an attractive place to live and do business. Further, it includes knowledge resources (e.g. a nation’s stock of scientific and technical knowledge, and the institutions involved in creating and expanding such knowledge), and human resources (e.g. the quality of human intellectual and physical skills).

In contrast to natural endowments of land, labour and capital inputs, a common characteristic of these additional classes of inputs is that they are products of human intellect. This, in turn, seeds the idea that many of the factors that affect the ability of firms to gain competitive advantage in the global market-place result not from the historical accident of how natural resources were divided among nations, but from the development and application of knowledge, or intellectual skill. To put this in other words, important inputs to the process by which a firm creates competitive advantage are intellectual resources. These intellectual resources are used to invent such things as innovative products, efficient production and distribution processes, clever merchandising and marketing strategies, and supportive public policies.
Firms gain unique or competitive advantage from such intellectual resources when they are converted into intellectual property, or firm-specific assets. Caves (1996) refers to this class of property as proprietary assets. Examples include brand names, product reputation, trademarks, copyrights, patents, trade secrets, consumer loyalty, advertising copy, technological leadership, data-gathering and analytical capability, research and development outcomes, special relationships with suppliers, and uncommon knowledge about how to produce and sell a less expensive or superior product.

Proprietary assets have several attributes that are relevant to competitive advantage. They can differ in effect on productivity or market share from similar assets held by competing firms. The assets or their effects are mobile between markets. Their life spans are not short relative to the length of a firm’s investment decision, even though they may be depreciable or augmentable. They are often intangible. They often rest on a set of skills or a repertory of routines possessed by the firm’s management team and labour force. In essence, they are the set of holdings that allows the firm to differentiate itself (and its products and processes) from its rivals.

In recent years a large body of empirical research has emerged, documenting strong ties between a firm’s investment in proprietary assets and its success in world markets. The latter is generally measured as some variant of market share or rate of growth in sales, and sometimes as the ratio of market to book value of a firm’s stock (see UNCTC, 1992 for a survey). Consistent findings specific to the processed food sector have been reported by a number of researchers (for example, Horst, 1974; Connor, 1983; Handy and MacDonald, 1989; Henderson and Frank, 1990; Reed and Marchant, 1992; Overend and Connor, 1994; and Henderson, Vörös and Hirschberg, 1996).

As indicators of firm-specific advantage, expenditures on research and development (generally specified as the ratio of R&D expenditures to value of sales) have repeatedly been demonstrated to be a thoroughly robust measure. Advertising expenditures (specified as outlays for advertising as a percentage of sales) have proven to be nearly as significant. This is often reflected in the value of a firm’s brand names (Table 6). Other factors with generally consistent positive

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>$ million</th>
<th>Brand name</th>
<th>$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca-Cola</td>
<td>24 402</td>
<td>Hennessy</td>
<td>2 998</td>
</tr>
<tr>
<td>Budweiser</td>
<td>10 237</td>
<td>Heineken</td>
<td>2 684</td>
</tr>
<tr>
<td>Pepsi-Cola</td>
<td>9 641</td>
<td>Johnnie Walker Red</td>
<td>2 641</td>
</tr>
<tr>
<td>Nescafé</td>
<td>8 732</td>
<td>Hershay</td>
<td>2 308</td>
</tr>
<tr>
<td>Kellogg’s</td>
<td>8 413</td>
<td>Guinness</td>
<td>2 281</td>
</tr>
<tr>
<td>Campbell</td>
<td>3 894</td>
<td>Kraft</td>
<td>2 189</td>
</tr>
<tr>
<td>Nestlé</td>
<td>3 792</td>
<td>Smirnoff</td>
<td>2 188</td>
</tr>
</tbody>
</table>

impacts include a firm’s intensity of use of skilled management and labour (e.g. repertory of routines), the value of intangible assets (as a percentage of total assets), multiplant operations (economies of headquarter services), and multiproduct operations (economies of scope). Contrary to often-expressed beliefs, economies of scale seldom appear as a significant factor. This may in part be due to the relatively small size of food processing plants needed to achieve maximum scale efficiencies (Table 7).

Drawing on data compiled from annual reports of a sample of leading US food manufacturing firms, the correlation between market performance and the intensity of a firm’s R&D and advertising is represented in Table 8. Performance is specified in terms of two variables, a contrived “competitiveness index” based on a combination of earnings and international market share, and profitability. This reveals sizeable differences in both R&D and advertising intensity between firms classified as high or low on each performance measure, consistent with findings in the more technical studies cited earlier. For this sample, intangible assets perform less well as an indicator, showing little difference among the different sets of firms. Quite

Table 7. Minimum efficient size of US food processing plants

<table>
<thead>
<tr>
<th>Industry</th>
<th>Minimum efficient size&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cane sugar refining</td>
<td>12.01</td>
</tr>
<tr>
<td>Roasted coffee</td>
<td>5.82</td>
</tr>
<tr>
<td>Pet food</td>
<td>3.02</td>
</tr>
<tr>
<td>Canned specialties</td>
<td>2.59</td>
</tr>
<tr>
<td>Dehydrated soups</td>
<td>2.26</td>
</tr>
<tr>
<td>Cookies and crackers</td>
<td>2.04</td>
</tr>
<tr>
<td>Beet sugar refining</td>
<td>1.87</td>
</tr>
<tr>
<td>Shortening and cooking oils</td>
<td>1.75</td>
</tr>
<tr>
<td>Malt beverages</td>
<td></td>
</tr>
<tr>
<td>Flavouring extracts</td>
<td></td>
</tr>
<tr>
<td>Frozen fruits and vegetables</td>
<td>0.92</td>
</tr>
<tr>
<td>Flour milling</td>
<td></td>
</tr>
<tr>
<td>Confectionery products</td>
<td></td>
</tr>
<tr>
<td>Prepared meats</td>
<td></td>
</tr>
<tr>
<td>Canned fruit and vegetables</td>
<td>0.17</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>0.08</td>
</tr>
</tbody>
</table>

1. Output of median plant as a percentage of industry shipments.

Table 8. Input intensity and competitive performance, leading US food manufacturers, 1995/96

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Competitiveness index&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Profitability&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5-1.0</td>
<td>0.0-0.5</td>
</tr>
<tr>
<td>R&amp;D expenditures/total sales</td>
<td>1.26%</td>
<td>0.56%</td>
</tr>
<tr>
<td>Advertising expenditures/total sales</td>
<td>11.22%</td>
<td>4.46%</td>
</tr>
<tr>
<td>Intangible assets/total assets</td>
<td>27.60%</td>
<td>30.30%</td>
</tr>
<tr>
<td>Competitiveness index, mean</td>
<td>0.74</td>
<td>0.38</td>
</tr>
<tr>
<td>Profit rate, mean</td>
<td>10.10%</td>
<td>7.70%</td>
</tr>
</tbody>
</table>

1. Combined rate of earnings on assets and international sales as a share of total sales, indexed to 1 for the highest firm.
2. Net earnings as a percentage of total assets.
Source: Original data.
possibly, this reflects the imperfect nature of measuring the value of intangibles, more than the lack of discriminating power. These data also suggest that profitability is a poor indicator of competitiveness, as constructed herein, but that competitiveness is an indicator of profitability.

To recap, this assessment indicates that competitive success among leading processed food firms is strongly influenced by the intensity with which firms use intellectual inputs that take the form of proprietary or firm-specific assets. Of crucial importance are research and development activities and advertising, particularly that aimed at building brand equity. These are activities that are generally conducted as part of headquarter services by multiplant and multiproduct firms. It is reasonable, therefore, to expect that the dominant firms in the processed food sector will be those demonstrating these characteristics, i.e. multiplant and multiproduct firms exhibiting brand leadership with skilled headquarters staff providing large inputs of advertising, research and development, and other types of intellectual resources. This is not to suggest, however, that physical ingredients are unimportant inputs. The issue of ingredient acquisition and management is taken up later in the chapter.

Demand

Conventional thought ties the size of a firm's home market to its ability to achieve economies of scale in plant operations and thus, to its ability to be cost-competitive in both home and foreign markets. In recent thinking, however, the character of product demand faced by firms in their primary market has taken on more dynamic implications. Specifically, contemporary concepts now focus on linkages between the nature of the primary consumer demands confronting a firm and the firm's ability to establish “first mover” advantages in the market-place. The logic follows along this line. A firm is more attuned to consumer preferences in its primary market because of that market's relative importance. Usually this is facilitated by physical and cultural proximity, i.e. much of the firm's facilities, management and labour force are located there. Further, key headquarter services such as market research are normally carried out there. This results in a clearer picture for the firm of the characteristics of consumer demand and a more sensitive early alert to emerging trends and changing consumer interests than is typically the case in secondary markets. Further, not only does the firm get greater insight into changing consumer preferences, but because of the market's relative significance, the firm is more inclined to respond with product and marketing innovations.

While lacking unanimous agreement, there is evidence that food consumption patterns around the world are converging (Table 9), and that changes in food consumption in some countries lead changes in others (Table 10). Both population mobility and market globalisation would seem to enhance these trends. The implication is, firms with primary markets in certain countries gain advantages over others in detecting
change in food demand, and in creating the ability to rapidly and efficiently respond with new products and merchandising strategies. A relevant question is, therefore, what are the characteristics of consumer demand in markets that appear to be at the leading edge of emerging consumption patterns?

Econometric studies of food demand show that as much as 97 per cent in annual variation in per capita consumption can be explained with just three variables: real household income, product price, and price of substitute products (Huang, 1985). Yet in reality, changes in food demand seem somewhat more complex. Other factors such as demographics (e.g. ethnic pluralism, family size, female employment, level of education) and preferences and attitudes (e.g. desire for variety, beliefs about nutrition and health) appear to be quite influential (Senauer et al., 1991).

In the United States, this is playing out in a number of ways. For example, the demand for variety has led to increased interest in the use of bioengineering to produce “designer foods”, encouraged product differentiation, and created competitive advantage for firms able to generate economies of scope. Both high real incomes and high incidences of working women have increased demand for convenience foods, including “oven-ready” prepared entrées and complementary hors-d’œuvres and side

| Table 9. Convergence in food consumption: coefficients of variation in food consumption across 29 European countries (kg/capita) |
|-----------------|-----------------|
|                  | 1961           | 1990 |
| Alcoholic beverages | 70.0           | 52.5 |
| Cereals          | 31.6           | 30.1 |
| Eggs             | 47.3           | 31.3 |
| Fruit            | 58.5           | 42.4 |
| Meat             | 39.8           | 28.8 |
| Milk             | 43.4           | 31.2 |
| Pulses           | 99.1           | 80.5 |
| Starchy roots    | 45.0           | 43.1 |
| Sugar            | 41.4           | 21.8 |
| Vegetables       | 43.5           | 42.6 |
| Source:          | Traill, 1996.  |

| Table 10. Coefficients of correlation in changes in per capita food consumption in Western Europe, 1984-89, and the United States, 1980-85 and 1985-90 |
|---------------------------------------------------------------------------------
| Twenty-five food and beverage products | 0.686* | 0.012 |
| Nine fresh food products              | 0.735* | 0.268 |
| Seventeen preserved food products     | 0.669* | –0.052 |
| Eight dairy and oil products          | 0.930* | –0.083 |
| * Significantly different from 0 at the 5 per cent confidence level. |

change in food demand, and in creating the ability to rapidly and efficiently respond with new products and merchandising strategies. A relevant question is, therefore, what are the characteristics of consumer demand in markets that appear to be at the leading edge of emerging consumption patterns?
dishes, often sold under a single brand name with a full-line merchandising approach. Also stimulated has been demand for snack foods, restaurant meals, and “one-handed” foods (e.g. those that can be held in one hand while the other hand is used to drive an automobile). Belief that nutrition and human health are inexorably linked has led to consumer demand for nutrition labelling and increased attention to food safety, and has stimulated such industry responses as new products or product variations with specific health claims (e.g. no fat, no cholesterol) and the marketing of nutriceuticals, i.e. foods combining nutrients and pharmaceuticals (e.g. foods that cure). Higher levels of education have improved understanding of linkages between how things are produced and environmental quality, leading to consumer demands for environmentally friendly foods and industry responses such as ecolabelling and organic products.

At the firm level, these changes in demand have resulted in increased attention to product innovation and quality control, and greater use of advertising, product promotions, brands and trademarks to convey product attributes and consistency in the delivery of these attributes. As firms build their capacity for such response in their primary market, they are at the same time creating the ability to lead demand changes in other markets. International quality and environmental standards, such as the ISO 9000 and 14000 regimes, facilitate firms achieving, and markets accepting, vigorous quality control and product consistency.

The implications of how demand conditions affect expectations regarding the character of firms that will be dominant in the processed food sector now seem clear. Firms with primary focus on those markets characterised by diverse, mobile, well-informed and educated, and high-income populations will be those that are best prepared to respond in a highly competitive manner to changes in consumer demand, and to lead those changes through product and merchandising strategies. Further, the demands now being expressed by consumers in these markets are good indicators of future demands in other markets.

Rivalry

The intensity of rivalry both in how rewards within a firm are structured and how the firm behaves in its markets has been shown to strongly influence competitive advantage. In terms of the structure of rewards, some firms emphasize long-term growth while others give more consideration to short-term earnings. Sometimes these differences follow national lines. For example, the United States has a financial environment wherein large blocs of corporate stock are traded frequently by institutional investors interested in short-term capital gains. In this environment, corporate attention tends to be focused on short-term earnings by the use of stock options as a major part of executive compensation. By contrast, in nations such as Japan and Switzerland where banks hold both corporate debt and stock, greater emphasis tends to be placed on long-term capital appreciation. Tax regimes can also figure in. In the case of the United States, all
capital gains are taxed as ordinary income, whereas in some other nations long-term gains are taxed at lower rates, thus becoming a preferred means of compensation. In firms oriented toward short-term earnings, rivalry among employees is often encouraged through such things as rapid promotions for outstanding work and annual bonuses tied to individual performance.

Rivalry within the management structure of a firm and an orientation toward short-term earnings seem to be well suited to firms in the processed food sector. While substantial sunk costs are made in proprietary assets such as brand names and new product development, those assets tend to build a shelter under which frequent change occurs. For example, roughly 250 mergers and acquisitions occur annually among US food manufacturing firms (Table 11), and 12,000-15,000 new food products or product variations are brought to market each year by these firms (Table 12). Thus, structuring incentive systems within firms to encourage short-term earnings rather than

<p>| Table 11. Mergers involving US food manufacturing firms |
|--------------------------|-------------------|</p>
<table>
<thead>
<tr>
<th><strong>Year</strong></th>
<th><strong>Number of mergers</strong></th>
<th><strong>Year</strong></th>
<th><strong>Number of mergers</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>225</td>
<td>1989</td>
<td>277</td>
</tr>
<tr>
<td>1984</td>
<td>225</td>
<td>1990</td>
<td>208</td>
</tr>
<tr>
<td>1985</td>
<td>291</td>
<td>1991</td>
<td>181</td>
</tr>
<tr>
<td>1986</td>
<td>347</td>
<td>1992</td>
<td>217</td>
</tr>
<tr>
<td>1987</td>
<td>301</td>
<td>1993</td>
<td>266</td>
</tr>
<tr>
<td>1988</td>
<td>351</td>
<td>1994</td>
<td>232</td>
</tr>
</tbody>
</table>

Source: Gallo, 1996.

<p>| Table 12. Number of new products introduced by US food manufacturers |
|--------------------------|-------------------|</p>
<table>
<thead>
<tr>
<th><strong>Category</strong></th>
<th><strong>1991</strong></th>
<th><strong>1992</strong></th>
<th><strong>1993</strong></th>
<th><strong>1994</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby food</td>
<td>95</td>
<td>53</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>Bakery foods</td>
<td>1,631</td>
<td>1,508</td>
<td>1,420</td>
<td>1,636</td>
</tr>
<tr>
<td>Baking ingredients</td>
<td>355</td>
<td>346</td>
<td>383</td>
<td>544</td>
</tr>
<tr>
<td>Beverages</td>
<td>1,367</td>
<td>1,538</td>
<td>1,845</td>
<td>2,250</td>
</tr>
<tr>
<td>Ready-to-eat cereals</td>
<td>104</td>
<td>122</td>
<td>99</td>
<td>110</td>
</tr>
<tr>
<td>Condiments</td>
<td>1,885</td>
<td>2,068</td>
<td>3,148</td>
<td>3,271</td>
</tr>
<tr>
<td>Candy, gum and snacks</td>
<td>2,787</td>
<td>2,555</td>
<td>2,042</td>
<td>2,461</td>
</tr>
<tr>
<td>Dairy</td>
<td>1,111</td>
<td>1,320</td>
<td>1,099</td>
<td>1,323</td>
</tr>
<tr>
<td>Desserts</td>
<td>124</td>
<td>93</td>
<td>158</td>
<td>215</td>
</tr>
<tr>
<td>Entrees</td>
<td>808</td>
<td>698</td>
<td>631</td>
<td>694</td>
</tr>
<tr>
<td>Fruits and vegetables</td>
<td>356</td>
<td>276</td>
<td>407</td>
<td>487</td>
</tr>
<tr>
<td>Pet food</td>
<td>202</td>
<td>179</td>
<td>276</td>
<td>161</td>
</tr>
<tr>
<td>Processed meat</td>
<td>798</td>
<td>785</td>
<td>454</td>
<td>565</td>
</tr>
<tr>
<td>Side dishes</td>
<td>530</td>
<td>560</td>
<td>680</td>
<td>980</td>
</tr>
<tr>
<td>Soups</td>
<td>265</td>
<td>211</td>
<td>248</td>
<td>264</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12,398</td>
<td>12,312</td>
<td>12,897</td>
<td>15,006</td>
</tr>
</tbody>
</table>

Source: Gallo, 1996.
long-term capital gains appears to correspond well with processed food firms that achieve competitive advantage through operating flexibility that matches with changes in consumer demand and other market conditions.

While rivalry within firms appears to be important to competitive success in this sector, rivalry among firms in their home market consistently shows up in research results as a leading factor associated with competitive advantage. This is in direct contrast to the often-stated belief that competition is wasteful because it leads to duplication and prevents firms from achieving economies of scale. That view is advanced by those who advocate the concept of "national champions", where one or two firms in an industry are chosen for special treatment so that they can build scale advantages to compete globally.

Empirical evidence in most industries, including food manufacturing, refutes the national champion argument. In summarising a great deal of study across a wide range of industries, Porter (1990) concluded, "[Firms in] nations with leading world positions often have a number of strong local rivals, even in small countries such as Switzerland and Sweden. This is true not only in fragmented industries but also in industries with substantial economies of scale" (p. 117). Specific to processed food industries, a number of econometric studies have reported statistically significant relationships between intensity of domestic competition, usually specified as some variation of home market concentration ratio, and external market competitiveness, usually specified as some variation of export propensity (Field and Pagoulatos, 1996; Henderson, Vörös and Hirschberg, 1996; Kim and Marion, 1995; Henderson and Frank, 1990). Consistently, these studies show that the lower the level of seller concentration in a food manufacturer's home market, the greater the firm's competitive success in external markets.

