WORLD FOOD AND AGRICULTURE TO 2030/50

HIGHLIGHTS AND VIEWS FROM MID-2009[1]

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CONTENTS

[1] Paper for the Expert Meeting on "How to Feed the World in 2050," FAO, Rome, 24-26 June 2009 (revised 25 July 2009). The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of the Food and Agriculture Organization of the United Nations. Thanks to the colleagues in FAO's Markets and Trade Division preparing the projections of the 2009 *OECD/FAO Agricultural Outlook* for making available preliminary results of ongoing work.

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ABSTRACT

We examine the long-term projections in the FAO Study World Agriculture: Towards 2030/50, prepared in the years 2003-05 (from historical data to 2001 and base year 1999/2001[3]) for selected broad country- and commodity-group aggregates. An overview of the Study's findings is attached as Annex. The objective of the examination is to establish if and to what extent the projections are still valid as predictions of what may be in store in world food and agriculture to mid-century. We test the projections against (a) actual outcomes, as far as available data permit, in the first eight years of the projection period (to 2008), and (b) against the just-completed 10-year projections 2009-2018 of OECD/FAO, both with and without the quantities of crops used as biofuels feedstocks. On both counts, but without accounting for the impact of biofuels (not included in the Study), the projections have been found to be still broadly valid at the level of the aggregates considered.

A fresh look is required to take on board the possible effects of biofuels. The existing medium-term projections of biofuels production and, in some cases, also of the crop quantities to be used as feedstocks, indicate that further growth is in prospect, though not at the very high rates of the last few years. The quantities of cereals by which, in these projections, world aggregate consumption would be higher because of biofuels would be still relatively modest (7 percent of world consumption in 2018, up from the current 4.8 percent), much of which will likely come from increased production over and above what it would be without biofuels. However, the potential exists for biofuels to be a major disruptive force conditioning agricultural futures, because of the growing integration of the energy and agriculture markets. This is a theme which, together with the possible impact of climate change, must inform all future attempts to speculate about long-term futures of world food and agriculture.

We also examine the Study's projections of food consumption (in terms of kcal/person/day) and the numbers undernourished in the developing countries in the light of some drastic revisions in the historical food consumption data and the parameters used to compute such numbers, as well as in the projected populations. Such revisions indicated that per capita food consumption in the Study's base year 99/01 was lower than known at the time. We had to adjust the projected food consumption levels of the Study to account for such revisions so that they can be compared with the latest published estimates (in SOFI08) of per capita consumption and numbers undernourished. Following such adjustments, the projected per capita food consumption (Kcal/person/day from all food commodities) in many developing countries is lower than in the Study. As a consequence, and given the revised higher population projections, the pace of decline in the numbers undernourished, slow and inadequate as it was in the projections of the Study, may turn out to be even slower. Achievement of the 1996 World Food Summit (WFS) target of halving the numbers undernourished in the developing countries by 2015 (from that in 1990/92) may recede well further into the future.

1. INTRODUCTION

This paper sketches out the possible evolution of world food and agriculture to 2050 in terms of the key variables (production and consumption of the main commodity groups and the implications for food and nutrition in the developing countries). It presents a view of how these variables may evolve over time, not how they should evolve from a normative perspective in order to solve problems of nutrition and poverty. The basis for the contents of this paper are Study's food and agriculture projections to 2015, 2030 and 2050, prepared in the years 2003-05 and published in 2006 (FAO, 2006 – hereafter referred to as *Interim Report* - IR). For easy reference, the Section on the main findings from Chapter 1 of the IR (Overview) is attached here as Annex. The reader is referred to the full IR for details.

The projections of the IR were based on historical data from the complete FAO (Faostat) Food Balance Sheets (FBS) available for all countries. The FBS data available then went up to 2001. Hence the base year of the

[3] Notation: 1999/2001 stands for the 3-year average 1999-2001; 2006/08-2018 stands for the period between 2006/08 and 2008. Ton = metric ton

projections was the 3-year average 1999/2001. The evaluation of the projections in terms of the rainfed and irrigated land use and yield configurations underlying the production projections against the land and water potentials of each country was not performed on that occasion. The latest attempt in this area dates from work carried out in 2000-2002 with projections going to 2030 from base year 1997/99 and published in 2003 (Bruinsma, 2003), using the land potential estimates from an older edition of the Global Agroecological Zones Study of FAO and IIASA (GAEZ, Fischer *et al*, 2002). For the IR the evaluation was delayed while waiting for fresh estimates of such potentials to be produced by the revision of the GAEZ. These estimates from the new GAEZ are currently being prepared for publication (Fischer *et al*, forthcoming) but not yet available in the format required for use in analyses of the IR-type. In the meantime for this EM event an attempt is made to unfold the land use and yield growth implications of the production projections to 2030/50 of the IR using the old GAEZ estimates of land potentials. These are presented in a separate paper (Bruinsma, 2009).

Naturally, presenting in mid-2009 projections completed in 2005 and based on historical data up to 2001 and on the outlook for key exogenous variables (the population and GDP projections) as known then presents some problems. The last few years have witnessed upheavals that must be taken into account in passing judgment as to how relevant our views of the future of four years ago are today. In the first place, there has been the intrusion of the energy markets into those for agricultural produce via the links of the high energy prices and the boost this gave to the demand for crops as biofuel feedstocks, helped by government policies favouring such use of crops. It is now widely accepted that this was a key factor explaining the food price surges up to mid-2008. Secondly, the overall economic outlook is being severely affected by the ongoing economic crisis, though the issue of how important this may prove to be for the longer term is moot. Additionally, the latest demographic assessments (U.N. Assessment of 2006 – U.N., 2007), and the just released Assessment of 2008 suggest that projected populations to 2050 may be higher than those of the 2002 Assessment (U.N., 2003) used in the IR, particularly in several countries of sub-Saharan Africa[4].