In essence, domestic rivalry motivates firms to innovate, lower their costs of doing business, and improve quality and service more so than they would absent such local market challenge. Without local rivalry, firms are more inclined to rest on conventional national advantages associated with resource endowments. With local rivalry, national resource endowments broker no unique advantage to any firm. Thus, firms are driven to more intellectual pursuits in order to achieve and maintain competitive advantage. While the competitive benefits of any given innovation typically depreciate over time, ongoing rivalry stimulates ongoing innovation, both as a means of gaining market share and out of fear of falling behind.

In forming future expectations, the lesson seems clear. Food processing firms that operate in markets characterised by vigorous rivalry, and that organise themselves in ways to stimulate a sense of internal rivalry within their corporate structure, are likely to be the dominant players on the global scene. Those that are protected at home by preferential governmental treatment, including the lack of
vigorous pursuit of national pro-competition or anti-trust laws, are not likely to be among the industry leaders.

**Related firms**

There are two sets of related firms that impact on the competitive performance of processed food firms: those that are vertically interdependent, such as upstream ingredient suppliers and downstream distributors, and those that are sources of technological spillovers. Access to and working relationships with these two sets of firms affect not only the commercial advantage of processed food firms, but also where firms elect to do business. The first set of connections, i.e. to competitive advantage, is discussed here. Implications for location of business enterprises are examined in Part II. How firms organise to do business with related firms is taken up in Part III.

Access to ingredients and other supplies is of obvious importance to any manufacturing industry. Access to retailers and other distributors is of obvious importance to any consumer goods industry. Food processing fits in both categories. As firms in these vertically related industries are more efficient, progressive and competitive, the greater is the advantage to the associated processed food firm. Competitive vertically related firms not only provide crucial input supply and product distribution services, but are also sources of market intelligence, process and product innovations, and joint problem-solving.

These vertical industry relationships are ever the more important in a sector such as processed food that is characterised by rapid product and process innovation, significant product differentiation, substantial brand equity, and market segmentation. This is reflected in a substantial restructuring of economic activity within the food chain (Figure 2). A half-century ago, in the United States for example, farms and their suppliers accounted for 57 per cent of the value added in the chain, and the entire set of downstream food processing and distribution industries 43 per cent. Now, the situation is greatly different. The contribution to the value of consumer food purchases by farms and the farm input industries is just over 22 per cent while food processing, grocery wholesaling and retailing, and food service/eating places each account for about 24-28 per cent.

This restructuring has resulted in a substantial increase in interfirm interdependence within the food chain. For example, a “quick service” restaurant chain is dependent upon a specialised ground beef/food service provisioner who is dependent upon specialty beef processor who is dependent upon a slaughterhouse operator specialising in young, lean, standard grade cattle. A grocery retailer is dependent upon a rack jobber for inventory and display of snack foods; the jobber in turn is dependent upon a specialised wholesale snack food distribution house which is
Figure 2. Value added in the US food chain
(Percentage by sector)

Source: Adapted from Gallo, 1996.

dependent upon a potato chip processor who is dependent upon both a vegetable oil supplier and a chipping potato handler, each of whom is dependent on others further upstream in the food chain. Likewise, the upstream firms are dependent upon the downstream enterprises as their source of demand.

These vertical interdependencies increase substantially in light of brand equity (e.g., the development and promotion of branded products and the supply infrastructure and quality control regimes behind those brands that are necessary to assure reliable delivery of uniform-quality products). From the food processor perspective, this motivates specification buying of unprocessed farm commodities, semi-processed bulk ingredients, and other inputs, usually under some form of supply contract, and equally close ties to downstream provisioners, wholesalers, and retailers, usually through various forms of promotional allowances, performance incentives, and other tie-in arrangements.

Means of co-ordinating these increasingly interdependent activities are taken up in Part III. However, from the perspective of competitiveness, the greater the efficacy of a food manufacturer’s vertical co-ordination process in terms of inducing things such as product upgrading, quality control, process innovation, and market-enhancing merchandising techniques among its suppliers and distributors, the greater its market advantage. This process is enhanced by co-operative research and development, joint problem-solving, and the sharing of both supply and market information. Achieving
these benefits has implications for a firm’s location decisions, as subsequently addressed in Part II. But it also points out the importance of the existence of a group of progressive vertically interdependent enterprises to firms in the processed food sector. In short, it can be expected that the dominating processed food firms will be those located in proximity to, and with close working ties to, equally competitive up- and downstream enterprises.

The second set of related firms is less transparent but nonetheless significant. These are firms that are in different lines of business, but that share ties to some similar processes or technology. Where similar technology to that used in processed food is developed in other industries, close ties to those industries can facilitate technology adoption and spillover into food. Examples include such things as enzymes and wastewater treatment technology developed in the petrochemical industry, flavourings and biotechnology developed in the pharmaceutical industry, and just-in-time inventory management systems perfected in automotive manufacturing. As with vertically related firms, processed food firms operating in environments where such different but related firms also operate can gain an advantage from spillover adoptions. In some cases there may be formal agreements for the joint development of technology application; in other cases, geographical proximity facilitates hiring experts with the technological and scientific skills necessary to create these spillovers.

Regarding expectations for the processed food sector, this logic suggests that firms closely associated with highly industrialised environments are likely to have a competitive advantage over others. This is of particular importance to a firm’s headquarter activities such as research and development. Thus, it appears that the competitive momentum of processed food firms based in the more highly industrialised parts of the world has good prospects for continuing.

II. LOCATION OF PRODUCTION

Conventional views of industrial economics hold that decisions by firms regarding where to locate their operations are conditioned by such things as a nation’s endowment of labour and natural resources, the size of a nation’s market and income therein, and border restrictions (e.g. tariffs and non-tariff trade barriers, constraints on foreign investment). In accord with such views, one would expect that, in the presence of trade barriers, major processed food operations would tend to be located in large, high-income countries with relatively abundant endowments of labour, capital, and natural resources such as energy, water, and land needed for agricultural and food production. Indeed, this is a pattern that is empirically observed. For example, the world’s 50 largest food processing firms at the beginning of the decade were all based in large industrial countries: 22 in the United States, 14 in the United Kingdom, 7 in Japan, and the rest in Australia, Canada, France, Italy, the Netherlands, and Switzerland (Table 13).
<table>
<thead>
<tr>
<th>Rank</th>
<th>Company Name</th>
<th>Headquarters</th>
<th>Food sales ($ Mil)</th>
<th>Food as a percentage of total sales</th>
<th>Foreign as a percentage of total sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Philip Morris Cos. Inc.</td>
<td>United States</td>
<td>30 452.3</td>
<td>70.6</td>
<td>27.3</td>
</tr>
<tr>
<td>2</td>
<td>Nestle S.A.</td>
<td>Switzerland</td>
<td>28 103.7</td>
<td>96.0</td>
<td>98.1</td>
</tr>
<tr>
<td>3</td>
<td>Unilever N.V.</td>
<td>Neth/UK</td>
<td>18 128.0</td>
<td>50.0</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>IBP</td>
<td>United States</td>
<td>10 185.3</td>
<td>100.0</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td>PepsiCo Inc.</td>
<td>United States</td>
<td>9 091.7</td>
<td>65.6</td>
<td>17.9</td>
</tr>
<tr>
<td>6</td>
<td>Grand Metropolitan</td>
<td>United Kingdom</td>
<td>9 528.1</td>
<td>60.8</td>
<td>49.8</td>
</tr>
<tr>
<td>7</td>
<td>Anheuser-Busch, Inc.</td>
<td>United States</td>
<td>9 208.7</td>
<td>97.1</td>
<td>NA</td>
</tr>
<tr>
<td>8</td>
<td>Kirin Brewery Co., Ltd.</td>
<td>Japan</td>
<td>8 946.2</td>
<td>95.0</td>
<td>64.8</td>
</tr>
<tr>
<td>9</td>
<td>Coca-Cola Co.</td>
<td>United States</td>
<td>8 908.2</td>
<td>99.4</td>
<td>55.1</td>
</tr>
<tr>
<td>10</td>
<td>Allied-Lyons</td>
<td>United Kingdom</td>
<td>7 969.8</td>
<td>100.0</td>
<td>40.4</td>
</tr>
<tr>
<td>11</td>
<td>Con-Agra, Inc.</td>
<td>United States</td>
<td>7 084.9</td>
<td>62.5</td>
<td>NA</td>
</tr>
<tr>
<td>12</td>
<td>Archer Daniels Midland Co.</td>
<td>United States</td>
<td>6 977.4</td>
<td>88.0</td>
<td>NA</td>
</tr>
<tr>
<td>13</td>
<td>BSN Groupe</td>
<td>France</td>
<td>6 859.1</td>
<td>90.5</td>
<td>36.9</td>
</tr>
<tr>
<td>14</td>
<td>MM/Mars</td>
<td>United States</td>
<td>6 750.0</td>
<td>90.0</td>
<td>NA</td>
</tr>
<tr>
<td>15</td>
<td>Erindania Gruppo Ferruzzi</td>
<td>Italy</td>
<td>6 438.1</td>
<td>100.0</td>
<td>79.8</td>
</tr>
<tr>
<td>16</td>
<td>Sara Lee Corp.</td>
<td>United States</td>
<td>6 424.0</td>
<td>45.1</td>
<td>32.5</td>
</tr>
<tr>
<td>17</td>
<td>The H.J. Heinz Company</td>
<td>United States</td>
<td>5 800.0</td>
<td>100.0</td>
<td>40.1</td>
</tr>
<tr>
<td>18</td>
<td>RJR/Nabisco Inc.</td>
<td>United States</td>
<td>5 783.0</td>
<td>45.3</td>
<td>13.4</td>
</tr>
<tr>
<td>19</td>
<td>CPC International, Inc.</td>
<td>United States</td>
<td>5 781.0</td>
<td>100.0</td>
<td>55.5</td>
</tr>
<tr>
<td>20</td>
<td>Campbell Soup Co.</td>
<td>United States</td>
<td>5 672.1</td>
<td>100.0</td>
<td>25.4</td>
</tr>
<tr>
<td>21</td>
<td>Borden, Inc.</td>
<td>United States</td>
<td>5 660.6</td>
<td>74.6</td>
<td>24.0</td>
</tr>
<tr>
<td>22</td>
<td>Guiness PLC</td>
<td>United Kingdom</td>
<td>5 063.9</td>
<td>97.7</td>
<td>66.7</td>
</tr>
<tr>
<td>23</td>
<td>Bass PLC</td>
<td>United Kingdom</td>
<td>4 969.6</td>
<td>73.1</td>
<td>9.7</td>
</tr>
<tr>
<td>24</td>
<td>Hillsdown Holdings PLC</td>
<td>United Kingdom</td>
<td>4 956.6</td>
<td>79.8</td>
<td>30.0</td>
</tr>
<tr>
<td>25</td>
<td>Nippon Meat Packers, Inc.</td>
<td>Japan</td>
<td>4 930.7</td>
<td>100.0</td>
<td>12.9</td>
</tr>
<tr>
<td>26</td>
<td>Asahi Breweries, Ltd.</td>
<td>Japan</td>
<td>4 859.8</td>
<td>96.9</td>
<td>96.1</td>
</tr>
<tr>
<td>27</td>
<td>Cadbury Schweppes PLC</td>
<td>United Kingdom</td>
<td>4 789.7</td>
<td>100.0</td>
<td>59.0</td>
</tr>
<tr>
<td>28</td>
<td>Quaker Oats Co.</td>
<td>United States</td>
<td>4 789.4</td>
<td>83.7</td>
<td>28.8</td>
</tr>
<tr>
<td>29</td>
<td>Associated British Foods PLC</td>
<td>United Kingdom</td>
<td>4 674.3</td>
<td>100.0</td>
<td>37.7</td>
</tr>
<tr>
<td>30</td>
<td>Kellogg Co.</td>
<td>United States</td>
<td>4 651.7</td>
<td>100.0</td>
<td>36.8</td>
</tr>
<tr>
<td>31</td>
<td>John Labatt</td>
<td>Canada</td>
<td>4 633.3</td>
<td>100.0</td>
<td>28.0</td>
</tr>
<tr>
<td>32</td>
<td>Dalgerty PLC</td>
<td>United Kingdom</td>
<td>4 609.1</td>
<td>57.5</td>
<td>63.8</td>
</tr>
<tr>
<td>33</td>
<td>United Biscuits PLC</td>
<td>United Kingdom</td>
<td>4 588.3</td>
<td>100.0</td>
<td>39.6</td>
</tr>
<tr>
<td>34</td>
<td>Seagram Company Ltd.</td>
<td>Canada</td>
<td>4 436.1</td>
<td>100.0</td>
<td>95.4</td>
</tr>
<tr>
<td>35</td>
<td>Ralston Purina Co.</td>
<td>United States</td>
<td>4 131.9</td>
<td>62.1</td>
<td>27.5</td>
</tr>
<tr>
<td>36</td>
<td>Tate &amp; Lyle PLC</td>
<td>United Kingdom</td>
<td>4 082.6</td>
<td>72.1</td>
<td>80.2</td>
</tr>
<tr>
<td>37</td>
<td>General Mills Inc.</td>
<td>United States</td>
<td>3 998.7</td>
<td>71.1</td>
<td>9.8</td>
</tr>
<tr>
<td>38</td>
<td>Chiquita Brands International</td>
<td>United States</td>
<td>3 822.8</td>
<td>100.0</td>
<td>NA</td>
</tr>
<tr>
<td>39</td>
<td>Taiyo Fishery Co., Ltd.</td>
<td>Japan</td>
<td>3 804.3</td>
<td>45.3</td>
<td>NA</td>
</tr>
<tr>
<td>40</td>
<td>Elders IXL Ltd.</td>
<td>Australia</td>
<td>3 620.1</td>
<td>25.3</td>
<td>37.1</td>
</tr>
<tr>
<td>41</td>
<td>Heiniken N.V.</td>
<td>Netherlands</td>
<td>3 558.5</td>
<td>97.2</td>
<td>76.8</td>
</tr>
<tr>
<td>42</td>
<td>Booker PLC</td>
<td>United Kingdom</td>
<td>3 477.7</td>
<td>82.2</td>
<td>8.3</td>
</tr>
<tr>
<td>43</td>
<td>Proctor and Gamble</td>
<td>United States</td>
<td>3 318.0</td>
<td>13.8</td>
<td>44.7</td>
</tr>
<tr>
<td>44</td>
<td>Itoham Foods Inc.</td>
<td>Japan</td>
<td>3 292.1</td>
<td>100.0</td>
<td>NA</td>
</tr>
<tr>
<td>45</td>
<td>Unigate PLC</td>
<td>United Kingdom</td>
<td>3 012.1</td>
<td>73.2</td>
<td>18.0</td>
</tr>
<tr>
<td>46</td>
<td>Yamazaki Baking Co.</td>
<td>Japan</td>
<td>3 008.8</td>
<td>100.0</td>
<td>NA</td>
</tr>
<tr>
<td>47</td>
<td>Ranks Hovis McDougall PLC</td>
<td>United Kingdom</td>
<td>2 942.3</td>
<td>97.8</td>
<td>22.1</td>
</tr>
<tr>
<td>48</td>
<td>Ajinomoto Co., Inc.</td>
<td>Japan</td>
<td>2 616.1</td>
<td>76.3</td>
<td>NA</td>
</tr>
<tr>
<td>49</td>
<td>Castle &amp; Cook, Inc.</td>
<td>United States</td>
<td>2 546.0</td>
<td>93.7</td>
<td>26.8</td>
</tr>
<tr>
<td>50</td>
<td>Tyson Foods, Inc.</td>
<td>United States</td>
<td>2 538.2</td>
<td>100.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Also by conventional belief, in a liberalised trade environment, transportation costs between nations with relatively large resource endowments and nations with large, high-income populations become an important locational consideration. A combination of technological advancement and national deregulation has been shown to result in transportation cost efficiencies that substantially enhance international trade (MacDonald, 1996). Augmented by such international shipping cost gains, this belief has resulted in such predictions as “the giant sucking sound” of factories moving from the United States to Mexico when trade was liberalised between those countries under the North America Free Trade (NAFTA) regime. It has also led some to predict that, as trade rules are liberalised multilaterally, less industrialised nations will become increasingly attractive homes for firms in the processed food sector. That is, greater geographical dispersion.

Further, it is usual in industrial economic thinking to argue that as the number of firms in the same industry increases at one location, the profitability of all declines. This is held to occur because increased competition in that region’s product market drives output prices down and in the factor market drives input costs up. Again, this convention leads to predictions of geographical dispersion.

New ideas are being incorporated into industrial location theory, however. These yield outcomes that can contrast sharply with predictions based on conventional thought. For example, Krugman considers the role of labour mobility (1991). In this case, firms located close to large, high-income markets pay higher real wages than do those in more distant locations that have higher costs for reaching customers. Consequently, the former attract labour inflow, which further enlarges the market. The end result is concentration rather than dispersion of firms in the industry.

Others have introduced the concept of agglomeration (Rivera-Batiz, 1988; Venables, 1994). This refers to the aggregation of related firms at one location. In essence, it occurs when an increase in the number of firms at a given location results in greater earnings for all firms at that location. It ties directly to the earlier discussion of vertically interdependent firms as a source of competitive advantage. The incentive to agglomerate follows from the vertical relationship between industries. In the case of processed food, firms in the upstream industries (e.g. ingredient supply) benefit from locating close to their market (e.g. food processing firms). Benefits take such forms as lower transportation costs, improved access to and sharing of market intelligence, joint resolution of problems, and more effective co-ordination between upstream and downstream firms. Likewise, downstream firms benefit from being located close to their suppliers.

Add to this scenario product differentiation, which is a defining characteristic of processed food. With product differentiation, a degree of unique specificity is introduced into food processor-input supplier relationships (and, for that matter, into food processor-food distributor relationships further downstream, and
ingredient producer-commodity supplier relationships further upstream). For example, an ingredient produced by one upstream firm for a given downstream food processor is itself often differentiated from similar ingredients supplied by this and other upstream firms to other food processors.

Where a given food processor uses differentiated (firm-specific) ingredients from a combination of different suppliers, and/or a given supplier provides differentiated (firm-specific) ingredients to a group of different processors, gains from agglomeration are evident. In this case, agglomeration takes the form of a clustering of upstream producers of differentiated ingredients and downstream producers of differentiated consumer-ready foods. Within this group of vertically related firms, each downstream firm may acquire somewhat unique inputs from a number of upstream firms. And, each upstream firm may supply somewhat unique inputs to each of a number of downstream firms. By agglomeration among a number of both up- and downstream firms, this complex web of vertical relationships can be carried out in an efficient and effective manner, thus reducing costs to all firms in the cluster.

Consider the cost of vertical co-ordination in this case to be a component of transaction costs between a food processor and its ingredient supplier(s). Venables (1993) has demonstrated that under conditions such as those described above, with modest levels of trade or transaction costs, agglomeration is the most efficient form of industrial organisation. Both (upstream and downstream) industries locate in the same country. This, in turn, lends support to the concept of an industrial base. Once some firms in an industry develop a base of operations at a specific location, given industrial characteristics such as those in the processed food sector, other firms in similar and related industries are drawn to the same location. That is, an industrial base is formed, and geographical concentration of related industries arises therein.

What, then, are the characteristics of a location that gives rise to an industrial base? Here, evidence is less transparent. Clearly, under the concept of agglomeration, initial geographical clustering in an industry with the characteristics of food processing leads to greater geographical concentration rather than dispersion. This supports the expectation that geographical concentration will continue to be evidenced in processed foods, and that much of this will be focused in countries where the sector is already clustered. But, do other locations offer suitable attractions for the forming of new clusters? If so, what are these attractions?

For the processed food sector, size of the home market appears rather consistently to be one of the chief draws, particularly for the large, multinational firms that dominate this sector. That is, food processing is drawn to nations with relatively large, high-income populations. Even though local food processors can be found nearly everywhere, most are relatively small. The world's 200 largest food
manufacturing firms in 1990, for example, accounted for an estimated one-third of total global production (Henderson and Handy, 1994). Of these, all but eleven were based in the industrialised countries of Western Europe and North America, plus Japan and Australia. Under a global scenario of progressive trade liberalisation, substantial income growth in heretofore less developed nations, particularly those with sizeable populations, could thus be a magnet for a new industrial cluster. Based on casual observation, in terms of inducing food sector development, the attraction of market size appears to be a more important outcome of multilateral trade liberalisation than are wage differentials.

Further, as Venables (1995) has demonstrated, economic integration (e.g., formation of common markets, customs unions, and free trade areas) can result in agglomeration within the integrated bloc of nations. To the extent that further market integration among nations occurs, this suggests that internal geographic clustering may ensue. That is, within such a bloc, the food processing sector may be increasingly drawn to those locations with large concentrations of factors such as proprietary assets (e.g., R&D, brand equity, and other intellectual resources). These are often countries with high educational standards and achievements (Porter, 1990), inducements for research and development (Hines, 1994), and strong legal protections for intellectual property (Lee and Mansfield, 1996).

To recapitulate, modern views of industrial location theory alter expectations for future locations of firms that dominate the food processing sector. More traditional views suggest that future growth would be driven by things such as relatively low wage rates and the relative abundance of natural resources, combined with market size effects. With trade liberalisation, this would result in geographic dispersion. Modern concepts, by contrast, suggest that industrial clustering may be more important, particularly when also considered along with relative market size (as reflected in population and income). Industrial clustering, in turn, while to some extent a product of historical accident, appears to be strongly influenced by intellectual resources and associated proprietary or firm-specific assets. This argues that existing patterns of geographical concentration are likely to remain – perhaps with new industrial clusters emerging in large, rapidly developing countries where intellectual resources are nurtured through education, and intellectual property enjoys protection of law. Given the characteristics of processed food industries, the modern view seems likely to prevail in this sector.

III. ORGANISATION OF FIRMS

Neoclassical concepts regarding how firms are organised to do business have a long and illustrious history, dating from Coase’s publication of his seminal work on the nature of the firm in 1937. These concepts focus largely on answering the
question, for what activities does a firm rely upon the market – that is, which are carried out by independent firms, and what activities does a firm take on itself – that is, internalise or integrate? Essentially, this is the firm’s “make or buy” decision regarding ingredients and other inputs. More recently, interest has expanded to activities that appear to fall somewhere in between, i.e. activities that are in some manner contracted out. Much of the attention in this latter area has focused on different types of contract including, inter alia, licences, franchises, joint ventures, strategic alliances, and various other instruments for vertical co-ordination.

In essence, Coase and his followers make the case that internalisation will occur when the costs associated with arm’s-length market acquisition are higher than the cost to the firm of producing the input itself. Incentives to internalise are tied directly to the existence of proprietary or firm-specific assets. Often, the value of these assets can be quickly dissipated by such things as disruptions in the orderly supply of critical ingredients (e.g. supplier shirking), or improper product handling such that quality is not preserved (e.g. distributor shirking). Because of the relative importance of such assets in food manufacturing (Table 14), the concept is particularly important here.

Specific to processed foods, Casson (1982) found that insufficient consumer information on quality and other product attributes has motivated firms to develop brands and related trademarks. Through complementary advertising and quality control, buyer uncertainty regarding a branded product has been reduced. Food firms then integrate vertically in order to assure the stability in quantity and quality of ingredient and product supply that is necessary to validate (actual or implied) attribute claims tied to the brand. This occurs because the financial risk associated with supply disruption, when dependent upon purchases through arm’s-length market transactions, is particularly high due to the investment sunk by the firm into building brand equity. Insufficient quantity of and/or off-quality in ingredient or product supply depreciates consumer confidence in the branded product, thus debasing its brand equity. By internalising upstream production, the firm gains direct control over its supply, thus enabling it to more fully protect its brand reputation. The incentive for upstream internalisation is as robust for a food distributor

<table>
<thead>
<tr>
<th>Table 14. Indicators of firm-specific assets of leading food manufacturing firms1 (circa 1990)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator</td>
</tr>
<tr>
<td>Number of food product brand names</td>
</tr>
<tr>
<td>Number of lines of processed food products²</td>
</tr>
<tr>
<td>Number of brands per line of food products</td>
</tr>
<tr>
<td>Intangible assets as a percentage of total assets</td>
</tr>
</tbody>
</table>

1. Drawn from a sample of 70 food manufacturing firms based in the US and 74 based in other countries.
2. Defined at the 4-digit level of the US standard industrial classification (SIC).

who has developed strong equity in a retailer brand (e.g. Marks & Spencer) as for a firm with a strong processor brand (e.g. Kellogg’s).

One of the currently unresolved issues is, which set of firms in the processed food sector will emerge as the driving force behind brand-building? That is, what firms will be dominant in forging vertical linkages, and in setting terms of contract? There appear to be two competing models (Cotterill, 1997). In one, dubbed by some the US model, major food manufacturing firms are the leading force, developing strong brands and product innovations, and forging upstream linkages to ingredient suppliers and downstream linkages to food wholesalers and retailers. In the other, sometimes labelled the UK model, retailers are more dominant. They develop strong retailer brands, are the source of many new product introductions, and originate upstream ties to food processors.

The answer to the question of which (if either) system will emerge triumphant in the future is not known with any degree of certainty. However, some contemporary developments argue for the manufacturer-led outcome. Building food brand equity depends on advertising, retail display (e.g. shelf space), and keen market intelligence on consumer behaviour. Branded foods are the most heavily advertised of all consumer goods. With emphasis on pan-national brands and the spread of pan-national commercial television, food manufacturers would seem to have an edge here.

Obviously, retailers have direct control over retail display. But, food processors have had much success in influencing how retailers use that display, through various types of shelving and promotional allowances and product rebates.

With the widespread adoption of product barcoding and the use of electronic checkout scanners, detailed information on consumer buying behaviour has become a commodity. Specialised firms such as A.C. Neilsen and Information Resources Inc. routinely buy scanner data from retailers and analyse and repackage it for any comer. The large food manufacturing firms are major customers. While retailers could change this balance by refusing to sell the raw data, they seem unlikely to do so in face of the corollary loss of information on competitors. All told, at this point the tilt seems to be toward the food manufacturing industries.

With increased globalisation in processed food markets, the importance of brand equity seems likely to become even greater. It remains unclear which principle, mutual recognition or multilateral harmonization, will emerge as the dominant means of rationalising standards of product identity and quality across national borders. While multilateral agreement on mutual recognition appears the easier to achieve, it has been shown that there is a propensity for both food producers and consumers to lobby for harmonization (Swinbank, 1990 and 1993). In either case, food brands would seem to rise in commercial significance. In the
case of mutual recognition, brands are a means for a firm to signal product consistency regardless of country of origin. In the case of harmonization, brands are a means for a firm to separate its products from the multitude of others that meet the same international standards.

A number of general cases for internalisation are well developed (Katz, 1989; Perry, 1989). Incentives derive from complex transactions where an arm’s-length market transaction cannot assure an efficient exchange. Some causes of failure in market transactions include moral hazard, risk-sharing, unequal information, opportunism, and double margins. Moral hazard arises, for example, where effort by the input supplier cannot be directly observed by the downstream firm. This can lead to shirking by the upstream firm and thus, supply problems downstream. Risk-sharing problems arise where, in the presence of uncertainty, the supplier shirks because of the possibility of a downstream event, over which the supplier has no control, that adversely affects joint earnings. Unequal information can also lead to shirking when the downstream firm knows the value of supplier effort but the supplier does not. Opportunism may arise by either party holding the other hostage for better terms of trade (price) once the second party has made a transaction-specific sunk (fixed) investment. Double margin problems can occur where, in the presence of some degree of market power at both the supplier and processor levels, both firms unilaterally reduce marketings to obtain higher prices, thus doubling the overall effect of profit margins in terms of raising price and reducing the quantity of consumer purchases.

In each case, internalisation, or integration by one firm into the vertically adjacent industry, has been shown to resolve the problem. At least conceptually, each of these situations can be envisioned in the processed food sector. As well, they can be visualised both upstream and downstream from food processing firms.

Contractual arrangements between vertically interdependent industries have been shown to offer solutions to these problems in many cases (Sheldon, 1996). Contracts fall somewhere between the polar organisational extremes of arm’s-length market transaction and vertical integration. In concept, contracts can be written to cover every contingency or eventuality that might arise between a processor and its suppliers or distributors. These are called complete contracts.

Contemporary understanding of contracts as a means of dealing with problems of internalisation has been substantially advanced by the work of Williamson (1975, 1979). Williamson uses the concept of transaction costs to reveal conditions under which it is more profitable for the firm to internalise than to deal with other vertically related firms by contract. He has shown that complete contracts are often inefficient because of the high cost of writing and enforcement. This gives rise to the use of incomplete contracts. Those are contracts that state the general nature of the obligations of the contracting parties but that, to reduce complexity, are mute on many contingent situations that might arise over the life of the contract (e.g. opportunistic behaviour, information
withholding). Where the probability of such a contingency is high, internalisation is preferred over contract.

Recently, considerable attention has focused on incomplete contracts (see Green et al. 1997, for example), which appear to have an expanding role in the food system. Empirical evidence suggests that, at least in the procurement of agricultural commodities for food processing in the United States, the combined use of contracts and vertical integration substantially exceeds arm's-length market procurement in a large number of cases; the use of both has generally increased in recent years; and the use of contracts is often preferred over integration (Table 15).

Incomplete contracts can take many forms, but for many analytical purposes can be lumped together under the general category of business networks (Rugman, 1997). Business networks are built on relationships among interdependent firms that are embedded in the social context of the firms. While some relationships may be spelled out in explicit contracts, many are institutionalised into mutual understandings and standard operating practices that arise out of joint problem-solving, common training regimes, revenue-sharing arrangements, and other ongoing collaborations. Granovetter (1985) has demonstrated that embeddedness inhibits opportunistic behaviour and facilitates

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Production and marketing contracts</th>
<th>Vertical integration</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broilers</td>
<td>92</td>
<td>92</td>
<td>7</td>
</tr>
<tr>
<td>Turkeys</td>
<td>60</td>
<td>65</td>
<td>12</td>
</tr>
<tr>
<td>Hatching eggs</td>
<td>70</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Market eggs</td>
<td>35</td>
<td>43</td>
<td>20</td>
</tr>
<tr>
<td>Milk, mfg. grade</td>
<td>25</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Milk, fluid grade</td>
<td>95</td>
<td>95</td>
<td>0</td>
</tr>
<tr>
<td>Market hogs</td>
<td>1</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Fed cattle</td>
<td>18</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Sheep/lamb</td>
<td>7</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Food grains</td>
<td>2</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Feed grains</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cotton</td>
<td>11</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Processing vegetables</td>
<td>85</td>
<td>83</td>
<td>10</td>
</tr>
<tr>
<td>Fresh vegetables</td>
<td>21</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Potatoes</td>
<td>45</td>
<td>55</td>
<td>30</td>
</tr>
<tr>
<td>Citrus fruit</td>
<td>55</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>Other fruit</td>
<td>20</td>
<td>40</td>
<td>20</td>
</tr>
</tbody>
</table>

1. Percentage of total production.
2. Excludes grain fed to livestock on the same farm.
information exchange, hence showing that business networks can be efficient methods of vertical organisation and thus, viable alternatives to vertical integration.

The concept of business network is perhaps most formalized in the Japanese keiretsu. In the Japanese brewing industry, for example, Kirin is part of the Mitsubishi keiretsu and it is the beer stocked at supermarkets that is part of that keiretsu. Sapporo beer is carried in the retail outlets associated with the Fuji group, and Asahi Breweries has been an exclusive supplier to the Sumitomo keiretsu for many years. Likewise, these breweries utilise suppliers tied to their respective networks.

The keiretsu approach of essentially exclusive vertical ties has not gained favour in North America and Europe, where behavioural norms are more individualistic and competitive. In these regions, the less rigidly structured strategic alliance has become a more common form of business network. Strategic alliances, while varying in structure and organisation, have many social embeddedness features that define, in a working manner, interfirm relationships. At the same time, they allow flexibility in terms of entry and exit of firms over time. In the food sector, these are sometimes joined with formal contractual arrangements (e.g. chicken grow-out contracts), particularly at the farm level where firms are more numerous and thus their performance is somewhat more difficult to monitor. But, more often they are more characterised by standard interfirm operating practices (e.g. joint development of products and processes, just-in-time ingredient supply, timely store-door product delivery, co-operative advertising). Such joint business practices are increasingly being codified in some form of interfirm revenue (or cost) sharing (e.g. licence or franchise fees, performance incentives, shelving and promotional allowances).

To recap, because of the importance of firm-specific or proprietary assets in the processed foods sector, firms have considerable motivation to reduce reliance on arm’s-length market transactions and to internalise vertically interdependent business activities. However, this does not necessarily translate into vertical integration. Indeed, casual observation suggests that the current trend is toward vertical de-integration. Rather, contracts are in many cases efficient means of responding to conditions that give rise to internalisation. Increasingly, these are incomplete contracts, generally taking the form of strategic alliances. This appears to be a harbinger of future organisational form in the sector. Speculatively, food manufacturing firms appear likely to emerge as dominant forces in these alliances, although it is premature to discount food retailers in this role.
IV. CONCLUSION

Contemporary concepts of industrial organisation, combined with empirical observation, provide considerable insight into what may be expected regarding the future structure of the food sector. At the same time, a number of questions are left without clear-cut answers. In summary fashion, this paper suggests that the following features are likely to prevail.

• Creating and effectively utilising intellectual property or firm-specific proprietary assets is a key factor associated with commercial success for firms in the sector. Of these, brand names, product reputation and product innovation are among the most important.

• Multiproduct and multiplant firms that are particularly skilled in providing unique, firm-specific headquarter services such as research and development, advertising, and the development of a repertory of routines have a substantial advantage over single product/single plant firms, even those that achieve scale economies.

• Firms with their primary markets in large, high-income, industrialised countries typically gain significant “first mover” advantages in capturing new, rapidly growing markets for processed food.

• An emphasis within a firm on employee rewards tied to relatively short-term performance helps position a firm in this sector to innovate in a manner that is likely to result in growth in both market share and earnings.

• An environment of competitive rivalry in a firm’s home market is conducive to the ability of the firm to compete successfully in other markets. The industrial policy concept of a “national champion” appears to be counter-productive in this sector.

• Firms in this sector that are located in countries or regions where a relatively large number of firms in related industries are clustered gain an advantage over those located elsewhere. Related firms include those in both supplier and customer industries and firms that share some technological similarities.

• Trade liberalisation, market enlargement, and globalisation appear likely to result in continued if not even more intensive patterns of geographical concentration in food manufacturing and related industries, rather than geographical dispersion.

• There are significant vertical interdependencies among firms in this sector. They are increasing in importance. This is leading firms to more closely tie
together vertically related operations. Various forms of incomplete contracts and interfirm alliances appear to be more likely than vertical integrations.

- Debate rages over what firms will emerge as “channel captains”. Most likely these will be either large multinational food manufacturers or retailers. An argument favouring the former can be weakly supported. It seems remote, at best, that agricultural producers will so emerge.
BIBLIOGRAPHY


HENNEBERRY, S.R., ed. (1997), *Foreign Direct Investment and Processed Food Trade*, Oklahoma State University, Department of Agricultural Economics, March.


THE FUTURE OF AGRICULTURAL PRODUCTION STRUCTURES

by

Donald McGauchie
President, National Farmers Federation, Australia

I. INTRODUCTION

In addressing the future of agricultural production structures in OECD countries, this contribution explores what farming might look like over the next twenty years or so as it adjusts to meet future challenges. The perspective offered is that of a practical farmer, producing crop and livestock products within an export-oriented, largely unsubsidised, southern hemisphere agricultural sector, which for years has had to battle not only the vagaries of fluctuating weather and “normal” economic conditions, but also the deleterious impact of a very distorted world trading environment.

Looking into the future is a challenging but risky exercise. History is littered with failed predictions. Who can forget, for example, the Club of Rome, which predicted in the 1970s, in the best traditions of Malthus, that the world would soon (that is, before now) run into a food production bottleneck because of the demands from a growing population, and that many minerals would be physically exhausted before the end of the eighties. Also in the 1970s we had the two oil shocks which led to predictions in some quarters that the price of oil would be more than $90 a barrel before too long (at the time of writing it is somewhere around $17 a barrel, twenty years on). Similarly, in the late nineteenth century it was suggested that the industrial world would soon run out of coal. Coal is still in plentiful supply and new, large coal mines continue to be developed, including in Australia.

These examples serve as a useful reminder that we simply do not know enough about the future to be able confidently to predict the detail. Moreover, detailed predictions fail to appreciate just how adept markets and farmers are at adjusting to changing circumstances. From his own first-hand experience, the author can attest to the ability of the farm sector to organise itself to meet new challenges and
changing circumstances and adopt new technology. Everything depends on whether the incentives to do so are present and whether farmers are receiving clear market signals to which they can respond. Governments, bureaucrats and collective agencies (such as marketing boards) are notoriously bad at picking markets. Trying to be too prescriptive about the future of agriculture in turn is likely to lead to a strategy of “picking winners” and thus the encouragement of structures and activities which ultimately risk running counter to where the market actually wants, and needs, to go.