It would be desirable to account for these new circumstances by re-doing the entire projections exercise. This proved, however, practically impossible given the great country and commodity detail involved (see IR, pp. 66-68) and the delay in updating FAO's FBS data (see Box 1). The second best option is to review the IR projections on the basis of the FAO data set used predominantly for the current monitoring published (for major countries and aggregates only) in the six-monthly *Food Outlook* and largely also for the annual OECD/FAO medium-term projections (hereafter referred to as CBS data[5]). The current round of these medium-term projections for the 10 years 2009-18 has just been completed (OECD/FAO, 2009[6]). These projections *ex hypothesi* incorporate all the information available at present, concerning both developments in the last few years as well as the views of what may be in store up to the year 2018 in terms of the overall economy, the energy sector and prices. As such, the projections provide a valid benchmark to compare with those of the IR in order to draw inferences about the continued validity, or otherwise, of the IR projections. Comparability is limited by differences in commodity coverage/specifications and in country groups distinguished (see *Box 1*). However, some comparisons at the level of large country aggregates (developing, developed, world) can be made to provide a reality check of the IR projections. Regional level projections are presented only in Section 4.

In what follows we run such a reality check, together with a presentation of the IR projections, for a few commodity aggregates, focusing particularly on cereals (sum of wheat, rice, coarse grains) and meat (sum of bovine, pigmeat, poultry, ovine, in carcass weight), for two reasons:

a) they do not present major comparability problems with the commodity specifications of the IR, and

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[4] In the 2002 Assessment, world population was projected to reach 8.9 billion by 2050. The projection is 9.2 billion in latest 2008 Assessment. The projections for the IR developing countries of sub-Saharan Africa are 1.5 billion and 1.7 billion, respectively.

[5] The CBS data used here in text, tables and graphs are updated as of 3 July 2009.

[6] Data and projections in xls available in http://www.agri-outlook.org/document/6/0,3343,en_36774715_36775671_40969158_1_1_1_1,00.html

b) they have held centre-stage in the debate on the food price surges: at the early stages of the price surges a quasi-consensus view was being propounded that spurts in the food/feed demand, particularly in the fast growing emerging economies (India, China) with their allegedly voracious appetite for meat, were a key determinant. This is no more a proposition many would defend, though it is an idea hard to die[7] (see Alexandratos, 2008).

In addition, we present comparisons for the commodity "vegetable oils". Here comparisons are of a more limited nature because of incompatibilities in the commodity specifications.

Box 1. The Data Situation

Before proceeding, a note on the data situation is in order. In preparing the projections published in the Interim Report and on previous work we had used exclusively FAO's Faostat data sets of production and trade of all commodities, including non-food ones like cotton and rubber, as they had been standardized and processed into the Supply-Utilization Accounts (SUAs) and the FBSs. Revisiting these projections in mid-2009 taking into account recent developments requires that we inspect them against SUA/FBS data updated to a more recent year when many changes occurred due to the advent of biofuels and the surge in food prices. Yet, such data are not yet available: at the time of writing (May, 2009) FAO's published SUA/FBS data go only to 2003 and provisional unpublished ones to 2005. The latter estimates include some really radical revisions in the historical data, including those for 1999/2001, the base year of the IR, particularly as regards the per capita food consumption which is of key importance in diagnosing the nutritional situation (see Section 4 below). Faostat non-SUA/FBS data go to 2007 for production and to 2006 for trade. It is obvious that the existing updates of the SUA/FBS data do not provide an adequate basis for revisiting the projections of the Interim Report in the light of new circumstances.

In what follows we resort to the above-mentioned CBS data set. It covers a more limited number of commodities compared with the coverage of the SUA/FBS data, e.g. it does not cover key food commodities like roots and tubers or pulses which are the mainstay of diets in several countries. It has data up to 2008 (the data of this latter year are often estimates) for production, trade and stocks (hence also the implicit total domestic disappearance or consumption for all uses). It often includes, though not in all cases, categories of utilization (food, feed, etc). The country coverage and detail in this data set is not always sufficient to generate the country groups used in the projections of the Interim Report (shown in FAO, 2006, p. 67). For example, Romania and Bulgaria were projected as part of the group "Other Eastern Europe". Likewise, the ten countries that entered the EU in 2004 were projected as a group separately from that of the older 15 EU countries. The CBS do not generally show data for recent years separately for these countries individually but only for the EU as a whole. This makes it impossible to generate data suitable for comparing the IR projections for many country groups with actual outcomes to 2007 and the estimates for 2008. For this reason, in the following discussion data are compared for the developing countries and the rest of the world or the developed countries. The latter comprises the groups "Industrial" and "Transition" of the Interim Report.

Problems of non-comparability of the data because of differences in the commodity specifications are even more serious. For example, in the IR the commodity "sugar" includes all sugar crops and derived products (including non-centrifugal sugar which is important in countries like India) converted into raw sugar equivalent quantities. The CBS does not use the same coverage, therefore direct comparison is not possible. The same goes for the commodity "vegetable oil": in the IR specification it comprises all oilcrops, oils and derived products converted into oil equivalent. This means that consumption of oilseeds directly as pulses (e.g. soybeans, groundnuts) or in other forms, is counted as consumption of the oil content equivalent in the IR data and projections but not in those of the other data bases and projection studies.

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[7] See, for example, a recent article in the *Economist* ("Green Shoots", March 21st, 2009) holding that the steady increase in demand from poorer countries is the single largest cause of rising prices! The correct statement is that increases in the demand of the developing countries represent the major component of global demand growth, but this is nothing new. It has been with us for some time and was present even when prices were not rising and often falling. It is the biofuels that caused the spurt in global demand in the years of price spikes.