Hence, instead of venturing specific predictions, this chapter focuses on some of the important emerging trends in the farm sector, and considers the broad implications. It also identifies where continued effort is needed to remove structural impediments to change, in keeping with the key point to be made: the best way of meeting the challenges of the next twenty years and ensuring that farm production processes adjust is to get the economic environment right, remove the “road blocks” to change, remove the distortions to trade and other political impediments, and make sure that the correct market signals reach farmers. The more market-oriented farmers are, the more likely they are to perform successfully – now, and in the future.

II. SOME FUNDAMENTAL ISSUES

The encouraging news is that the distortions created by extensive government intervention in agriculture in many countries are, without question, giving way to more market-oriented arrangements. Farming is becoming more responsive to market demands. The discouraging news is that it is all happening too slowly, and farmers in many parts of the world continue to resist what is in their own long-term interest.

The Uruguay Round settlement has provided renewed impetus in this direction. Coming after seven years of herculean effort, it is resulting in a gradual winding back of some of the worst forms of border protection, and providing liberalisation and greater predictability of market access arrangements. For specialist agricultural exporting countries such as Australia, New Zealand and other members of the Cairns Group, the achievements of the GATT were far from ideal, but much better than appeared possible at various points along the journey.

The European Union now asserts that it has repented with regard to the bad old policies which created such phenomena as “wine lakes” and “butter mountains”. It is doubtful, however, whether self-congratulations are in order. Recently, for example, an article in the May 1997 Newsletter of the EU Delegation in Australia reported a decision by the European Commission to introduce a tax on the export
of certain cereals and cereal products. It quoted the EU Commissioner for Agriculture in these terms:

“The introduction of the tax was necessary in order to stabilize wheat prices. Prices had been increasing due to a generally low level of world stocks and uncertainty with regard to the 1997 harvest both within and outside the EU, due to climatic influences. The introduction of the tax was a precautionary measure to avoid an overheating of the EU cereals market. The EU is no longer subsidising export of cereals products, but taking steps to conserve cereals stocks for the domestic market. The tax is an example of the EU’s flexible use of policy instruments to accommodate market requirements.”

(European Union News, 1997, p. 5)

Two very clear messages leap out from this statement, both of which indicate that there is still a long way to go. First, there is the implicit paternalism: farmers and other market participants are unable to work through such market fluctuations unaided. If European farmers are to have their hands held like this all the time, how and when will they be able to learn risk management techniques – such as forward selling and futures trading – which can help them cope? Moreover, the EU’s market intervention as described will presumably destabilize residual markets and exacerbate price volatility for others, a fact not acknowledged in the article.

Secondly, if the EU really did want to strike a blow in the interests of conserving cereal stocks and promoting policy flexibility, a far preferable way would have been to reduce the extent of distortions within the livestock sector, where vast quantities of high-priced cereals are routinely fed to pigs and cattle well removed from the canons of economic efficiency.

This example neatly illustrates the attitudinal gulf that still exists between farming interests in many OECD countries, and their various policy advisers, and those who experience the turbulence of international markets day in, day out. It may also illustrate that, compared with getting such woolly thinking straightened out, consideration of issues such as optimal sizes of farms and access to external financing and technology rank as somewhat secondary in importance.

In a related area, there are worrying signs of alliances between farming interests who are ambivalent about trade liberalisation and consumerist groups. One example that has recently disadvantaged a number of livestock product exporters, including Australia, concerns the EU-imposed ban on imported beef not containing certification that the originating cattle were free from treatment with naturally occurring hormone growth promoters (HGPs). On this occasion, it appears that the more robust appeal mechanisms of the World Trade Organisation’s Dispute Settling Panel may work in the interests of fairer trade. The United States and Canada took a complaint to the Panel, arguing that the EU ban had no scientific justification and that the EU had not undertaken a proper risk assessment as
required by WTO provisions. The Panel, in an interim report, appears to have upheld the complaint.

Going beyond the outcome of this specific case, the general lesson to be learned is the need, in today's quality-conscious and consumer-oriented world, for responsible debate and reporting of all potentially sensitive issues. Media sophistication being what it is, not to mention the temptations of “a good story”, everyone connected with agricultural policy-making must exercise the maximum care. These comments are not intended to play down the importance of actual or potential consumer (or environmental) concerns – quite the contrary. But there is no shortage of examples where sensationalised reporting caused, in the Australian vernacular, a bushfire to break out which was then very difficult to contain. Probably the most graphic case in recent times was the damage done to world beef markets by the BSE incident. It must be admitted that some initial reactions in Australia were selfish enough to think that the country might benefit from Europe's or the United Kingdom's difficulties. It is now clear that beef producers everywhere suffered as a result of this incident, and are still struggling to regain consumer confidence in the product.

III. MARKETING, QUALITY AND TECHNOLOGY

One consequence of trade liberalisation, in concert with continued economic development, rising living standards and ever-more demanding consumer requirements, is the progressive shift away from the marketing of bulk undifferentiated products and towards specific product farming and marketing, designed to service emerging niche markets.

This trend opens up numerous possibilities for innovative farmers and others, but it also contains a formidable challenge: how can farmers, as opposed to those beyond the farm gate, capture the value added on offer? Certainly, there is no guarantee that the value added benefits will flow back to farmers and, to the extent that they do not, improved farm productivity and efficiency will, as always, be needed to enable farmers to remain viable.

Thus, for several decades, consumer prices for food products have risen at about the same rate as the general rate of inflation while farm gate prices for agricultural products have failed to keep pace. This trend is also evident in other industrialised countries.

On the positive side, farmers must recognise that consumers are becoming more interested in processed foods and prepared meals than in just farm gate products. There is a shift from produce markets to supermarkets. People seek high-quality, easy-to-prepare food, and they are eating out more often. One
consequence is that farm production systems will need to be more in tune with providing high-quality goods that are capable of product differentiation.

Consistency of quality is equally important. Considerable advances have already been made from the application of farm-related biotechnology, which has the potential to deliver both improved quality and increased quantity. Where biotechnology will ultimately lead is unclear – trying to pick technical change is even more difficult than picking prices, especially as some innovations which may come on stream have not even appeared on the drawing board yet.

In meeting the demands of the market-place, incentives and opportunities for biotechnology will increase – just as the continual adoption of new technology has been a major feature of agriculture in the past. In fact, it has been a necessity for survival for most farmers.

Constraints on the application of biotechnology may come from consumers. Where reluctance is the result of poor information, it is up to farmers to play a leading role in educating consumers, as in the case of the HGPs previously mentioned.

Government regulation can also hold back the development and spread of new technology. Regulators typically lag behind the market in these cases. They are busy making regulations for yesterday’s technology advances, and overlook the fact that new technology is continually coming onto the market. Regulatory activism is itself a problem, containing the same paternalistic sentiments highlighted with regard to the EU’s cereals pronouncement. In Australia and New Zealand especially, but also in other parts of the world, the question arises more frequently: is regulation of this type needed at all? What good purpose is it serving, apart from being an added cost and distortionary imposition on farmers? As noted earlier, attitudinal change on a far-reaching scale is required, and the bureaucratic impediments to that happening are not to be underestimated.

Ultimately, the process of gearing farm production processes to reflect market and consumer concerns as opposed to continuing as a traditional bulk commodity supplier will be accelerated if farmers become more market-oriented and the market is allowed to work – not distorted by vested interests and well-meaning governments trying to second-guess the market and “pick winners”. The same applies to the spread of new technology.

Given the right incentives, farmers – and farm production processes – will respond.

That fact can be illustrated by briefly describing some of the adjustments that have occurred within Australian agriculture in recent years. The backbone of the country’s farm sector is broadacre farming, which involves a mix of livestock...
and cropping enterprises. Previously these farms were described as operating in the "wheat-sheep zone", but the picture has become more complex over the past twenty years or so. Australian farmers are extremely adept at responding to changes in relevant prices by adjusting their enterprise mix. Admittedly, this is often a response to poor prices and inadequate incomes, but the consequences of not responding in a farm sector that remains overwhelmingly export-oriented would be profound.

When world grain prices are buoyant and returns from livestock grazing (sheep – mainly for wool production – and beef cattle) are depressed, Australian farmers have shifted rapidly out of livestock and into cropping. Thus Australian sheep numbers have declined by over one-third since the late 1980s in response to a global oversupply problem in the wool industry, and the areas sown to crops have correspondingly increased.

Moreover, within the cropping sector there have been significant changes as well. Wheat retains its pre-eminent position, but the market has become more specialised with different types of wheat now being produced in different geographic regions for distinct end-markets. Once, most Australian wheat carried the uninspiring label FAQ (fair average quality); now there are a myriad of qualities and specifications. Ten years ago there was virtually no production of canola; now, it is the dominant winter oilseed crop, and farmers have needed to master a range of new production techniques along the way.

In some regions of Australia, cotton has supplanted livestock grazing and cereal crop production. The cotton industry is now one of Australia's largest and most successful agricultural enterprises. The dairy industry, which during the 1960s and 1970s was one of Australia's poorer-performing farming industries with a chronic low-income problem, has been transformed over the past decade as new markets for value added dairy exports in Asia have opened up and farmers have received clear price signals encouraging them to expand production. Dairy farmers today are far more productive, efficient, technologically advanced, and operate on a larger scale than was the case twenty-thirty years ago.

Similarly, the wine grape industry has witnessed a dramatic expansion of production over the past decade, as the quality and price competitiveness of Australian wines have become increasingly appreciated by consumers in Europe, Asia and elsewhere. It has become apparent too that Australian wine-making technology is on a level with the best in the world, having learned from the traditions of older established regions but without the restrictions or rigidities that accompany them. Large-scale planting of vines is occurring in many regions of Australia, including several new wine-producing regions. To date the results are encouraging, and there is considerable confidence for the future. A related trend is that some of Australia's specialist dried vine fruit farmers – despite producing
arguably the best-quality dried vine fruit in the world – are shifting to the production of wine grapes, either using the same grape varieties or planting premium wine varietals, such as Chardonnay.

Meanwhile, other Australian broadacre farmers are experimenting with a wide range of new enterprises – including agroforestry, olives, flowers, emus and ostriches – in an endeavour to find profitable alternative uses for their land and niche markets. And, Australian farmers everywhere are continuing the relentless drive for improved productivity and technological advancement – whether by genetic improvement in crops and livestock; the use of bigger, better or smarter machinery, improved management practices, including risk and financial management tools; or the greater use of information technology, such as the Internet, satellite imaging, climatic forecasting, sophisticated soil, plant and animal diagnostic procedures, and proprietary computer software programmes.

Just as it is remarkable to look back twenty years and list how many farming aids are taken for granted today that were not in use then – personal and laptop computers, faxes, mobile phones, videos, electronic fund transfers, electric fences, four-wheel drive motor bikes, helicopter mustering of cattle, laser levelling, drip irrigation, direct drilling and chemical ploughing, large-scale haymaking equipment, and so on – so we can be confident that the next twenty years hold the prospect of even greater change and opportunities for progress.

To repeat, those opportunities are more likely to become reality the more farmers are able to observe and respond to market signals, uncluttered by political distortions or well-meaning but misguided regulators.

IV. INTEGRATION AND FARMING STRUCTURES

Farmers the world over have been characterised as rugged individualists, pursuing their livelihood despite a hostile economic or climatic environment. While such images may once have been an accurate portrayal, the reality now is that farmers are part of an integrated food chain. It is inevitable that this integration will deepen into the next century.

The question for the future is whether farmers will retain a degree of independent decision-making or whether they will be reduced to the status of a controllable employee working in the supply division of a large industrial conglomerate. In many ways, this has already happened with the chicken meat industry, where the “farmers” do not own the growing birds and are told what, when and how much to feed, and when to market the output, by the processing firms that are in control.
There is likely to be an increasing divergence within farming between large, capital-intensive, corporate-owned, industrialised enterprises on the one hand, and more traditional family-owned businesses on the other.

The former are more likely to predominate in intensive forms of agriculture, where many of the production processes can be fully or largely controlled, and where the impact of climatic variability can be minimised. Examples include pig and poultry production, wine-making, the feedlot sector, irrigation crops such as cotton, and other intensive horticultural enterprises. The latter will probably continue to prevail in broadacre agriculture, where a premium applies to individual management skills and where the nature of the incentives for performance is contrary to a “nine-to-five” working mindset.

Within these two streams, of course, are many variants. Within intensive farming, there are plenty of examples of successful family-style businesses – some of which, by their very success, take on characteristics of a fully-fledged corporate business over time.

Within broadacre farming, there are examples of successful corporate investment, where managers are appropriately rewarded as if they were family business owners, and where economies of scale or opportunities to spread – and thus reduce – risk exist.

Certainly in the future, family-owned broadacre farming businesses will continue to predominate and be successful, but they will be quite different from their predecessors. As part of getting closer to the consumer and being able to respond more quickly to changing consumer trends, farm business will need to be more integrated with marketers, processors and retailers. Moreover, with consumers increasingly demanding higher quality and more consistently reliable food, farmers will need to be part of more formal quality assurance procedures – and right throughout the production system, not just when produce is about to be sold.

A corollary of this is that the more effective farmers will forge common interest partnerships with businesses beyond the farm gate, and not be locked into an adversarial seller-buyer relationship as in the past. Already these new systems of business operation are common within the manufacturing sector, such as between suppliers and manufacturers in the automotive industry, and they are becoming increasingly evident in the agro-food industry. Their hallmark will be co-operation and shared objectives, but this does not necessarily mean that formal co-operatives will be required or appropriate. Some of the traditional forms of statutory marketing authorities of the type that have operated in Australia and New Zealand in the past will have difficulty in coping with these requirements, especially if lowest common denominator pooling arrangements continue to apply. Brand development, which is already strong in many countries and product categories, will strengthen further, imposing tighter – but not unreasonable – specifications on supplying farmers.
V. ENVIRONMENTAL ISSUES

A number of commentators believe that the future of farming will be characterised by further concentrations in the number of production units. This may be in the form of fewer farmers combined with more intensive agricultural production, perhaps involving less land.

Talk of increased concentration or intensity of farming immediately raises the issue of the environment. Environmentally (or ecologically) sustainable agriculture has become a popular slogan and objective, and rightly so, even if there is some confusion about exactly what the term means.

Environmentalists and others are quick to point to the negative effects of the so-called Green Revolution and the impact on the environment of the widespread and intensive use of chemicals to increase farm output, or the overuse of water. It would seem that much of the overuse of chemicals has been the result of misguided policies of extensive subsidisation of agriculture by governments. The incentives to farmers in this environment have been very clear – produce as much as possible from as much land as possible. Subsidising farmers and then trying to implement expensive environmental programmes is a double waste of taxpayer funds.

Conversely, farmers who are not dependent on subsidies and who must remain sensitive to the needs of the market have a very different attitude towards land use, chemicals and other purchased inputs. For these farmers, land needs to be maintained in top condition to safeguard their production and income base into the future.

Looked at another way, profitable, market-oriented farming has more capacity to deal with environmental issues than do heavily subsidised farming systems. Provided farm incomes are adequate, there are numerous opportunities to establish new farm management practices that can effectively deal with environmental concerns.

To some people, the suggestion that market-oriented farming and liberalised trade in agriculture can be positive for the environment is counter-intuitive. Surely bans, controls and other programmes are more effective. If left to their own devices, won’t farmers simply keep pouring more pollutants onto their properties and degrading the land? Such thinking is part of the paternalistic mindset, common to regulators and other meddlers, referred to earlier. It is quite erroneous, of course.

If massive subsidies are gradually reduced, the incentive to keep adding inputs to artificial farming systems will be similarly reduced – as farmers will be bearing the direct cost. Likewise, if farmers continue to expand supply without
consideration for underlying market factors, prices will fall and incomes will come under renewed pressure.

At the same time, it is necessary to consider afresh the contribution which the appropriate application of effective farm chemicals can make to the wider environment. A leading writer on this subject is Dennis Avery of the Hudson Institute in the United States. A number of his arguments seem particularly relevant to the issues discussed in this volume. The title of one of his books alone is enough to cause apoplexy to environmentalists: Saving the Planet With Pesticides and Plastic. Avery’s thesis is that a greater concentration of agricultural production is not a cause of environmental problems, but a solution:

“The biggest danger to the world’s natural environment today is low-yield agriculture. Amazingly, the world’s agricultural professionals have been so busy apologising for the supposed sins of monocropping and pesticide spraying that we have missed the most important environmental benefit of modern farming. It produces more food from fewer acres, so it leaves more land for nature.”

(Avery, 1997)

Avery calculates that an additional 26 million square kilometres of land would have had to be cleared for farming had the Green Revolution not occurred. To put it into perspective, this is an area equivalent to the whole of North and Central America.

Avery argues that the methods used to achieve high rates of agricultural production are already far safer for the environment than alternatives. For example, he points out that “the world lacks the organic nitrogen to support current crop output organically, let alone tripling it in the future”. To achieve the necessary levels of nitrogen would, he argues, be environmentally costly:

“The only realistic way to get huge increases in organic N? Clear more forests to grow lots more clover, trading wildlife for legumes.”

Of course Avery’s conclusions do not diminish the importance of removing large-scale subsidies and making agriculture around the world more market-oriented. Getting rid of government interventions and distortions will help ensure that only production necessary to satisfy market requirements occurs.

Avery’s views are provocative, but there is a powerful logic in his argument which should not be dismissed lightly. There could be considerable environmental costs associated with holding back the trend of concentration of agricultural production.
VI. QUALITY ASSURANCE

As noted above, with an increasing focus on consumer requirements, the role of quality assurance (QA) will become more important. This will be particularly so at the farm level. How best to deliver QA is an important issue.

The need to drive home the message of QA reinforces the view that farm structures must be market-driven. If consumer signals are not clear to those developing and producing farm products, they will not deliver the quality required. Looked at another way, if farmers do not embrace QA, they will lose markets.

Ultimately, QA must be developed along the marketing chain and must involve farmers, marketers, processors and of course customers. It goes hand in hand with the shift to more vertically integrated production and marketing structures. Those that perform best at QA will gain a marketing edge.

Just as reliance on government assistance and a culture of “they will look after us” can lead to complacency and lowest common denominator outcomes, so too can reliance on centrally co-ordinated QA programmes administered by bureaucrats who think they know what is best for farmers. Such an approach might be well intentioned but it is unlikely to succeed in the long run. There may be a role in promoting the need for QA for governments and other external bodies, but in the end it must be the commercial investments at stake that make the decisions and drive the implementation process.

The adoption of QA has important implications for farm management performance around the world. Farmers will need to farm smarter and be better-trained to handle these new techniques. Educators must also be at the forefront of change, able to deliver relevant and timely education services. Governments already have a role in providing education services relating to QA but equally, so does the private sector. In Australia for example, an extensive private market has developed for QA services, as it has elsewhere.

VII. INDUSTRY AND TRADE POLICIES

Farm policies and production structures cannot be considered in isolation from wider policies pursued by governments, and indeed globally.

As an export-oriented farmer, the author knows only too well (and often too painfully) the impact on his profitability of such wider issues as interest rates and other macroeconomic policy settings. No matter how confident they may feel to cope with international agricultural market forces, export-oriented farmers can be greatly hampered by wider domestic and international macroeconomic forces. It
must be stressed that farmers, like other business people, are constantly urging governments to get their economic houses in order.

A more stable macroeconomic environment over the next twenty years is obviously preferable to the stop-go experience of the past. The OECD has played an important role in promoting sound economic management, and it should be encouraged to continue.

Policies for other industries, both at home and overseas, can also exert a major impact on the agro-food sector. It is difficult enough to cope with the vagaries of weather and commodity cycles without having to take into account the impact of higher costs and market distortions due to assistance given to producers in other sectors of the economy. In Australia, there has been a vigorous debate about the impact on farmers (and exporters generally) of assistance accorded to manufacturers, and increasing awareness of the cost of such policies to the economy. In fact, Australian research agencies have led the world in measuring, and making transparent, the costs of sectoral policies to particular industries, and overall trade distortions.

The point cannot be emphasized too strongly: it is important to remove discriminatory policies wherever they might be found if the agro-food industry is to meet the challenges facing it over the next twenty years – we cannot afford to wait another twenty years for substantial progress to be made.

The cost of sectoral assistance falls on three broad groups:

- consumers who are forced to pay higher prices for some goods and services and whose spending patterns are thereby distorted;
- other domestic industries which must use the higher-priced goods and services and also compete with the protected industries for resources and capital; and
- exporters (including many farmers in Australia’s case) and import-competing industries who face higher costs like all industries but who also receive less domestic currency for their exports (or greater import competition) due to exchange rate effects.

To some extent, domestic industries can pass on higher costs to consumers. Efficient farm exporters cannot do so as they face world markets and prices. That is why various forms of import protection effectively become a tax on exports.

Just as domestic policies in non-farm industries can hurt domestic farmers and impede adjustment, so farm policies in one country can damage the prospects of farmers in another country. The arguments were developed in detail and strongly articulated by the Cairns Group in the Uruguay Round context, and do not need to be repeated here.
From Australia's perspective there have been some positive developments in trade access recently:

- Mexico removed the 10 per cent tariff on scoured wool and wool tops from Australia, enabling Australian exports of wool to Mexico to increase by more than 50 per cent.
- Malaysia reduced its liquid milk tariff to zero, and Thailand applied a zero tariff to 88,000 tons of powdered milk.
- As part of the compensation package to Australia for enlargement of the EU to include the Nordic countries, Australia achieved additional access for beef, sheepmeat, cheese, oats and rice.

More generally, in the United States the latest farm bill has decoupled assistance from production and the government now provides an income payment to farmers which will be phased down over a seven-year period. However, some programmes in the United States have practically escaped reform, including the Grains Export Enhancement Program and the Dairy Industry Incentive Program.

Pressure for reform must be kept up if farmers everywhere are to receive the right market signals and make the necessary adjustments. Now is a good time to commence the process for the next round of multilateral trade reform, which has already been dubbed the "Millennium Round".

Along with domestic farm assistance policies, trade policies can also have an influence on the environment. Dennis Avery's work (and the work of others) on environmentally sustainable agriculture has raised some important trade-related issues that are worthy of consideration. The possible implications for the structure of future farming and production processes, especially in some developing countries, are important. For example, restricted farm trade encourages the continuation of environmentally damaging production processes. To quote again from Avery's (1997) *Choices* article:

"If today's pervasive farm trade barriers persist, densely-populated Asia will continue to try to maintain national food self-sufficiency to placate their own farmers at the expense of their wildlands."

**VIII. FOOD SECURITY AND FOOD SELF-SUFFICIENCY**

One of the recurring concerns of food policy in the postwar era has been that of food security. In Europe and Japan during and immediately after the Second World War, and more recently in Africa, the spectre of hunger and starvation has been real, and it has exerted a powerful influence on the political process. Japan
also became understandably nervous about its energy supplies following the oil shocks in the 1970s.

While these concerns are perfectly understandable, they do not excuse the development of wrong-headed policy responses. In particular, it is vital that countries do not confuse issues of food security with an overarching goal of food self-sufficiency. The two are obviously very different. Food security can be assured by stable and reliable trading arrangements in which the interests of both parties are respected. Special arrangements may be required to deal with extreme climatic events, but the history of the past fifty years is that global food supply has been remarkably steady, even if national harvests have varied in the short term. If food-importing countries fear that war or embargoes will threaten their food security, then judicious accumulations of stockpiles may possibly be justified, despite the obvious high cost.

Conversely, a formal policy of seeking self-sufficiency raises a whole raft of broader considerations. As a survey by The Economist put it:

"Modern farming calls for a constant stream of purchased inputs: energy, fertiliser, pesticides, seed, veterinary medicines, animal feed, machinery, spare parts and so on. [Governments would need to] guarantee self-sufficiency in inputs too, which is a far more ambitious (and expensive) proposition."

(1992, p. 9)

Most countries have come to realise the futility and inappropriateness of pursuing self-sufficiency policies, despite occasional lapses in political rhetoric. However, it is a matter of some concern that this realisation is not completely established within China. From time to time, there are signals that China believes self-sufficiency is the way to go. It is necessary to disabuse it of such notions. In part, it must be explained how exposed a catastrophic climatic event within China would leave that country if it pursued self-sufficiency goals. Equally, we need constantly to reinforce the virtues and benefits for China of being a full member of the international community within a liberalised trading environment, and of diversifying its sources of food supply. And it is necessary to guard against any suggestion of food being used as a political lever, whether against China or anyone else.

IX. CONCLUDING COMMENTS

The underlying theme of this paper is that an agricultural system that is market-oriented will be the most effective way of meeting the challenges over the next twenty years and beyond. Getting the economic environment right is more
important than speculating about the fine details of future production processes – which, anyway, would probably be wrong.

The most efficient production systems will be market-driven; farmers should receive clear signals about what the market – that is, the consumer – really wants, not what bureaucrats and politicians think the market wants or should have.

Within an overall market-driven production system, there will inevitably be variation in how farming is structured across different sectors, regions and countries. Some identifiable trends are already under way. For the broadacre sector, family farm structures are likely to remain the most efficient and effective form of business organisation, while for more intensive farming, corporate structures with outside investors are likely to play a more important role.

With an increased focus on meeting market needs, farm production processes will continue to become increasingly integrated with the complete marketing chain. This will likely mean a greater emphasis on direct contractual specification of market requirements for all levels of the production and marketing chain. Ultimately, consumer standards and refinements will drive the process. Providing what the market wants will place more emphasis on QA. Factors such as safety, quality and reliability will be important.

The need for ever-greater food production and the trend towards more concentrated agriculture are likely to raise concerns about environmental impacts. Extreme caution is called for here – misguided policies could do considerable damage to agriculture and the world’s environment. There are some very persuasive arguments in favour of more rather than less concentration of agriculture in terms of the environment.

Countries that are moving to more market-driven, consumer-oriented systems of farm production and marketing – such as Australia, New Zealand, Canada and the United States – will have a far greater chance of success than countries with more highly subsidised and protected agricultural sectors. However, it will remain vitally important for the former countries to keep promoting the reform agenda.

The decks must be cleared in relation to international trade and farm policy distortions. Then, there will be less need to worry about how big farms might be over the next twenty years, what production processes will be optimal, what managerial skills will be needed, and so on. Given the right signals, farmers can get on with the job of adapting to changing circumstances themselves.

Without reform, agricultural production structures in many countries will probably not be very different from what they are today: inward-looking, inefficient, lagging behind international best practice and not well-placed to meet the challenges of a market-driven, consumer-oriented system. We owe it to our successors to do better than that.
BIBLIOGRAPHY


I. INTRODUCTION

This contribution examines the current direction of policy reforms and prospective policy challenges. The effects of domestic and international pressures are analysed, and the policy challenges likely to arise from these pressures are discussed. While a great variety of developments and challenges were identified, only a few could be dealt with in-depth.

Traditional agricultural policies – governments dominate

Agricultural policy has had the role of fulfilling many different objectives, such as food security, price stability and rural/structural development, as well as environmental and income goals. Traditional agricultural policies in many OECD Member countries relied heavily on price support measures, trying to stabilize or increase farm incomes through promoting output and productivity. Ironically, the fact that productivity goals were achieved rendered these policies unsustainable. Rapid output growth made it necessary to combine support instruments with domestic intervention purchases and export subsidies to dispose of accumulated surpluses. The budgetary implications of these policies became burdensome, the international pressure for reform grew, and the focus on price support proved inappropriate to cope with an ever-increasing number and complexity of domestic policy objectives and international policy obligations.

* Mr Viatte is the Director, and Mr Schmidhuber an Economist in the Agricultural Markets and Trade Division, of the Directorate for Food, Agriculture and Fisheries.
Some OECD countries responded to these developments by increasing the number of policy instruments and widening their scope; in recent years, the focus in the policy formula shifted from price support to a multitude of direct payments. Some countries opted for more radical reforms, encompassing a fundamental deregulation of agricultural markets and a minimisation of public policy presence. Yet other countries were and remain reluctant to change, and reforms are responding primarily to external pressures – or have not yet been introduced at all.

**Future policy challenges: the need for shifts in the policy agenda**

A number of projections suggest that a mere continuation of the current reforms will not be enough to meet the policy challenges of the future. From the domestic perspective, there will be a need for greater flexibility in policy implementation and instrumentation when it comes to agriculture’s effect on the environment and rural development’s interactions with upstream and downstream industries. The focus of the reform agenda will thus shift away from traditional price policies, and towards the broader regulatory framework.

Prospective international developments will add to the pressure for reform. The most important changes could have to do with growing regional integration; globalisation of food markets; rapidly growing trade in processed products; an ever-increasing number of trading partners with different national standards, regulations and levels of economic development; rapid advancements in biotechnology, transportation and communications; growing market power in the food processing and distribution industry; new food products and processing methods; the need to cope with transboundary environmental issues; and the need to respond to steadily growing global food needs.

**II. DOMESTIC REFORM PRESSURE – THE NEED FOR FASTER AND MORE COMPREHENSIVE PROGRESS**

**The present situation**

There is a growing recognition in OECD countries that traditional agricultural policies, which rely heavily on price support, are failing to achieve their stated objectives, such as stabilization of farm income and protection of the family farm (OECD, 1995). Technology-driven industrialisation of the sector, combined with the fact that more farm households are engaged in other activities as well, has resulted in greater structural diversity, thereby eroding the effectiveness of support policies designed for a more homogeneous sector.
Growing competition for scarce public funds is placing increasing pressure on governments to ensure that resources are used efficiently. Policies designed to benefit farmers are seen as too costly to consumers and taxpayers. Negative side-effects, most notably on downstream industry and the environment, are becoming more apparent. Broader concerns about industry competitiveness, the amount of value added by agriculture, and the future of rural economies have reinforced the pressure for reform in many countries.

Each year the OECD monitors agricultural policy developments in Member countries against their stated goal of increased market orientation through progressive and concerted reductions in agricultural support. The 1997 report shows that further progress was made in reducing support to OECD farmers (–8 per cent compared with 1995 as measured by the producer subsidy equivalent, PSE), though mainly because of higher international prices. Overall support remains high and the total PSE was estimated at $166 billion in 1996. The other main findings are:

- Market price support, which keeps domestic prices above those on world markets, remains the major form of policy measure in most OECD countries, often used with supply controls. Direct payments are playing a larger role (increasing from 18 to 23 per cent of total support between 1986-88 and 1996), but in some cases are still closely linked to production and used to compensate for reductions in price support.

- The shift away from market price support and towards direct payments has resulted in reductions in the insulation of domestic producers and consumers from world markets, albeit with continued wide variations in the levels, composition and trends across countries and commodities.

- Domestic agricultural policy reforms related to implementation of the Uruguay Round Agreement on Agriculture (URAA) reflect a move in the direction of greater trade liberalisation through improving market access and reducing export subsidies and other trade-distorting practices.

- The OECD consumer subsidy equivalent (CSE), which measures the implicit tax on consumers due to agricultural policies, totalled $95 billion in 1996 – a decrease from 1995 of nearly 21 per cent. The percentage of CSE also decreased, from 37 per cent in 1986-88 to 23 per cent in 1996.

- A broader indicator than the PSE/CSE is total transfers. The report estimates that OECD total transfers associated with agricultural policies were $297 billion in 1996, accounting for 1.3 per cent of GDP overall.
The need to continue agricultural policy reform

The move towards greater market orientation is likely to continue. At the same time the speed of reform has to increase, for the following reasons.

To increase transfer efficiency

Only a small portion of the money transferred to the agricultural sector through price support translates into increased farm household incomes. OECD estimates of the transfer efficiency ratio of price support are very low, with as little as $1 of additional income resulting from every $5 of consumer and taxpayer expenditures. The majority of this “leakage” is believed to accrue to the upstream and downstream industries (OECD, 1995 and 1997a). Direct payments that are not linked to production promise the most efficient form of support, while market price support has been shown to be a wasteful form. A shift from market price support to “de-coupled” direct payments would have substantial impacts on the agro-food sector as a whole, and not only on primary agriculture.1

To ensure competitiveness and flexibility

In most cases, agricultural support policies have resulted in higher prices at the producer level. Passed through the food chain, higher agricultural prices ultimately result in higher prices to consumers. The reform of support policies will reduce input prices for processors and result in improved competitiveness and lower consumer prices. The actual benefit for the processor will of course depend on the extent to which support policies affect producer prices, while the effect on the consumer will depend on the importance of the farm commodity in the value of the final consumer good. Traditional support policies have additional ramifications. They create rigidity in agricultural production, constraining the development of the food processing industry. Regional distribution, the scale of activity, plant utilisation, product innovation and industry adaptability can be adversely affected by policies, a situation which in turn reduces the flexibility of primary production.

To pay more attention to the environment

While reform to reduce production-linked support measures will contribute to improving environmental performance in agriculture, it will often need to be complemented by well-targeted environmental measures. Many of the current policy measures addressing the environment are not transparent in their objectives, nor well targeted to outcomes, nor tailored to particular situations. An OECD seminar in Helsinki in September 1996 emphasized the need for governments to adopt a balanced approach, so that any financial incentives for providing environmental benefits should be used in parallel with measures to ensure that farmers are held
responsible for any environmental damage. Thus, the polluter-pays principle is an important element in environmental policy for agriculture, although it is recognised that in this domain particular problems may arise with respect to its application.

While the calculation of environmental indicators for agriculture and the analysis of policies on the environment is currently under way in the OECD, there is still a need for more information and data on the relationship between agriculture and the state of the environment, and better evaluation and monitoring of the effects of agri-environmental payments. This will help ensure that policy measures are cost-effective, and designed to achieve environmental objectives consistent with the other benefits of agricultural policy reform (OECD, 1997a).

To facilitate structural adjustment

The agricultural sectors in OECD countries continue to face pressure to adjust to multiple economic, social and demographic forces and to the specific process of agricultural policy reform. The strength and pace of adjustment differs between countries and regions. Structural adjustment at the farm level tends to occur through out-migration of labour, increasing farm size, mechanisation and, increasingly, through diversification of the sources of income of the farmer or of members of the household. Up- and downstream sectors are becoming more integrated with farm-level operations, and there would appear to be a tendency in many countries for greater concentration at all levels of the agro-food system.

Careful targeting is needed to ensure that structural adjustment programmes facilitate rather than inhibit or retard adjustment, and that they are consistent with economic policy in general and agricultural policy reform in particular. Solutions need not always be sector-specific. Tackling labour market and other rigidities may be an important part of the solution to adjustment problems in agriculture – for example, ensuring that farm families are eligible for broader safety net and labour market programmes.

To promote rural development

Rural development concerns have influenced the re-instrumentation of agricultural policies that has occurred in recent years, and the new policy configurations should prove beneficial. In-depth reflection is under way in many OECD Member countries, including in particular the European Union, on how best to promote rural development; and the question of a reorientation of policy away from output-related agricultural instruments to a broader approach is a key element in that debate. Outside the OECD area, there is a growing need for sound rural development strategies that will help contain external costs of urbanisation and avoid a growing economic marginalisation of rural areas.
The policy challenges

- The key challenge for the future reform process is to strike a balance between the need for faster and deeper reforms in order to ensure international competitiveness, and the need to facilitate structural adjustment in a socially acceptable manner with more attention given to societal/environmental preferences.

- Policy reform should promote a market environment in which price signals remain reliable in guiding production decisions. Progressive reductions in price support should reduce the tendency of policies to mask market signals and inhibit adjustment, and thus make producers more responsive to changing consumer demands and the needs of processors.

- Greater transfer efficiency is an important advantage of direct payments. Restricting direct payments to addressing positive externalities would also boost the overall economic efficiency of these transfers.

- Policy-makers need to encourage research that helps improve policy design and implementation, and encourage market approaches that lead to improved environmental performance with least distortion to production and trade.

- Policies need to respond to the challenges of a continuing structural adjustment process; the timing, pacing and sequencing of policy measures will have to be compatible with the low mobility of production factors (particularly land and labour) characteristic in agriculture in the short run.

The need for regulatory reform

The context

To reap the fullest possible benefits, agricultural policy reform will have to be accompanied by regulatory reform in general. The practical implementation of present agricultural policies has required numerous and complex regulations, often affecting all upstream and downstream industry. Regulations become more specific and detailed and increase the overhead necessary for the administration and control of agricultural policies. An OECD study suggests that a part of the existing regulatory overhead will automatically disappear with policy reforms, as many regulatory measures are an integral part of traditional agricultural policies. The study warns, however, not to oversimplify the issue, as the regulatory interventions necessary for policy implementation can vary considerably.

Regulatory reform in food and agriculture will certainly face challenges in overlapping areas as well: deregulation of investment and competition policies, new regulations in rapidly changing areas such as biotechnology and food safety. Policy
design should ensure that the application of new technologies is compatible with freer trade while responding to the need for new regulations (e.g. for food safety) necessary to benefit fully from technological innovation. It should also serve to minimise external costs that might occur when those new technologies are applied.