2. INTERIM REPORT PROJECTIONS AND REALITY CHECKS

A major point made in the Interim Report was that the growth of demand of the developing countries and the world for both cereals (excluding their use for biofuels which was not accounted for in the IR) and meat would be gradually decelerating. Yet, as noted, in the debate on the food price surges of the recent period up to mid-2008, it was often stated (or rather assumed, given that food consumption data were hardly available) that the spurt in the demand for meat and the associated demand for feed cereals in the developing countries, particularly China and India, was a major factor explaining why cereal prices surged. So the first question to ask is whether the predicted deceleration is actually happening. Then we should examine whether the OECD/FAO projections sketch out future trajectories that are close enough, or otherwise, to those of the IR.

2.1 Cereals

Table 1 compares the Interim Report's (IR) projections with the most recent data for 99/01 and the latest three-year average 2006/08, with and without the cereals use for biofuels. Figure 1 illustrates the relevant trajectories.

Consumption, Developing Countries
We had projected a gradual slowdown in the growth of the cereals consumption (all uses, not only food) in the developing countries, to 1.8 percent p.a. in the first sub-period 99/01-2015. *Is it happening*? It is. Over the period 99/01-06/08 growth decelerated to 1.8 percent p.a. from 3.0 percent in the 1980s and 2.0 percent in the 1990s, while per capita consumption increased to 244 kg in 2006/08. Therefore, on this criterion, the IR projections seem to be on the right track. *Will they continue to be so in the future*? The OECD/FAO medium-term projections to 2018 foresee aggregate consumption of the developing countries to rise to 1 462 million tons (mt) in 2015 (close enough to the 1 472 mt of the IR – Table 1) and on to 1522 mt by 2018. The IR projections seem to be on the right track also on this criterion.

Consumption, Developed Countries
The IR had projected a rebound of growth in the early years of the projection period because of the expected recovery of the transition countries after the deep declines of the 1990s. It did rebound, to 1.4 percent in 99/01-06/08, i.e. by more than projected in IR (0.6 percent in 99/01-2015). However, much of the rebound was due to the growing use of grains for biofuels (overwhelmingly maize for ethanol in the United States of America[8]) and the associated price rises. Without it, the rebound was much more modest (0.4 percent p.a.), lower than in the IR projections. That it was lower can be interpreted as reflecting the fact that not the entire use of maize for ethanol represented additional consumption: part of it was met by reductions in, mainly, the use of grain for livestock feed following the higher prices, hence the lower than projected growth of consumption for food and feed (see Section below on biofuels)[9].

What about the future? The OECD/FAO projections foresee faster growth in the developed countries, 1.5 percent p.a. from 06/08-2018, than the IR. However, the OECD/FAO projections of the developed countries *include biofuels* (80 mt in 06/08, 172 mt in 2018). Excluding such use from the projections, the growth rate of consumption for all other uses from 06/08-2018 is reduced to 0.8 percent. In the end, the IR projection for 2015 of 815 mt compares with the 945 mt (with biofuels) and the 777 mt (without biofuels) of the OECD/FAO projections for the same year. Again, it is implicit that the growth of biofuels will squeeze out some of the IR projected consumption for food and, predominantly, feed. Overall, therefore, the IR projections for the developed countries (excluding biofuels use) seem to be on track.

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[8] Use of maize for fuel alcohol in the United States of America had reached 91 mt in 2008 (www.ers.usda.gov/data/feedgrains/FeedGrainsQueriable.aspx). This is the only source with data of cereals use for biofuels extending back to 1980. Data for more recent years are available for some other countries, in the data set used in the OECD/FAO projections: they indicate, for 2008, 6 mt in the European Union (EU27), 2 mt in Canada and some 4 mt in China.

[9] It is noted that not all the maize used for biofuels should be considered as subtracting an equal amount from supplies available for feed: some 30 percent of the maize used for biofuels is returned to the feed sector in the form of by-products (mainly distillers' dry grains - DDGs).

Consumption, World Totals

The sum of the above two country groups shows that for the world as a whole consumption growth was higher (1.6 percent p.a. from 99/01-06/08) than the projected 1.4 percent from 99/01-2015. It was, however, lower (1.3 percent p.a.) than projected in the IR if the United States of America's maize use for biofuels is excluded from world consumption. The OECD/FAO projections for 2015 are 2407 mt (with biofuels) and 2235 mt (without biofuels) vs. the 2287 mt in the IR projection for the same year.

Conclusion on Cereals Consumption

By and large, the trajectory of actual consumption to 2008 of the world as a whole and also separately for the developing and developed countries (excluding the biofuels component) follow fairly closely the IR projection paths (see Figure 1), which is one of gradually decelerating growth. Ergo, we could use the existing IR projections (at least for these large country aggregates and the world as a whole) and then add on top one or more alternative views of future use of cereals for biofuels (we address this topic later on in this paper, while a companion paper for this EM delves more in depth into this topic – Fischer, 2009). In this way we could get a path of possible developments in the global demand for cereals over the time horizon of the projections that would be compatible with the IR projections, the developments to date, the medium-term outlook of OECD/FAO and at least one view of cereals use for biofuels. Obviously, updating the Study's views of cereals futures for individual countries and small country groups requires a fair amount of work to run similar reality checks at country level, while taking on board also the drastic revisions of the FBS historical data on food consumption for all commodities (discussed in Section 4, below)

Production and Net Imports, Developing Countries

The interface of the production historical data and the projections is not as neat as those for consumption, given fluctuations, caused by both weather and policies. The data of the developing countries production are plotted in Figure 2 (also shown in Table 1). Production was nearly stagnant over the period 1996-2002 (1023 mt in 96/98, 1030 mt in 2001/03), while consumption kept growing and stocks were being depleted. This was one of the factors that presaged the price spikes that followed in the subsequent years (Alexandratos, 2008). During this period, almost all the increases in consumption were met by stocks drawdown. The role of China has been particularly important in these developments during this period: the country started running down the huge stocks it had accumulated in the 1990s (closing stocks of 309 mt in 1999, 84 percent of annual consumption, falling to 148 mt by 2005, 40 percent of consumption[10]). From 2003 onwards there was a rebound in production (reaching 1205 mt in 2006/08). During this latter period, the production increases were more than sufficient to meet the growth of consumption. Indeed part of the production increases went to rebuild stocks (Figure 3). China's role was important also in this second period. Without China, the turnaround from stock depletion to stock rebuilding is much less pronounced, though still evident in the data.