**The need for deregulation**

**To ensure international competitiveness for farmers and processors**

The pressure for regulatory reform in the agro-food sector is closely linked to agricultural policy reform. Regulations associated with agricultural policies often inhibit the ability of the agro-food sector to exploit the opportunities provided by changing consumer demand and by new production and processing technologies. Outdated grading policies, for instance, tend to narrow choice for processors. In many OECD countries the dairy industry was slow to respond to consumer demands for low fat dairy products, in part because price support systems were based on fat content. New technologies, particularly biotechnology, will increase the pressure to review and update existing regulations or eliminate outdated, unnecessary or harmful ones. Deregulation will strengthen the competitive position of farmers and food processors in the international markets.

**To minimise administrative costs**

The search for increased transfer efficiency will reinforce the use of direct payments and may result in a more complex regulatory environment. Indeed that result has occurred, especially when payments replacing or supplementing market price support are based on historic yields, number of animals or the condition that producers set aside (idle) agricultural land. Care must be taken to design support measures so as to minimise the (often considerable) cost of administration and compliance without losing sight of the increased economic efficiency that is associated with reinstrumentation.

**To ensure undistorted investment flows**

As protection barriers are lowered and countries become more similar, the relative importance of investment regulations is likely to rise, and remaining differences in the regulatory environment are likely to become more important in determining trade and investment flows (Lawrence, 1996). A number of important international agreements have already addressed this issue: the agreement on trade related investment measures (TRIMs) of the Uruguay Round Agreement, the NAFTA agreement, and a number of bilateral treaties for the promotion of FDI.

Additional efforts are currently under way to consolidate and strengthen existing OECD instruments through the development of a multilateral agreement on
investment (MAI). The MAI seeks to establish a broad and legally binding multilateral framework based on high standards for the liberalisation of investment regimes, with strong investor protection and effective dispute settlement procedures. It will be a free-standing international treaty open to all OECD Members and the European Communities. It will also identify possible ways of involving non-member economies, a number of which have already indicated their wish to accede.

The need for new regulations

i) Competition policies

New regulations may be necessary to reap the full benefits of innovations or to minimise external costs that might occur when new technologies become available. Deregulation does not automatically ensure greater competition; better regulation may be required to avoid market failure and to minimise negative externalities. As governments withdraw from markets in food and agriculture, there might be a need for complementary measures, both to ensure effective competition and to help internalise externalities.

A recent OECD study identifies a number of important lessons that deserve attention in the design of future competition policies in food and agriculture:

i) policy reform in the agro-food sector does not automatically ensure greater competition in the food processing industry; 7
ii) antitrust authorities are sanctioning a growing number of mergers and acquisitions based on expected efficiency gains; 8
iii) restrictive business practices and investment laws can limit market access and foreign competition when other trade barriers are already dismantled; 9
iv) state trading enterprises can survive the most thorough agricultural policy reforms and should be subjected to stricter disciplines under the auspices of the WTO. 10

ii) Food safety

Food safety regulations 11 are implemented to protect human health and safety. The pressure for stricter enforcement and new regulation has gained momentum with highly visible outbreaks of food-borne diseases (BSE, E. coli, salmonella, campylobacteria, listeria). As consumers become increasingly informed and concerned about the safety and quality of food products, pressure for new regulations is expected to intensify. As incomes rise, consumers will also be willing and able to pay more for improvements in food safety. 12

iii) Biotechnology

Some applications of biotechnology in agriculture have already created a number of regulatory difficulties 13 and a complex regulatory environment involving multiple agencies and ministries. 14 Certainly new regulations will be needed to
reduce negative side-effects arising from such practical applications. Innovations will probably continue to come at a rapid pace, and so entail ongoing review of existing legislation and prompt reaction to new developments. Food safety, environmental risks, patents, intellectual property rights and ethical consequences of biotechnology were the main areas of concern in the past, and are likely to dominate national and international disputes in the future.

The policy challenges

For regulatory reform

- Policy-makers face the challenge of implementing regulatory reform in ways that are compatible with agricultural policy reform. This challenge cuts across a number of areas and raises several issues: the difficult balance of addressing legitimate consumer concerns with food safety at reasonable economic and administrative costs; the appropriate division of responsibility between public and private mechanisms and approaches; the protection of property rights; and the unresolved question in the trade context of mutual recognition versus international harmonization of standards.

- New regulations must be transparent. This is a particularly critical issue for consumers. Policy-makers must understand and respond to the complexities of food safety and technological innovations in creating a regulatory framework in order to help consumers make informed choices.

- The development of food safety standards should be based on cost-benefit analyses. Both benefits from higher standards and the costs implied are difficult to measure; policy-makers could encourage research into new and improved evaluation methods.15

For competition and investment policies

- As barriers to trade fall, the measures that limit market access by limiting competition will become increasingly untenable. While difficult to address, common disciplines for competition policies will be needed to realise the full benefits of globalisation.

- Deregulation and freer trade in agriculture do not automatically result in greater competition. Policy-makers have to ensure that neither the food industry nor the farm sector (co-operatives) will be able to exploit monopolistic market positions.

- Policy-makers should promote internationally binding agreements that help to consolidate and strengthen investment rules. The OECD’s multilateral agreement on investment (MAI) could provide an important step in this direction.
The need for faster, comprehensive domestic reform will be reinforced by international pressures. The growing globalisation of the world economy, accompanied by regional integration, will have significant impacts on food and agriculture. Expected developments include a change in the composition of trade and in the order of magnitude and nature of investment flows; growing vertical integration and co-ordination in the agro-food complex; an increase in the scale of farms and food processing operations; shifts in ownership or changes in the concentration of the industry.
At the same time, biotechnology will provide new food products (novel food) and innovative techniques to produce and process food, and may widen the options for storage and transportation. These changes will be accompanied by rapid advances in communications and declining transportation costs. The great number of possible combinations of advantages promise enormous extra benefits through synergies. It may also, however, bring about a number of negative externalities. Policies need to respond to these challenges to ensure the full benefits from developments while minimising negative side-effects. This will require adjustments in trade and investment policies, competition policies and environmental policies – as well as social policies.

Trade policies

The trade policy environment is one of the principal factors affecting the pace and direction of adjustment faced by farmers and food processors. The Uruguay Round Agreement on Agriculture was probably the single most important step towards freer trade in agriculture; its provisions on market access, export subsidies and domestic support apply to all products, basic and processed alike. These and other provisions of the Uruguay Round Agreement – particularly those on dispute settlement, sanitary and phytosanitary regulations and technical barriers to trade – are becoming increasingly important with the shift in the composition of traded products.

From bulk to processed food trade

One of the most important trends in agricultural trade is the shift from bulk commodities to processed and consumer-ready products. Growing regional and international integration, combined with increasingly diversified consumer preferences, could reinforce this development. Food manufacturers will react to changing preferences with new and more sophisticated food products. New technologies, particularly biotechnology, will provide new products and production methods for farmers, and innovative processing and packaging methods for food manufacturers. But globalisation also means that trade will increase between trading partners who are at different levels of development and with different industry standards. And richer consumers will not only ask for a greater variety of food products but also place more emphasis on safer food.

From tariffs to non-tariff barriers?

The need to accommodate demand for safer food in an environment of diversified food products, new processing and packaging methods, different labelling conventions and an ever-increasing number of trading partners at
different development stages could reinforce the importance of some emerging policy issues, such as the use of non-tariff barriers, in future trade negotiations. It may intensify the demand for stricter food and environmental standards and bring to the fore policy issues such as “harmonization versus mutual recognition” of divergent national standards (see Box 2). In any case, the demand for safer food will clearly call for internationally binding regulations, institutional arrangements for their enforcement, and the settlement of disputes. As other barriers to trade fall, these emerging issues are likely to take on increasing importance in future trade disputes.

Are stricter food standards a barrier to trade?

Growing demand for stricter standards could increasingly interfere with the objective of freer trade. This raises the questions of whether and to what extent stricter standards can act as a trade barrier. As these restrictions are imposed on producers both at home and abroad, such regulations should remain neutral in view of the possible distortion of international competition. Arguably, a lack of quality standards would reduce food quality and safety; high standards can, however, be arbitrary and used as a means of disguised protection. To avoid this, the WTO agreements on sanitary and phytosanitary regulations (SPS) require “scientific evidence” in order to justify stricter standards.

In a recent trade dispute, the WTO has ruled preliminarily that the European Union unfairly barred imports of US beef produced with the aid of synthetic growth hormones. This is the first ruling that is based on the SPS agreement. The importance of this decision is that it sets a precedence for attacking scores of other trade barriers, from Japanese certification of apples to European rules for poultry inspection. More than 80 disputes have been brought before the WTO since the SPS; enhanced dispute settlement procedure were established in 1995, and in almost all cases the complainants claim that they are facing trade barriers that are not based on scientific evidence. The economic stakes involved are substantial. With claims that the costs of the beef ban alone amount to as much as $250 million a year, these issues are likely to be a top priority in the future trade policy agenda.

The outlook: differences in the short run, convergence in the long run

Income growth is likely to be a key factor in the evolution of standards. In the short run, country-specific differences in income and standards may increase the potential for trade disputes. Additional potential for conflicts may arise as many trading partners will be passing through the early stages of economic growth, which are often characterised by more intensive use of resources with little attention to environmental side-effects. In the long run, however, economic growth is recognised as a crucial factor in increasing the demand for higher standards and
environmentally friendly production methods. Two aspects are important: i) income growth will raise the level of standards and awareness of food safety and environmental problems in all countries; and ii) stronger income growth in the non-member countries will reduce income differentials vis-à-vis trading partners. This suggests that standards are likely to converge, reducing the potential for trade conflicts in the longer term.
The policy challenges

• As traditional barriers to trade fall, policy-makers will have to ensure that non-tariff trade barriers will not be erected under the pretext of SPS and TBT regulations.

• While the increase in the relative importance of food standards is a natural consequence of lower tariff barriers, it will be important to limit their absolute role, given an increasing number of production and processing methods and trading partners.

• “Scientific evidence” is evolving, scientific methods improve, and disputes increasingly revolve around both different standards and the
underlying methods used to produce scientific evidence. \(^{23}\) Policies should promote research that helps to base WTO decisions on internationally accepted scientific methods.

- Regulatory agencies have to ensure that labelling statements contribute to consumer transparency; this means that some labels may have to become compulsory while others are permitted, and the rest prohibited.
- The use of internationally accepted food safety tools and improved consumer education should be encouraged. To minimise the costs of food safety regulations, they should be subject to rigorous cost-benefit analyses and limited to areas of market failure.

**Regional integration – a step towards globalisation?**

**Trends and issues**

In addition to multilateral trade negotiations, many countries are making commitments towards greater economic integration in Regional Trade Agreements (RTAs). More and more nations realise that economic vigour in general, and competitiveness in agricultural markets in particular, come from trade-oriented policies, and that regional integration is an important step towards greater economic integration. The special advantage of RTAs is that they allow a smaller number of countries to agree more rapidly on significant reductions in trade barriers than the multilateral fora.

**In parallel with global liberalisation?**

The trend towards integration of agricultural markets predates the beginning of the Uruguay Round in 1986, but the UR Agreement certainly helped to reinforce a process of integration that was already under way. Since 1990, more that thirty regional agreements have been signalled to the GATT/WTO (Blandford, 1995). This also means that the proportion of trade governed by commitments taken in RTAs and the WTO in parallel is likely to expand. Some observers have raised the question of whether the trend towards greater regional integration is compatible with multilateral trade liberalisation – whether RTAs compete with, or complement, the multilateral liberalisation.

**Trade diversion – vigilance is imperative**

As regional agreements provide preferential market access for the participating countries, they are inherently discriminatory for third parties. The welfare gains from increased trade within the region (trade creation) could be reduced or more than offset by discrimination against shipments from outside the region (trade diversion). The clearest example of a regional agreement contributing to increased protection in agriculture was the expansion of the Common Agricultural Policy (CAP) to the new members
of the European Common Markets during the 1970s and 1980s. A recently published study by the World Bank suggests that a significant amount of trade within Mercosur is the result of trade diverted from more efficient non-Mercosur producers to less-efficient producers within the bloc.

**Positive – on balance**

On balance, however, there is evidence that growing regional integration has contributed to multilateral liberalisation. RTAs have allowed countries to liberalise faster and more deeply than would be possible under multilateral agreements; and they have provided laboratories for approaches and techniques that subsequently found application in multilateral negotiations (Jones and Blandford, 1996). Thus for example the creation of the Single Market in the European Union in 1993 provided the impetus for addressing more than 200 non-tariff barriers to trade in food and beverages between member countries (Commission of the European Communities, 1990). The benefits are estimated to be as high as 2 to 3 per cent of the value added of the food processing sector in the European Union.

**Growing integration of agriculture**

Regional integration, independent of formal trade agreements, is another important trend likely to serve as a stimulus for trade in food and agriculture in the years to come. The tendency for nations to coalesce regionally seems to be growing for both strategic and economic reasons; the Asian-Pacific market, probably the most prominent example, is set to be the most important future growth area in this domain. Intra-regional agricultural trade in the countries of the Pacific Economic Co-operation Council (PECC) has grown significantly over the past fifteen years. The PECC area now rivals the European Union as the region most integrated through agricultural trade (65 per cent compared with almost 70 per cent) (Coyle, 1996).

---

**Box 4. GATT and RTAs – the technical context**

MFN (most favoured nation) is the primary principle governing the treatment of RTAs in the WTO. The general statement of MFN requires that “goods of any contracting party be given no less favourable treatment than that given to any other contracting party” (Jackson, 1969). For example, MFN prevents the United States from giving Germany import preferences at the expense of the United Kingdom (Henderson, Handy and Neff, 1996). The intention is to produce a liberal trading environment that avoids creating trade distortions. Regional trade agreements are an exception to MFN, allowing trade preferences within a trade agreement. MFN also allows for preferential treatment of developing countries. Special access is granted by the European Union under the Lomé Convention to a designated list of African, Caribbean and Pacific (ACP) nations, which were colonies of the EU member countries.
The policy challenges

- To ensure both local and global welfare gains from regional integration, the design of RTAs should aim at minimising discrimination in trade with and investment in non-member economies. This will also ensure a maximum of compatibility with the multilateral liberalisation process.

- Agriculture plays an important role as producer of raw material for the food processing industry; it should be fully included in these agreements from the outset. Complete integration of agriculture in RTAs is essential to minimise distortions in the composition of trade flows and to maximise transparency in investment decisions in upstream and downstream industries.

- Vigilance is required with regard to the development policy dimension of RTAs. Where preferential market access is provided to a limited number of developing countries [through the Lomé Convention by the European Union, or the Caribbean Basin Initiative (CBI) of the United States], these agreements should be scrutinised for their distortionary effects on nations outside the preference area. Important though trade access may be for developing countries, it should be evaluated against more direct – and often more efficient – assistance programmes.

Innovations drive globalisation in food and agriculture

Transportation and information technologies – Trends and issues

Progress in transportation and communications will be an important factor affecting global food and agriculture over the next twenty years. New transport facilities will widen the range of products shipped over long distances, and provide the preconditions for further growth in international shipments of processed food products and perishable agricultural goods. Deregulation and privatisation of rail and air traffic will reduce shipment costs.

New and more efficient communications will provide new business opportunities for farmers in all countries. Farmers will be able to advertise their produce in a cost-efficient way to a global clientele (and thus sell their goods to a growing number of customers), and discover new and more efficient ways of buying farm inputs. An OECD study (Blandford et al., 1997) investigates the potential, the options and the policy issues relating to “virtual food markets” and the Internet. The study suggests that the Internet offers immense business potential in agricultural input and products markets; it lowers transaction costs for all market participants, reduces geographic and time constraints, and widens the scope for doing business (see Box 5).
Box 5. Innovations in transportation and communications

Transportation and communications costs continue to fall in real terms because of the combined effects of technological improvements, organisational and managerial innovations, and investments in public facilities (Henderson, Handy and Neff, 1996). A number of examples may help to illustrate past developments and future potentials.

In Chicago in 1865, a bushel of wheat sold for about 60 cents, while in London that bushel sold for $1.20; the difference reflected the costs of transportation from Chicago to London. Transport and storage costs accounted for most of the price of the product at the consumption point in London. Between 1865 and 1900, transport rates between Chicago and London fell to 10 cents a bushel, because of dramatic improvements in the technologies of transportation (Henderson, Handy and Neff, 1996).

Today, transport costs are less important barriers to global trade, precisely because of the dramatic improvements made over time. Innovations will continue to reduce real transportation costs for most modes, products, and regions, thereby reducing the economic distance among countries, and the benefits from trade. For example, freight trade between Asia and Europe commonly moves via large containership to the US West Coast, then onto container trains across the country to the East Coast, and finally aboard ship for transit to Europe (Henderson, Handy and Neff, 1996). This innovation allows the use of very large (lower-cost) ships that could not pass through the Panama or Suez Canals.

Improved communications will help to overcome transportation constraints and open new opportunities for trade. For instance, US exports of chilled beef to Japan require precise co-ordination among several enterprises, from the slaughterhouse to a trucker, then onto a railroad, through a port, onto a ship, through a Japanese port, and onto a truck again before final delivery. Better communication technologies allow shippers to tailor volumes and delivery dates for shipments of perishable goods to the precise needs of importers; to shift rapidly among alternate routes and modes to avoid congestion; to track electronically the progress of the shipment to avoid loss or delay; and to co-ordinate rapidly the associated information and payment flows among the parties (Henderson, Handy and Neff, 1996).

The Internet, permitting relatively low-cost access to information, is facilitating the development of virtual commodity markets in agriculture. These markets exist for a range of inputs and final products. For example, virtual commodity exchanges, the posting of buy or sell offers, exist for live animals and meat products as well as farm machinery and genetic materials. Individual sites offer a variety of products and services, ranging from regional speciality products such as snails to organic wheat to agri-tourism facilities. In addition, the Internet is becoming an important tool in information transmission and assistance in decision-making for precision farming, as well as facilitating the use of risk management instruments such as futures and option contracts.

The Internet also helps to reduce transactions costs as buyers and sellers no longer need to travel to market with their products, incurring possible product loss – and market access is increased as the Internet reaches some 60 million potential customers. Trade bulletin boards (commodity exchanges) increase market transparency as buy and sell offers are posted on the net for all participants to see. In order to exploit the full potential of the Internet, it is necessary to have not only an efficient and competitive communication system but also a competitive transportation network, as products must in the end be delivered from seller to buyer. At the same time, by removing geographical and time constraints, virtual markets will also permit those producing specialised products and/or located in remote areas to increase the size of their markets and contribute to their economic viability.
Better communications also mean improved market transparency. This will allow countries to anticipate supply shortages, help them gauge deficits more precisely, and guide their assistance more effectively. New communications will reinforce the benefits from improved transportation as well, and yield a wider range of more efficient logistical arrangements. The synergies of transportation and information technologies could yield efficiency gains comparable to the benefits provided by new carrier systems (ships, containers, air freight) in the past. In fact, better communications are already making an important contribution to overcoming transportation problems in many OECD markets, and promise to alleviate infrastructure constraints in rapidly growing economies outside the OECD area.