It is important to note that in both periods, changes in net imports played a minor role as contributors to changes in aggregate consumption. They fluctuated in the range 91 mt (2003) - 136 mt (2008). The IR had projected net imports to play a larger role as contributors to the growth of consumption in the developing countries. They were projected to rise from the 112 mt in 99/01 to 168 mt in 2015 and on to 232 mt and 297 mt in 2030 and 2050, respectively. The OECD/FAO projections have 140 mt in 2015 and 154 mt in 2018. If developments in the first half of the current decade are a harbinger of things to come, we may need some radical re-thinking of how we view the future of the developing countries in terms of growing dependence on imported cereals. Lower imports than projected in the IR mean lower projected consumption and/or higher projected production. We have seen that consumption growth of the developing countries is largely on the projected path. Therefore, if projected imports must be lower, it is the production projections that must be revised upwards. This is asking the question: is the IR projection of 1.6 percent p.a. from 99/01-2015 too low in the light of the production growth rebound of recent years (2.3 percent from 99/01-2006/08)?

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[10] Problems associated with China's huge stocks accumulated by the late 1990s included overflowing granaries and losses due to quality deterioration as well as large financial losses from sales (domestic and export) at below-cost prices. These problems prompted policy reforms to reduce stocks. They included some relaxation of the policies that obliged farmers to produce cereals (OECD, 2005:37; see also USDA, 2001).

Before jumping to conclusions, we need to take a closer look at the production increases and pose the question whether the acceleration of growth is likely to prove durable or it is the result of extraordinary circumstances. This requires a look at the data for individual countries. Appendix Table A1 lists the 29 developing countries (accounting for 16 percent of cereals production of the developing countries in 99/01) which in the period 99/01-06/08 achieved cereals production growth rates exceeding 4 percent p.a., 5.7 percent p.a. as a group, up from 1.7 percent p.a. in the 1990s. For several of them the spurt in growth of the last few years represented recoveries from troughs in the preceding years. Such growth rates are certainly not very informative for judging long-term growth prospects.

If we were re-doing the IR projections today, we would certainly want to revisit the production projections of the individual countries in the light of developments in the last few years. The key issue is, of course, whether this would affect in any significant way the aggregates for all developing countries and the prospects for the growth of their net cereals imports. For this we can resort to the OECD/FAO projections to 2018. In these projections, the spurt in the growth of production of the period 99/01-2006/08 (2.3 percent p.a.) is not maintained[11]: they project a growth rate of 1.3 percent p.a. from 2006/08 to 2018. Their projected production for 2015 is 1327 mt vs. 1304 in the IR (Table 1). We also saw that their consumption is somewhat lower than that of the IR. By implication, their projected net imports, being the difference between two much larger numbers, are lower than those of the IR for 2015, 140 mt vs. 168 (Figure 3).

Much of the difference in net imports is due to India and China[12]: in the IR they turn into modest (for their size) net importers by 2015, while the OECD/FAO projections have them as continuing small net exporters (6.4 mt in 2015 and 5.1 mt in 2018). Excluding India and China, the two projections of net imports for 2015 are close – 143 mt in the IR, 146 mt in OECD/FAO. China and India have the potential of influencing decisively the cereals trade prospects of the developing countries. The two countries together had been net importers in the past but became net exporters after 1999, reaching peak net exports of 26 mt in 2002 after which net exports declined to 4-6 mt annually in the last 4 years 2005-08.

A few years ago these two giants were seen as turning into net importers again over the medium term. Thus, the 2004 issue of the Food and Agricultural Policy Research Institute (FAPRI) projections to 2013 had them as net importers of 11 mt in 2013. The latest (FAPRI, 2009) edition has them as net exporters of only 1 mt. in 2018. In like manner the OECD Agricultural Outlook of 2004 had China becoming a significant net importer[13]. A recent International Food Policy Research Institute (IFPRI) report (Rosegrant *et al*, 2008, Figure 4.7) has, in its baseline scenario, China's net cereals imports exceeding 50 mt in both 2025 and 2050 and India remaining net exporter in 2025 and turning into net importer in 2050. In conclusion, the net trade position of the developing countries, being the difference between the much larger numbers of production and consumption, remains sensitive to even small variations of these two larger numbers. Views about the future cereals trade positions of China and India can cause any outlook of the developing countries import needs to swing around. As noted, such views tend to change over time. Back in the mid-90s, Lester Brown (1995) considered the prospect of burgeoning cereals imports of China as a major threat to world food security, a clear exaggeration at the time (see critique in Alexandratos, 1996) and even more so at present. Many people seem to be mesmerized by the hugeness and high

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[11] The latest cereals production forecast for 2009 for the developing countries indicates virtually no increase over that of 2008 (FAO, *Food Outlook*, June 2009)

[12] China's net trade position does not include those of the Taiwan Province and the Hong Kong SAR, both net importers to the tune of 7 mt annually in the last ten years and projected to remain so in the future. Thus, all China is really a net importer of cereals, both at present and in the projections.

[13] "From a net exporter of both wheat and coarse grains at the beginning of the *Outlook*, China could become a significant importer of cereals assuming that the TRQs, implemented by China under the WTO accession agreement, will be used efficiently. By the end of this decade, China could import more than ten times as much wheat, coarse grains and rice as in the recent past. Both wheat and rice import quotas are projected to become filled at least in some years, and coarse grain imports, already by far the largest part of Chinese cereal imports, could reach levels equivalent to twice the import quota for maize". *OECD Agricultural Outlook 2004-2013*, (p.52)

economic growth rates of China and its apparently voracious appetite for livestock products and food in general. This may be true (for some time) for things such as energy and metals, much less so for food: the income elasticity of the demand for food tends to decline rather rapidly, limited as it were by the elasticity of the human stomach. The IR projection of the status of China and India as modest net importers by 2015 reflected the dominant view of a few years ago. There is no compelling reason for changing the long-term projections just now, but the matter should certainly be kept under constant review.

Production, Developed Countries

IR had projected an acceleration of developed country production (not accounting for the effects of the biofuels) in the first projection sub-period (0.9 percent p.a. from 99/01-2015, up from zero in the 1990s) because of the expected recovery in the Transition countries. The advent of the additional demand for biofuels led to production increases even faster than projected in the IR, 1.3 percent p.a. from 99/01-06/08 (Table 1), a growth rate significantly influenced by a quantum jump of 13 percent in 2008, following the price spikes. The OECD/FAO projections foresee even higher growth in the future (1.7 percent p.a. from 2006/08-2018), largely because of growing use for biofuels. The latter are projected to just over double, almost all of it in the developed countries. If we assumed that all cereals used for biofuels were from home production in the developed countries, then, without them, production in 2015 would be 920 mt vs. 985 mt in the IR. This difference can be attributed in part to the above-mentioned possibility that biofuels use of cereals would squeeze out some of the demand for other uses (mostly feed) and in part to the lower net imports required by the developing countries in the OECD/FAO projections, as discussed above.

Production, World

For the World as a whole (the sum of the developed and developing countries) the IR projection is 2287 mt for 2015. This compares with the 2416 mt (with biofuels) or 2244 mt (without biofuels) of the OECD/FAO projections for the same year. If it were not for the biofuels, the IR projection of 3012 mt for 2050 would not be in need of major revision. However, the advent of the biofuels requires that we must at least speculate on possible upwards revisions, perhaps to some 3150 mt, as discussed in Section 3 on biofuels.

Table 1 **Cereals (Wheat, Rice milled, Coarse Grains): IR Data to 2001 & Projections vs. Revised CBS Data to 2008 & Oecd/Fao Proj. to 2018**

	Million Tons						Growth rates - % p.a.						
	1999/2001	**2006/08**	**2015**	**2018**	**2030**	**2050**	80-90	90-00	99/01-06/08	06/8-2018	**99/01-2015**	**2015-30**	**2030-50**
CONSUMPTION													
World -IR data & Projections (excl. biofuels)	1,866		2,287		2,677	3,010					1.4	1.1	0.6
World - CBS data	*1,900*	*2,130*					*1.9*	*1.0*	*1.6*				
*USA - Maize for Ethanol (USDA data)**	*16*	*74*					*20.2*	*4.5*	*24.4*				
World - CBS data excl. USA maize Ethanol	*1,884*	*2,056*					*1.9*	*0.9*	*1.3*				
World - oecd/fao proj. (incl. biofuels)		*2,121*	*2,407*	*2,490*						*1.5*			
World - oecd/fao proj. biofuels		*84*	*172*	*175*						*6.9*			
World - oecd/fao proj. (excl. biofuels)		*2,037*	*2,235*	*2,314*						*1.2*			
Developing Countries - IR data & Projections (excl. biofuels)	1,125		1,472		1,799	2,096					1.8	1.3	0.8
Developing - CBS data	*1,148*	*1,301*					*3.0*	*2.0*	*1.8*				
Developing - oecd/fao Proj.		*1,301*	*1,462*	*1,522*						*1.4*			
Developed Countries - IR data & Projections (excl. biofuels)	741		815		877	914					0.6	0.5	0.2
Developed - CBS data	*752*	*829*					*0.8*	*-0.4*	*1.4*				
Developed - CBS data excl. US maize Etha	*736*	*755*					*0.7*	*-0.5*	*0.4*				
Developed - oecd/fao proj. (incl. biofuels)		*820*	*945*	*967*						*1.5*			
Developed - oecd/fao proj. biofuels		*80*	*168*	*172*						*7.1*			
Developed - oecd/fao proj. (excl. biofuels)		*740*	*777*	*796*						*0.7*			
PRODUCTION													
World -AT data & Projections	1,885		2,290		2,679	3,012					1.3	1.1	0.6
World - CBS data	*1,887*	*2,147*					*1.6*	*0.9*	*1.9*				
World- oecd/fao proj.		*2,127*	*2,416*	*2,500*						*1.5*			
World - oecd/fao proj. (excl. biofuels)		*2,043*	*2,244*	*2,325*						*1.2*			
Developing Countries - AT data & Proj.	1,026		1,304		1,567	1,799					1.6	1.2	0.7
Developing - CBS data	*1,026*	*1,205*					*2.8*	*1.8*	*2.3*				
Developing - oecd/fao Proj.		*1,192*	*1,327*	*1,374*						*1.3*			
Developed Countries - AT data & Proj.	859		985		1,112	1,212					0.9	0.8	0.4
Developed - CBS data	*861*	*942*					*0.6*	*0.0*	*1.3*				
Developed- oecd/fao proj.		*935*	*1,088*	*1,126*						*1.7*			
Developed - oecd/fao proj. (excl. biofuels)		*855*	*920*	*955*						*1.0*			
NET IMPORTS													
Developing Countries - AT data & Proj.	112		168		232	297							
Developing - CCBS data	*110*	*121*											
Developing - oecd/fao Proj.		*122*	*140*	*154*									