Thus, improved communications and transportation will enhance international food security, help to avoid excessive price swings, and increase the ability of markets to remain responsive to shortages without increasing public food inventories. But progress will not be automatic. Some of the changes will call for new policy responses, others for reform of existing policies.

The policy challenges

- Public policy should aim at providing a regulatory environment conducive to innovation and investment in transportation and communications.

- The OECD has suggested rules and regulations to make the Internet a secure market-place, most importantly by developing guidelines for cryptography policy. Policy-makers should promote these initiatives, which will be essential to reap the full potential of “the Web” to create business opportunities in food and agriculture.

- Given that there is significantly less utilisation of information technology services by agricultural and rural residents, an important public policy question is how best to achieve an improved level of access. There are several policy options which governments can choose, such as: i) introducing new regulations (the traditional approach) for the definition of universal access, ii) encouraging a market-oriented approach in line with new directions in telecommunications policies, or iii) subsidising the infrastructure or service as a means of encouraging the private sector to provide a new, much higher level of access to rural households (Huff, 1997).

- To allow farmers to make the best use of market-oriented risk management tools, policies should promote transparency in the use of those tools, facilitate access, and help reduce asymmetric information bias.

- Better transportation and communications could also allow a reassessment of the minimum safe levels of global grain stocks. A portion of previously large stocks had been built up to offset transport- and information-related...
inefficiencies and uncertainties. Holding and managing inventories is costly, both for private and public agents. The improvements in transportation and communications should be taken into account when minimum safe levels of stocks are reassessed and policy recommendations issued.

**Biotechnology**

*The issues: minimise the trade-offs between needs, costs and benefits*

The biggest single challenge for food and agriculture in the twenty-first century will be to develop sustainable production systems to meet the need for safe food supplies for a growing world population without damaging the environment. Biotechnology could provide the most important contribution, with its potential to produce more and higher-quality food with more efficient and possibly more sustainable production methods. But reaping the benefits of biotechnology could also pose numerous and serious externalities, and generate a multitude of policy challenges. Arriving at a judicious balance will not be a simple task.

**Potential**

The growth potential of biotechnology encompasses almost all areas of food and agriculture. Improvements in agriculture include higher crop yields and quality, the development of biopesticides and biofertilizers, new pesticide- and virus-resistant plants, progress in animal breeding, advances in control of parasitic diseases, and new products for animal health care. The range of innovations in the food area encompasses new food products (novel food), enhanced palatability and nutrient content, increased shelf stability, new biodiagnostic and food safety applications and edible packaging. Many of these developments are controversial and will require policy responses in the future.

*How safe are these new developments?*

With any new technology, safety issues must be addressed. Potential public health hazards posed by the introduction of a genetically engineered product into the food supply include an increase in toxins, inclusion of new and potentially allergenic proteins, or the introduction of “unnaturally occurring” hormones into the food supply. A recent food safety concern arose from the allergenic effect of genetically modified soybeans (methionine-rich soybeans engineered through transfers of genes from brazil nuts). Recent environmental concerns focused on the possibility that herbicide resistance of commercial biotech crops could be transferred to weeds. An example is herbicide-resistant sorghum, which can cross with some other weeds in the field and thus produce Johnson grass, which is a very difficult weed to control in many agricultural areas.
Intellectual property rights – who owns the genes?

An important precondition for functioning markets is an appropriate legal framework that affords protection of research results. There are estimates that the possibility of obtaining patents on genes and certain ways to manipulate them has resulted in investment of about $10 to 15 billion in the last fifteen years. Intellectual property rights in this area, however, pose fundamental societal questions. There are claims that these rights should not cover ownership of genes or hybrids, that their resulting benefits should be shared more equitably. A larger version of this dispute exists at the international level. Countries in the southern hemisphere often claim ownership of the germ plasm that was originally used for hybrids and genetically modified crops now protected by intellectual property rights. Countries such as Ethiopia expect some return for the thousands of years of selection that have gone into their indigenous crops (Cavalieri, 1996).

Regulations: how much is possible, how much is necessary?

Biotechnology applications in food and agriculture are the subject of extensive regulatory review to protect against potential negative effects on food safety and the environment. But the regulatory environment differs across countries and regions. Where biotechnology is commonly applied, for instance in the United States, Canada or Australia, the regulatory environment seems to be relaxed. Where public concerns have emerged about biotechnology, not least in northern Europe, the regulatory framework appears to be relatively stringent. The most recent example in this context is the novel food legislation in the European Union. One of the problems there is that the new regulations add to an increasingly complex regulatory environment, involving numerous regulatory agencies and ministries. Another is that compliance costs can be considerable. US grain traders and European food retailers claim that it would be prohibitively expensive to isolate genetically modified soybeans and corn, as stipulated by the novel food legislation in the European Union.

The policy challenges

- The key policy challenge is to strike a balance between growing food needs, the potential contribution of biotechnology and the externalities which could be brought about from tapping its potential. The restrictiveness of regulations will determine how much of the theoretical potential of biotechnology will be available in practice.

- Biotechnological innovations will call for new regulations to ensure that negative side-effects of practical applications remain minimal. The speed of innovation over the recent past suggests that pressures to adjust existing legislation and to react to new developments will continue. The policy
challenge here is to adjust dynamically the regulatory framework so that it allows the realisation of benefits of technological innovation at minimal external costs (food safety, ethical problems, etc.).

- The need to respond dynamically to innovations may also mean a constant pressure to simplify the existing legislation and to avoid regulations that were appropriate in the past becoming a hindrance. But regulatory reform and liberalisation can also be driven by the competition for employment in agriculture, particularly in the biotech industry. Policies have to ensure that “regulatory competition” remains compatible with the general safety concerns.

- Externalities can be an endogenous element of biotechnological innovations. Progress in biotechnology will change the nature and extent of externalities. Negative side-effects may disappear as progress is made. The regulatory environment has to adjust to improvements in order to reap the benefits of improvements.

- The nature of externalities from biotechnological progress needs to be considered when assessing the costs and benefits of innovations. For instance, irreversibility and intergenerational problems resulting from innovations should be an integral part of the risk assessment process for new legislation. These concerns may justify preventive policy measures, particularly for sensitive ethical issues.

- There are also differences in the relative importance of costs and benefits from biotechnological innovations across countries. Some externalities may not be perceived as such by poorer countries, or it may be assumed that possible benefits outweigh the potential risks. International policy agreements have to respect the country-specific priority structures and ensure a fair balance between the economic interests of, e.g., farmers in poorer countries and the food safety concerns of consumers in developed countries.

Globalisation, agriculture and the environment

Conflicting interests

Within countries…

The conflicting interests of two major societal groups are at the heart of the current policy debate. On one side there are the concerns expressed by environmental, consumer and business organisations, which generally support a closer scrutiny of the environmental effects of trade policies. Their interests focus on conservation and sustainable development as well as safer and healthier products; their concerns revolve around allegedly negative impacts of free trade due to shifts in production and
harmonization of standards at a lower level. On the other side, farmers and food organisations are concerned that stricter food and environmental standards will weaken their international competitiveness. The food industry is often concerned about a lack of standardization for labelling and packaging standards, including “ecolabelling” (Krissoff et al., 1996).

... and in international markets

At the international level, the importance of diverging standards may grow as tariff barriers fall and more and more trading partners with different production and processing methods try to exploit their comparative advantage. The environment – as part of the national factor endowment – contributes to the comparative advantage of a country’s agriculture. Production can cause positive and negative side-effects for the environment (externalities) and the internalisation of these externalities affects competitiveness. A nation’s agriculture benefits from the internalisation (remuneration) of positive externalities (amenities), and faces costs if it has to bear (internalise) the negative side-effects. Thus farmers facing stringent environmental standards fear a loss of international competitiveness. They press for special charges on imports produced under lower environmental standards or consider the existing trade barriers an appropriate means to compensate for an unfair cost advantage from “dirty imports”.

Are such claims economically justified?

At the national level, standards should aim to internalise externalities caused by agriculture. This ensures a minimal difference between private and social costs and thus reinstates correct comparative advantages. At the international level, however, the answers are not that evident. To the extent that the environment is part of national factor endowment and farmers use only their local resources for agricultural production, the factor proportion theorem holds in the same way as for the conventional production factors such as labour and capital – i.e. “environment-rich” countries can use the environment more intensively than countries facing scarce resources.26

The guidance of relative factor endowments becomes questionable when international resources are affected. In practice, these issues include transborder pollution, climate change, deforestation and the loss of biodiversity. The internalisation of transboundary externalities is a formidable challenge for practical policy implementation. Inter-generational aspects of many environmental issues add to the complexity.

Diverging national standards will continue to create conflicts between trade and environmental interests. In some cases, countries impose the same environmental standards on imports as on domestic products. In other cases, standards are
sanctioned by the provisions of GATT Article XX\textsuperscript{27} or under the SPS agreement. The legality of many other standards, however, has been called into question, creating trade conflicts. US restrictions on harvesting tuna are a prominent example in this context.\textsuperscript{28} Farmers too are raising similar concerns, seeking protection from foreign produce subject to lower environmental standards and control costs. Livestock producers, for example, would benefit from protection against imports from countries with less demanding requirements for animal waste management.

The policy challenges

- The key challenge is to strike a balance between the overall societal interest in sustainable development (including safer and healthier products), possible negative impacts of free trade due to shifts in production and harmonization of standards at a lower level than the domestic level, and the need to sustain international competitiveness for farmers and the food industry.

- This means establishing the legal and technical basis for defining legitimate differences in countries’ environmental standards, acceptable both to environmental groups and to farmers and the food industry, and to identify methods that permit disguised protectionism to be distinguished from genuine environmental concerns.

- When legitimate environmental concerns are identified, to decide when a country has a right to pressure others to accept its environmental goals and, possibly, its methods of achieving them.

- OECD countries have agreed that unilateral actions to deal with environmental challenges outside the jurisdiction of the importing countries should be avoided, and that international consensus should be the approach to transboundary environmental problems. These principles should also be extended to unilateral restrictions based on requirements related to production and processing methods (PPM).

- Nations now take many different approaches to meeting environmental goals; even when performance standards are similar, policy instruments can differ markedly. Some countries provide subsidies, others levy taxes. The OECD has addressed this issue by encouraging its Members to adopt common principles, such as the polluter-pays principle for environmental policy design.

**IV. THE GLOBAL FOOD BALANCE – ISSUES AND POLICY CHALLENGES**

A major challenge for policy-makers in both OECD and non-OECD countries will be to ensure that the necessary increase in food production is achieved
efficiently while maintaining the sustainability of the resource base. Naturally, the influence of agricultural policies in OECD countries will be limited, and the major challenges are likely to arise where food needs will grow most rapidly. Nevertheless, attention should be given to the impacts of OECD policy reform and trade liberalisation on global food stocks, commodity price variability and international food security.

The past – progress that is remarkable but insufficient and unevenly distributed

The world as a whole has been making progress towards food security and improved overall nutrition. Total calorie availability, for instance, increased from 2 375 kcal\(^29\) per day and person in 1965 to 2 542 kcal in 1980, and reached about 2 730 kcal per person per day in 1995. Over the same period the quality of the typical diet was enhanced with protein intake, growing from 64 g per person per day to almost 71 g in 1995.\(^{30}\) But progress has been uneven across countries, population groups and household members. The resulting problems of malnutrition and undernourishment are widespread and massive. About 800 million people in developing countries do not have access to sufficient food necessary for a healthy and productive life; this is equivalent to about 20 per cent of the population in developing countries. In Sub-Saharan Africa as many as 37 per cent of the population are affected, and that share is higher in some individual countries (Alexandratos, 1995).

Rapid growth in grain production has been the mainstay of higher food production. World cereal production doubled over the past 30 years, and rice production increased even faster. Growth in production came from three sources: yield increases, land use intensification (irrigation, multiple cropping) and area expansion. Rapidly rising yields played a dominant role, benefiting from both genetic progress and increased input use.

The outlook – food needs for the twenty-first century

Global demand for food will continue to increase, driven by robust economic growth in Asia and Latin America. In other regions progress towards better nutrition will be slower, and improvements are expected to remain unevenly distributed across population groups and household members. The growth in total food consumption is expected to average around 1.5-2.0 per cent p.a., about 0.3 per cent above population growth – slightly below the growth rates attained in the past twenty years. The main factors creating a slowdown in growth are saturation, slower population growth, and limited income growth prospects in areas with low per capita calorie consumption (Sub-Saharan Africa, South Asia); this means that potential demand will not fully translate into effective demand.
Most of the incremental food needs will be matched by higher production in developing countries. Additional food demand in these countries will be met by higher OECD exports from bulk commodities, but also increasingly from processed food products. FAO estimates suggest that grain net import requirements of developing countries will rise to about 160 million tons by the year 2010; by 2020, an OECD-funded study suggests, this flow will increase to about 220 million tons.31 For overall food trade, developing countries have recently turned from net exporters to net importers. This trade gap is expected to widen, driven by lower net exports of sugar and rising imports of other temperate zone commodities (Alexandratos, 1995, pp. 124-25).

Past growth in agricultural production has been accompanied by a downward trend in international commodity prices relative to the price of manufactures. This is likely to continue, although perhaps at a slower pace. Commodity prices could benefit somewhat from reduced surplus disposal by OECD exporters, rising demand driven by lower import barriers, and continuing deregulation efforts in the domestic food sectors (OECD, 1997b). The highly competitive farming systems of North America and Australia could gain from this development, given their favourable endowment of land, highly developed infrastructure facilities and an excellent research capacity. These factors will, in conjunction with the continuing technological dynamism of the western farming industry, ensure that possible price increases remain limited.

The policy challenges

Three major policy challenges arise from this outlook: i) policies have to ensure that sufficient food is produced under sustainable agricultural systems through technological changes which increase productivity; ii) policies have to promote international food security through functioning international markets, which provide free and reliable access to meet additional import requirements; and iii) policies have to ensure that everyone has access to sufficient food, by addressing poverty as the root cause of hunger.

i) Ensuring sufficient and sustainable food production

- Most of the increase in global food production will have to come from higher productivity. Two principal options are available to increase productivity: intensification based on existing resources (crop varieties), applying more inputs (fertilizer, pesticides, water, farm management),32 and lifting the existing yield plateau33 through developing new varieties or new food products. Numerous studies suggest that the existing yield potential is insufficient to meet future food needs, but there is also evidence that the potential for future yield growth remains substantial. Policies can play an
important role in helping to tap into this potential in a socially benign, environmentally friendly and sustainable way.

- Investments in agricultural research hold the key to sustainable growth in food production. Low-income developing countries will have to increase investment in agricultural research from the current 0.5 per cent of agricultural output to 1 per cent in the near term and 2 per cent in the longer term (Pinstrup-Anderson, 1996). The social and environmental quality of growth has to improve in parallel. Policies must ensure agricultural sustainability and sound management of natural resources. This encompasses improvement of water quality, more efficient use of water, reversal of land degradation, reduced use of chemical pesticides, and rehabilitation and protection of marine fisheries.

- Policies should also address the distributional dimension of productivity growth. Most people in developing countries reside in rural areas, and are often concentrated in less-favoured areas. These are areas with agricultural production potential but irregular rainfall and fragile soils. Yet, most of the agricultural research investment is still focused on more favoured areas. Policies should address this problem to ensure a better balance.

ii) Ensuring international food security and market stability

- Trade will be an important element in meeting long-term food needs. Freer trade provides importing countries with a wider choice of suppliers and allows them to take full advantage of the world market to make up for shortfalls in domestic production. Trade also helps to exploit comparative advantage: access to export markets allows countries to earn foreign exchange which, in turn, opens access to international food sources. Policy reform has to respond to these challenges by making trade a more important and a more reliable contributor to domestic food supplies.

- Policies have to promote greater international market integration and stability. Further progress in reducing trade barriers is necessary to enlarge the volume of trade, the number of market participants and (thus) the collective capacity to adjust to shortages. More stable international markets are more reliable food sources. In parallel, domestic deregulation efforts must continue, and initiatives towards private risk management need to be encouraged. Farmers' aversion to high risk (particularly in developing countries) suggests substantial benefits from better risk management. As governments withdraw from regulating and controlling domestic prices, farmers and merchants have to develop their own skills and strategies to react efficiently to market signals, deciding when to sell and when to store, and whether to contract forward or use futures and options as part of their risk management strategy. The role of governments is to provide transparent, fair and
undistorted access to these tools – an important element in the future policy agenda in OECD and non-OECD countries alike.

- International food security also requires that food-exporting nations remain consistent and reliable suppliers. Export embargoes and taxes undermine the benefits of trade liberalisation. They tend to impair adjustments in domestic consumption, reduce exports and thus accentuate price swings in international markets. The policy challenge is clear. These restrictions have to be brought under stricter disciplines in internationally binding agreements as rapidly as possible, most appropriately in the next multilateral trade agreement under the auspices of the WTO.

iii) Ensuring access to food

Important though the contributions from access to international food markets may be, hunger remains a poverty problem; it remains a problem of “entitlement”, a problem of access to food. Alleviating poverty will thus continue to be the single most important weapon in fighting hunger. The distribution of poverty across countries, regions and members of families and its dependence on the agricultural sector itself mean that there is no “panacea” for fighting hunger:

- Policies have to address the poverty/hunger problem on a broad front. In the short term, reducing hunger should focus on the household level, by improving access to food through increasing command over resources and raising incomes. In the longer term, policies should support sustainable development, taking into account the catalytic role of agriculture in the development of the overall economy; policies should also ensure consistency in various areas, including development assistance, food aid and macroeconomic reform plans.

- Agriculture plays a pivotal role in reducing poverty and hunger, since it is both the food-producing sector and a catalyst for overall economic development. Particularly in the poorest economies, agriculture is the most effective – and frequently, the only viable – lead sector to generate economic growth. Agricultural growth stimulates development in non-agricultural sectors, which in turn results in increased employment and higher incomes for the poorest. Policy-makers can fuel this engine of growth in the poorest countries by promoting policies that allow resources to be attracted to agriculture through economic incentives and promote agricultural productivity.

V. SUMMARY AND CONCLUSIONS

There is a growing recognition of the need for a new orientation for agricultural policy. Policy-makers will have to balance a wider range of objectives and mediate
among a broader range of stakeholders. This will create the need for greater flexibility and adaptability of policies, for coherence with the broader policy framework and for a shift in focus from farmgate agriculture to the entire food sector. With this reorientation, the role of agricultural policies will be expanded, from protecting and directing the farm sector towards facilitating development in the agro-food sector within the general economic context. More attention will have to be paid to sector-wide impacts of agricultural policy reform, to the environment, and to the sustainability of the resource base. Policies also need to respond to the challenges of a continuing structural adjustment process: timing, pacing and sequencing of policy measures will have to be compatible with the low short-run mobility of production factors characteristic for agriculture.