** Historical data for cereals use for biofuels going back to 1980 exist only for the USA (www.ers.usda.gov/data/feedgrains/FeedGrainsQueriable.aspx)*

Fig. 1 World Cereals Consumption: Historical Data (with & w.o. US Maize for Ethanol) & IR & Oecd/Fao Projections

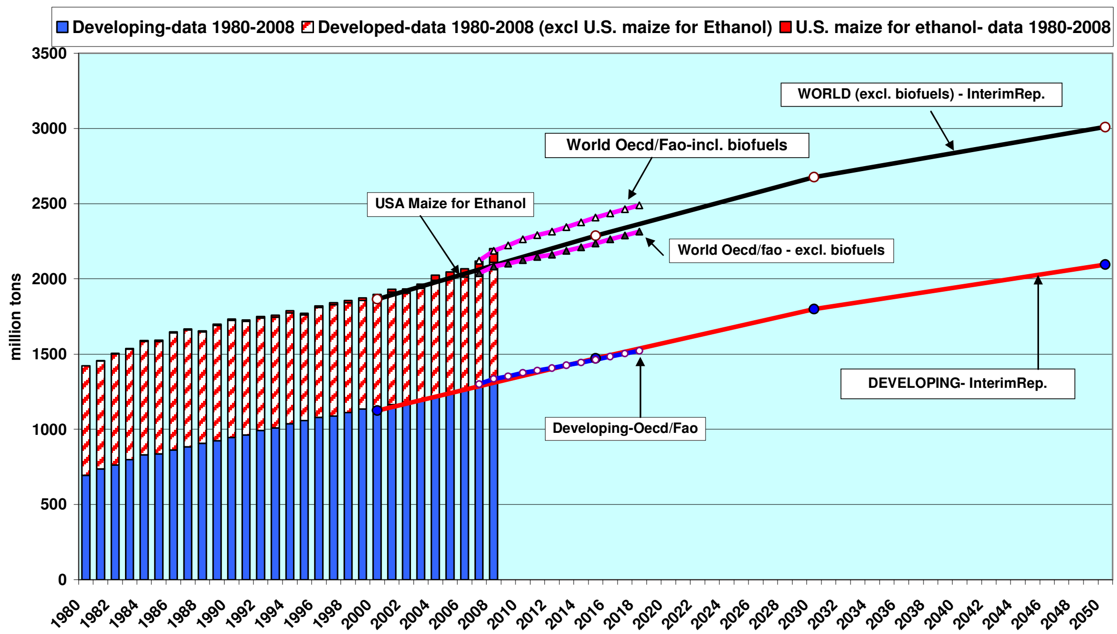


Fig. 2 Developing Countries: Cereals Prod., Consumption & Net Imports (right axis)

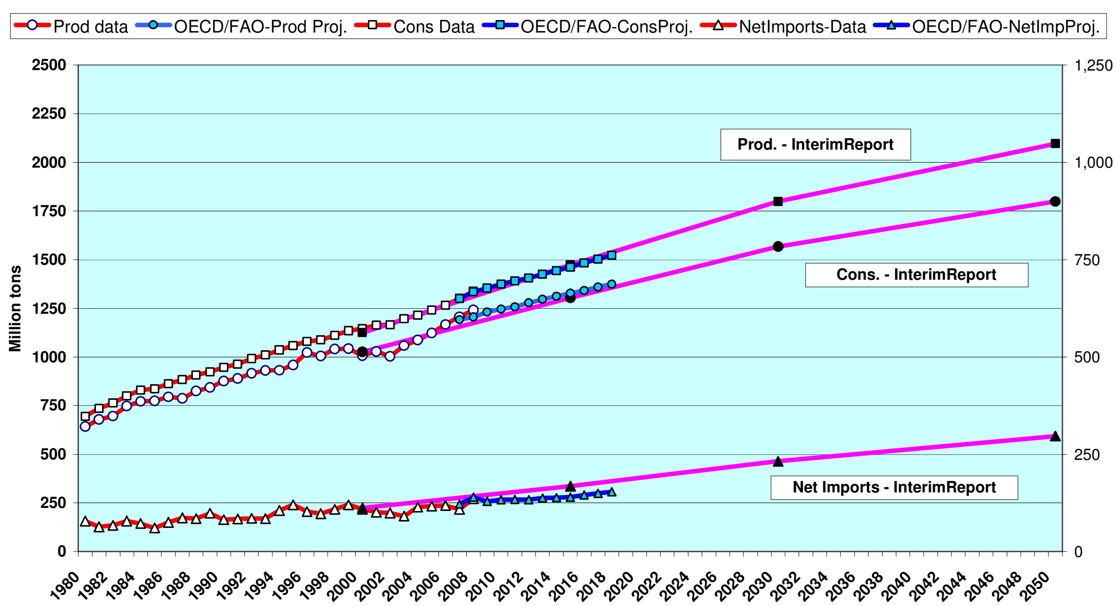
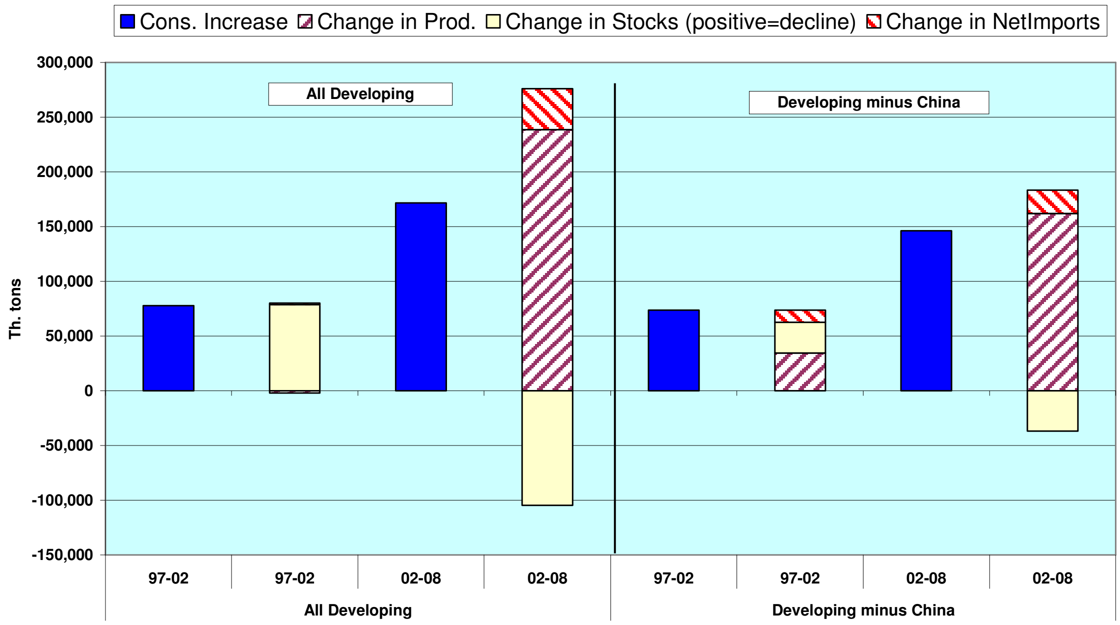