Reorientation of agricultural policies will create the need for reinstrumentation. Traditional agricultural policies, heavily biased towards price support, are going to be phased out. Direct payments will have to become better targeted, more cost-efficient and de-coupled from farm production or factors of production. If these conditions are fulfilled, they could provide an important tool to respond to the multi-functional role of agriculture, particularly in relation to the environment and rural development.

Reinstrumentation will have to be accompanied by regulatory reform; this involves deregulation, but also the need for new regulations in response to changes in societal preferences and concerns and a number of developments with global impacts on the food and agriculture sector – key among them innovation in biotechnology, communications and transportation.

The policy challenges likely to occur from these developments may differ in the specific technicalities, but they are often the same in principle. Many of the challenges may arise from the uncertainties brought about by the new developments. Uncertainties call for safety issues to be addressed. This holds for biotechnology and information technology alike. The key challenges are: i) to design policies so that their influence starts (ends) where markets fail (function); ii) to promote policy instruments that allow flexible adjustment to the enormous speed of innovation; and above all, iii) to provide policy consistency across countries.

Policy consistency is a major challenge at the international level. As conventional barriers to trade fall, policy consistency will be needed to ensure that no new trade barriers can be erected under the pretext of diverging national standards or regulations.

Finally, there is also the need for a better assessment of policy developments that have taken place, policies under way, and policy alternatives for the future. The growing interdependencies of developments in the agro-food sector mean that more emphasis will have to be placed on the optimal policy mix. That implies the need to analyse impacts on farm incomes, structural adjustment, environmental quality, rural development, trade, and the functioning of world markets.
NOTES

1. Various support measures need, however, to be evaluated on a case-by-case basis, as considerable differences can be expected depending on implementation and other circumstances. Since the late eighties, the proportion of direct payments has increased from 18 to 23 per cent of the total PSE. The share of support not linked to production is still rather low, albeit increasing.

2. For example, under new US farm legislation (the Federal Agricultural Improvement and Reform Act of 1996), the link between income support payments and farm prices was removed by providing for fixed but declining “production flexibility contract payments”. Thus, future production decisions should be based more on market conditions than on expected programme payments.

3. Surplus production, storage and disposal, for example, caused a myriad of new regulations with complex rules for supply control and market administration. In parallel, detailed regulations for direct payments and extensification premiums are needed to cope with or to counter the side-effects of price support policies.

4. The complexity and specificity of regulations caused problems for monitoring effects and efficiency, and opened the door for fraud and misuse.

5. OECD, AGR/CA(96)22/REV1, Paris, 1996.

6. The relative importance of inbound and outbound FDI in the food industry varies significantly across OECD countries. While the United States and the United Kingdom have been major hosts for inbound FDI in the food industry, investment flows to Japan have been negligible. However, the impacts of restrictive investment regulations on FDI flows are not always clear. A 1993 survey of 17 multinational firms (mainly US-owned) suggested that the main reason for FDI was slow growth of domestic markets. Other reasons included risk reduction and the desire to capitalise on technological, product and marketing expertise, service considerations, and transportation cost. Public policies were considered to impede FDI decisions only in a few cases such as Canada’s poultry policy and the supply management for dairy or the US sugar and peanut programmes.
7. Recent experience with agricultural policy agreed by OECD countries suggests that reforms should be accompanied by complementary measures to ensure effective competition. Otherwise, the existence of oligopolistic market structures and non-contestable markets may allow the food processing sector to capture the entire benefits of farm policy reform. Farmers too can misuse market power, and there is evidence that co-operatives can benefit from monopolistic market power. An example of this concern is the recent deregulation of the United Kingdom Milk Marketing Boards, the sole buyers of milk from producers and the sole sellers of milk for processing. With the demise of the Boards in late 1994, farmers were concerned about price pressures in view of the market power of large processors. The creation of voluntary producer-owned co-operatives helped to countervail this market power and even allowed producer prices to increase under the new arrangements. As a consequence, processors have now expressed concerns about anticompetitive behaviour from the farm co-operatives. Both the UK Government and the European Commission are monitoring the situation to ensure that there is no misuse of market power.

8. In recent years, there has been considerable merger and acquisition activity in the agro-food sector while many other proposed arrangements have been prohibited. At the same time, the attitude of competition authorities towards mergers and acquisitions is changing. Most of them now accept that mergers and acquisitions can enhance overall welfare if they yield offsetting cost reductions through economies of scale, synergies and other means. Emphasis on efficiency gains and benefits from economies in conjunction with the need for enhanced international competitiveness in a globalised food market could yield an even greater number of mergers and acquisitions in the food industry in the years to come.

9. Eliminating barriers to trade does not necessarily ensure access to markets. Restrictive business practices and discriminatory investment laws can limit foreign competition — and their impact can become more visible as other barriers to trade are relaxed. Restrictive business practices include granting absolute territorial protection to distributors; excluding producers from trade associations; and preventing supermarkets and distributors from developing house brands.

10. Both import and export arrangements have operated within the agro-food sector for many years, including state trading entities (STEs) with control over exports (Australian Wheat Board, Canadian Wheat Board, New Zealand Dairy Board). STEs with control over imports include the Japanese Livestock Industry Promotion Co-operation, the Norwegian Grain Co-operation, and numerous public or semi-governmental marketing boards in non-OECD countries. Some of these arrangements have been ended in the course of the Uruguay Round Agreement; others are likely to follow in upcoming negotiations. The monopolistic power of STEs depends on the degree of market segmentation and the prevalence of other market distortions, e.g. limitations on market access, tariff rates and export subsidies.
11. Food safety standards can take a number of forms, impose different degrees of restriction, and imply different costs to consumers and processors. In general, standards determining the precise methods to meet the requirements (product and process standards) impose higher compliance costs than those focusing on the targets (performance and target standards). But product and process standards imply lower enforcement costs to government agencies and reduce the information costs to firms. Unlike performance and target standards, product standards provide little incentive to develop technologies to reduce compliance costs.


13. The most recent example is the novel food legislation proposed in the European Union. Its strict implementation would require genetically modified crops to be kept separate from traditional varieties. The proposal implies that “such crops would be separated from the start and throughout the production chain”. This implies that other countries where these crops are grown must follow the same procedure, even though regulators there view these varieties as indistinguishable from traditional varieties. It also means doubling up on silos, farm machinery, means of transportation and processing facilities. In addition, other, uncontrollable circumstances could render the proposal impractical.

14. Diverging regulations arising from this environment are increasingly cause for trade disputes. Most of the debate today is brought about by different food safety standards and risk assessment procedures. In the long run, divergences are likely to affect the competitiveness of the food sector at large, including the farm sector.

15. The compliance costs generally exceed the enforcement costs by many orders of magnitude. High costs of compliance on food business feed through as higher prices to consumers and inhibit innovation. Consequently, it is important to policy-makers to adopt a regulatory framework which allows the achievement of the desired level of food safety at the minimum cost to food suppliers.

The theoretically correct measure of the value to consumers of improvements in food safety is the maximum amount they would be willing to pay for a specified reduction in the risk of food-borne disease, and consequently the risk of ill-health and/or loss of life. However, since no formal markets for food safety exist from which a monetary price can be isolated, estimates of “willingness to pay” must be derived indirectly. Two approaches are commonly employed: expressed “willingness to pay” whereby consumers are asked directly, for example through contingent valuation surveys; and revealed “willingness to pay” whereby the value of improvements in food safety is derived indirectly, for example through consumer choices between bottled mineral water or tap water.

“Willingness to pay” values are widely quoted in the literature and, in certain cases, employed in cost-benefit analysis of new food regulations, for example in the United States. However, there remains some debate over both the
theoretical basis of “willingness to pay” as a measure of the value of reductions in the risk of human ill health and/or loss of life, and the empirical estimation of such values. Consequently, more often than not there is no attempt to quantify risk reductions as part of cost-benefit analysis of proposed food safety regulations.

16. The WTO defines technical regulations as: “[a] document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method” (General Agreement on Tariffs and Trade, 1994). The WTO definition of a standard is “[a] document approved by a recognised body, that provides for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory” (GATT, 1994).

17. Members are encouraged to base their measures on international standards, guidelines or recommendations (harmonization). Countries can, however, maintain or introduce measures which result in higher standards, on the condition that such measures are scientifically justifiable and based on appropriate risk assessment and the actual risks involved. In deciding among alternatives which provide the same level of food safety or animal and plant health, governments are to apply those which are least trade-restrictive. If another country can demonstrate that the measures it applies provide the same level of health protection, these should be accepted as equivalent. To increase transparency, countries must notify other countries of any new or changed SPS requirements which affect trade. They are also required to set up “Inquiry Points” to respond to requests for more information on new or existing measures.

18. In addition, the TBT Agreement contains a code of good practices for so-called conformity assessment procedures, which include the following: “Any procedure used, directly or indirectly, to determine that relevant requirements in technical regulations or standards are fulfilled. Conformity assessment procedures include, inter alia, procedures for sampling, testing and inspection; evaluation, verification and assurance of conformity; registration, accreditation and approval as well as their combinations” (GATT, 1994).

19. All WTO members are automatically signatories of the TBT Agreement, compared with 45 signatories to the “Standards Code”. One innovation of the Agreement of particular importance for agricultural products is that it covers technical regulations related to process and production methods, in addition to product characteristics. The TBT Agreement requires countries not to create unnecessary obstacles to trade when employing technical regulations – but precisely what constitutes necessity is still somewhat unclear and could provide an escape hatch. An important difference between the SPS and TBT Agreements is that there still is no explicit requirement for basing TBT regulations on scientific evidence.
Product and process standards are not all governed by a single global body of rules. There are GATT rules, GATT precedents (case law), the Codex Alimentarius Commission, industry standards, and national institutions and laws whose jurisdictions overlap and contradict each other. The common functions of standards institutions are establishment of the standards, harmonization of standards across national and other administrative jurisdictions, enforcement of standards, and arbitration of disputes when members disagree on the application of standards. Of all the institutions performing these functions, the WTO has the greatest scope. The WTO, as was also true for GATT before it, does not permit the use of technical standards as trade barriers. But Article XX of the GATT allows for general exceptions to the principles of most favoured nation and national treatment: “No country should be prevented from taking measures necessary to ensure the quality of its exports, or for the protection of human, animal or plant life or health, of the environment, or for the prevention of deceptive practices, at the levels it considers appropriate, subject to the requirement that they are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail or a disguised restriction on international trade, and are otherwise in accordance with the provisions of this Agreement” (GATT, 1994).

Members’ obligations following the Uruguay Round are fairly extensive, although there are in many cases no fixed measures for compliance. Members are encouraged to:

- use existing international standards unless there are unusual circumstances;
- participate in formulating new standards where none currently exists;
- publish intent to create standards (where no international standard exists) so other countries have an opportunity to consult and suggest amendments before the standard is applied;
- give higher priority to performance of standards in producing acceptable products than to design or description;
- accept other countries’ standards that differ from their own as long as the objectives of their own standards are met;
- give notification of the objective and rationale of new technical standards and allow consultation; and
- give assistance to other members (particularly developing country members) that wish to establish technical standards.

20. Labelling may not always enhance transparency. Label statements can be misleading even if they are true. The US Food and Drug Administration (FDA), for instance, do not allow labelling statements such as “the milk was derived from cows not injected with bST” unless an accompanying statement makes it clear that there is no substantial difference between milk from bST-treated cows and milk from untreated cows.
(Food and Drug Administration, Docket No. 94D-0025, Federal Register, 20 February 1994; 59:6279-6280).

21. Some of them, like the 1987 Protocol on Substances that Deplete the Ocean Layer (Montreal Protocol), have even established quantitative performance goals.

22. For example, requiring the use of certain environmental control technologies or bans on certain agricultural chemicals.

23. A team of experts gathered by the European Parliament in response to the WTO decision against the EU ban on imports of hormone-treated beef, for instance, claim that “growth hormone residues in meat poses significant public health risk of breast and other cancers” – Agra Europe, E4, 23 May 1997.

24. OECD, Recommendation of the Council concerning guidelines for cryptography policy (adopted by the Council at its 895th session on 27 March 1997 [C/M(97)6/PROV]).

25. Biotechnology offers effective techniques to address consumer concerns about microbial contamination of foods. Biotechnical methods may be used to decrease the time necessary to detect food-borne pathogens, toxins and chemical contaminants, and to increase detection sensitivity. Enzymes, antibodies and micro-organisms produced using rDNA techniques are being used to monitor food production and processing systems for quality control. Microbial probes, biosensors based on adenosine triphosphate (ATP) content, are being used experimentally as indicators of bacterial contamination. Biosensors to detect animal disease, alterations in product quality or temperature abuse are under investigation. These developments offer the potential of lowering the cost and improving the safety of the food supply in a timely manner.

26. In fact, the environmental standards between countries have to diverge if they are meant to reflect the relative scarcity and the differences in societies’ preferences for the public good environment. If, and only if, environmental standards reflect this relative scarcity are they also able to provide the correct shadow price system for the public good environment.

27. Trade-related environmental matters are not explicitly covered in the GATT Articles with the exception of Article XX, which furnishes signatories with ten exceptions to GATT’s guidelines aimed at limiting trade restrictions. Trade measures that fall under Article XX are permitted on the condition that they “are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade”. Article XX subparagraphs (b) and (g), respectively, relate to measures that are “necessary to protect human, animal, or plant life or health” and measures for “the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption”.

191
Additionally, the latest round of negotiations, the Uruguay Round, established rules on issues relating to food, health and safety standards.

28. The US Marine Mammal Protection Act sets dolphin protection standards for the domestic fishing fleet and for imports from international fishing boats that harvest yellowfin tuna in the eastern tropical Pacific Ocean. This has created disagreement between the United States and countries that export tuna to the United States.


30. FAO food balance sheets, FAOSTAT, Rome 1996.

31. The exact import requirements for the non-OECD area (including Mexico, Poland, Hungary and the Czech Republic) amount to 216 million tons.

32. Numerous studies have addressed the importance of these options and their scope for future yield increase. The results available from work at the FAO (e.g. Alexandratos, 1995) suggests that i) there is still some scope, although it is shrinking, to increase yields in many developing countries based on existing genetic resources, both through a better dissemination of existing varieties and heavier input use; ii) intensification can also be positive from an environmental viewpoint (e.g. to avoid a depletion of soil nutrients); iii) farm management skills are a key factor determining yield differences, and better farming practices promise the most substantial and sustainable contributions to yield growth.

33. New technologies promise a number of interesting possibilities to increase food production in the future. Biotechnology in particular offers a multitude of options. There are new plant varieties resistant to disease and adverse climatic conditions; others are resistant to certain pesticides and promise to simplify plant protection and cut costs. New traits of conventional food products have been developed with higher contents of nutrients or improved durability. Biofertilizers and natural pesticides can make crops more productive and are more environmentally friendly than their conventional, chemical counterparts.

34. See, e.g., The Rome Declaration, World Food Summit, FAO, 1996.
BIBLIOGRAPHY


Annex

LIST OF PARTICIPANTS

CHAIRMAN

Wolfgang MICHALSKI
Director, Advisory Unit to the Secretary-General

PARTICIPANTS

Tom ARNOLD
Assistant Secretary
Ministry of Agriculture
(Chairman of the OECD Agriculture Committee)
Ireland

Bob BANSBACK
Director, Industry Development
Meat & Livestock Commission
United Kingdom

Simon G. BEST
CEO and Managing Director
Zeneca Plant Science
United Kingdom

Ke BINGSHENG
Vice President, International Program
China Agricultural University
People’s Republic of China

Walter BRINKMANN
Senior Vice-President
Coca-Cola Greater Europe
Belgium

Dimitri DAMIANOS
Advisor to the Prime Minister
Office of the Prime Minister
Greece

Eduardo DÍEZ PATIER
Directeur Général Adjoint: Relations Agricoles Internationales
Ministère de l’Agriculture, de la Pêche et de l’Alimentation
Spain

Michael GARRETT
Executive Vice-President
Nestlé
Switzerland
Francis GAUTIER  
Vice Chairman  
Groupe Danone  
France

Alan D. GORDON  
Chairman  
GIRAG S.A. (GIRA Group)  
Switzerland

Hartwig de HAEN  
Deputy Director General  
Economics and Social Department  
FAO  
Italy

Dennis R. HENDerson  
Professor Emeritus  
Ohio State University  
United States

Robin S. JOHNSON  
Corporate Vice President  
CARGILL  
United States

Alexander McCALLA  
Director, Agriculture and Natural Resources  
World Bank  
United States

Donald McGAUCHIE  
President  
National Farmers Federation  
Australia

Gerrit MEESTER  
Head, Strategy Policy Division  
Ministry of Agriculture  
The Netherlands

Masateru NAKAGAWA  
Président Directeur Général  
Mitsui & Co. Europe Group  
Japan

Guy PAILLOTIN  
Président  
Institut National de la Recherche Agronomique (INRA)  
France

Per PINSTUP-ANDERSEN  
Director General  
International Food Policy Research Institute (IFPRI)  
United States

August SCHUMACHER  
Administrator  
Foreign Agricultural Service  
Department of Agriculture  
United States

Mrs Eugenia V. SEROVA  
Director, Department of Agriculture  
Institute for Economy in Transition  
Russia

Shinichi SHOGENJI  
Professor, Faculty of Agriculture  
University of Tokyo  
Japan

Björn SIGURBJÖRNSSON  
Secretary-General  
Ministry of Agriculture  
Iceland

Veli-Pekka TALVELA  
Director General, International Affairs  
Ministry of Agriculture and Forestry  
Finland

Stefan TANGERMANN  
Professor, Institut für Agrarökonomie  
University of Göttingen  
Germany
<table>
<thead>
<tr>
<th>Name</th>
<th>Position/Title</th>
<th>Organization</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander TILGENKAMP</td>
<td>Director, International Affairs, DG VI</td>
<td>European Commission</td>
<td>Belgium</td>
</tr>
<tr>
<td>André TORDJMAN</td>
<td>Professor of Marketing</td>
<td>Groupe HEC</td>
<td>France</td>
</tr>
<tr>
<td>Hirofumi UENO</td>
<td>Government Advisor, formerly Vice Minister</td>
<td>Ministry of Agriculture, Forestry &amp; Fisheries</td>
<td>Japan</td>
</tr>
<tr>
<td>Gérard VIATTE</td>
<td>Director</td>
<td>Directorate for Food, Agriculture and Fisheries</td>
<td>OECD</td>
</tr>
<tr>
<td>Mrs Diane VINCENT</td>
<td>Assistant Deputy Minister</td>
<td>Agriculture and Agri-food Canada</td>
<td>Canada</td>
</tr>
</tbody>
</table>