Fig. 3 Growth in Cereals Demand Met by Changes in: Prod., Stocks & Net Imports, 1997-2002 vs. 2002-08



2.2 Meat

Consumption, Developing Countries

In the Interim Report we had emphasized that the fast growth of meat consumption in the developing countries that had occurred in 1980s and the 1990s was reflecting predominantly developments in China and a few other countries (e.g. Brazil, *Interim Report*, Table 3.7). We had projected that such growth was bound to slow down as these countries reached mid-high levels of per capita consumption. Other developing countries would experience faster growth than in the past, but that would not be sufficient to sustain the growth of consumption in the developing countries and the world as a whole at the high rates of the preceding two decades. Is the slowdown happening?

Table 2 shows that the deceleration in the developing countries is taking place: from over 5 percent p.a. in the 80s and 90s to 3.1 percent in the first 7 years of the projection period and more or less on target to meet the 2.8 percent projected for the period to 2015. The OECD/FAO projections foresee a growth rate of 2.6 percent p.a. from 2006/08-2018, in line with the 2.8 percent p.a. of the IR from 99/01-2015. They project per capita consumption to rise slowly from 29 kg in 2006/08 to 33 kg in 2015, the same as in the IR for that year.

Consumption, Developed Countries

In contrast, meat consumption in the developed countries has been growing faster than anticipated in the IR. Per capita consumption rose from 75 kg in 99/01 to 80 kg in 2006/08. In the OECD/FAO projections it rises further to 85 kg in 2015 and on to 87 kg in 2018. This contrasts with the IR projection of 83 kg for 2015 and 95 kg in 2050. The overshooting is wholly due to the strong rebound of consumption in the Transition countries (the former USSR and Eastern Europe) in the early years of the projection period after the slump of the 1990s. Their per capita consumption rose from 46 kg in 99/01 to 57 kg in 2006/08, a level the IR had projected to be reached at a later year. Clearly, account must be taken of this fact in any further discussion of the livestock sector prospects. Needed revisions would raise their consumption in the medium term. However, the key issue here is whether this would alter in any significant way the longer term prospects as depicted in the IR. Think of it this way: these countries' consumption of 23 mt of meat in 2006/08 accounts for 8.5 percent of the world total. Their population is on the decline (from 404 m. in 2007 to 346 m. in 2050). Therefore, even if they continued their rapid growth of meat consumption to reach the average of the developed countries (some 95 kg per capita by 2050), they would add to world consumption another 9 mt (or 2 percent) to the 465 mt the IR had projected for

2050, not a significant change. Therefore, the key issue remains whether the developing countries, with their growing weight in world population and meat consumption, are likely to make faster progress than we had projected (from 26.7 kg per capita in 99/01 to 44 kg in 2050). So far the growth is on the projected trajectory with per capita consumption having reached 29 kg in 2006/08. As noted, the OECD/FAO projections indicate 33 kg for 2015 and 34 kg in 2018.

Consumption, World

The growth of world meat consumption has been slowing down, from 3.3 percent p.a. in the 80s and the 90s to 2.3 percent p.a. from 99/01-2006/08. The IR projects 2.0 percent p.a. for 99/01-2015 and further declines in growth in the subsequent projection periods. The OECD/FAO projections have 1.9 percent p.a. from 2006/08-2018, i.e. the acceleration caused by the rebound of consumption in the Transition countries in recent years is not maintained. Overall, therefore, the IR projections of world meat consumption can be considered as an acceptable longer term outlook in the light of developments to date, at least for the global totals.

Production

The production projections mirror those of consumption, given that net trade is a very small fraction (less than one percent) of production/consumption for the large country aggregates considered here. Therefore, the above commentary on the consumption magnitudes applies also to those of production.

Table 2 Meat (Bovine, Ovine, Pig, Poultry): IR Data to 2001 & Projections vs. Revised CBS Data to 2008 & Oecd/Fao Proj. to 2018

	Million Tons (carcass weight)						Growth rates - % p.a.						
	1999/2001	**2006/08**	**2015**	**2018**	**2030**	**2050**	81-90	90-00	99/01-06/08	06/8-2018	**99/01-2015**	**2015-30**	**2030-50**
CONSUMPTION													
World -IR data & Projections	228		305		380	463					2.0	1.5	1.0
World - CCBS data	230	270					3.3	3.3	2.3				
World - oecd/fao proj.		*267*	*312*	*328*						*1.9*			
Developing Countries - IR data & Proj.	127		191		258	334					2.8	2.0	1.3
Developing - CCBS data	128	159					5.2	6.5	3.1				
Developing - oecd/fao proj.		157	195	208						*2.6*			
Developed Countries - IR data & Proj.	101		113		123	130					0.8	0.5	0.3
Developed - CCBS data	102	112					2.3	0.4	1.3				
Developed - oecd/fao proj.		110	117	120						*0.8*			
PRODUCTION													
World -IR data & Projections	230		306		382	465					1.9	1.5	1.0
World - CCBS data	230	271					3.3	3.2	2.4				
World - oecd/fao proj.		*268*	*312*	*329*						*1.9*			
Developing Countries - IR data & Proj.	125		190		255	332					2.8	2.0	1.3
Developing - CCBS data	126	158					5.1	6.2	3.3				
Developing - oecd/fao proj.		156	192	205						*2.5*			
Developed Countries - IR data & Proj.	104		116		126	133					0.7	0.6	0.3
Developed - CCBS data	104	113					2.3	0.4	1.2				
Developed - oecd/fao proj.		112	120	124						*0.9*			

2.3 Vegetable Oils

The IR (p. 27, 52-58) highlighted the importance of vegetable oils as a fast growing item in the food consumption growth of the developing countries. It projected that such growth would continue for some time (IR Tables 2.7, 3.9). It also highlighted the growing weight of the non-food uses of oils in industry (paints, detergents, lubricants, generally oleochemicals and, increasingly, biodiesel). It projected that world consumption for both food and non-food uses would continue to grow at high rates, though not as high as those of the recent past. To the extent that the historical data on non-food uses included biodiesel, the IR projections must be considered as containing an allowance for biodiesel, though of unknown magnitude. How do the IR projections compare with developments in the current decade and the OECD/FAO projections?

Straightforward comparisons of quantities like those shown earlier for cereals cannot be made for vegetable oils. This is because the CBS data are not of the same specification as those used in the IR analyses (see Box 1). In addition, in the OECD/FAO projections the oilseeds-oils complex is treated as two commodities: "vegetable oil" (the sum of only the four major oils – from soybeans, rapeseed, sunflowerseed, and palm) and "oilseeds" (sum of rapeseed, soybeans and sunflowerseed). It does not cover the other oils and oilseeds (coconut, groundnut, sesame, cottonseed, olive, others), some of which are important in several countries. Therefore, the IR data and projections cannot be compared directly (in terms of quantities of production and consumption) with the data in CBS nor with the OECD/FAO projections. We can at best compare projected growth rates of consumption of vegetable oil only (not of oilseeds) of the IR vs. those of the OECD/FAO exercise, which are not affected significantly by the differences in commodity coverage and specification.

Comparisons of the consumption growth rates are shown in Figure 4. The growth rates in the IR projections for the period 99/01-2015 are generally lower than those of the OECD/FAO projections for 2006/08-18. However, the latter include an allowance for biodiesel. Without it, the OECD/FAO growth rates of consumption are lower than those of the IR. In practice, the IR growth rates are halfway between those of the OECD/FAO projections with biodiesel and those without biodiesel, e.g. the IR world growth rate of 2.7 percent p.a. is halfway between the 3.4 percent of OECD/FAO with biodiesel and 2.2 percent without biodiesel.

As noted, the IR projections contain an unknown component for biodiesel, but it must be small: the use of oils for biodiesel really shot up in the last few years, from under 1 mt in 99/01 to 10 mt in 2006/08 (mostly in the EU and to a lesser extent the United States of America and several developing countries – Argentina, Brazil, Malaysia, Indonesia, Thailand), according to the data used in the OECD/FAO projections. It is noted that the four oils included in the OECD/FAO definition of the commodity "vegetable oils" are the fastest growing ones. Therefore, it is to be expected that the growth rate should be higher in the OECD/FAO projections than in those of the IR which includes also the slower-growing oils. By and large, therefore, the IR projections can be considered an acceptable basis for generating a long term outlook for the sector after adding one or more alternatives for biodiesel use of vegetable oils.

The IR projections indicated growing export orientation of the sector in the developing countries (a growing share of total production going to exports) and a growing import dependence of the developed countries (a growing share of their consumption coming from net imports from the developing countries – Figure 5). The OECD/FAO projections confirm these prospects, though direct comparability of quantities is not possible. The developed countries are increasing their net imports of oils from 8.1 mt (20.4 percent of consumption) in 2006/08 to 16 mt (28.2 percent of consumption) in 2018. At the same time they continue to be net exporters of oilseeds, predominantly soybeans from the United States of America, to the tune of 20.5 mt in 2018, up from 15.5 mt in 2006/08. These net oilseeds exports correspond roughly to 4-5 mt of oil equivalent[14], therefore their net imports of all oils and oilseeds (in oil equivalent) would be some 11-12 mt in 2018 (16 mt minus 4-5 mt). This is higher than the IR projection for 2015 which is 7.2 mt. The difference can be attributed to the higher oil and oilseed imports following the growth of the biodiesel industry in the developed countries.

[14] The bulk of the developed countries oilseed exports are soybeans from the United States of America but also rapeseed and sunflowerseed (mainly Canada, Eastern Europe, Ukraine). Therefore, if we wanted to convert the net oilseed exports of the developed countries to oil equivalent (to obtain a number that can be compared with the definition used in the IR), they would correspond to some 4-5 mt of oil (using an average oil extraction rate near that of soybeans 18-19 percent, but increased to 20-25 percent to account for the higher extraction rates of rapeseed and sunflowerseed, 41-43 percent).

Fig. 4 Growth rates of Vegetable Oils Consumption

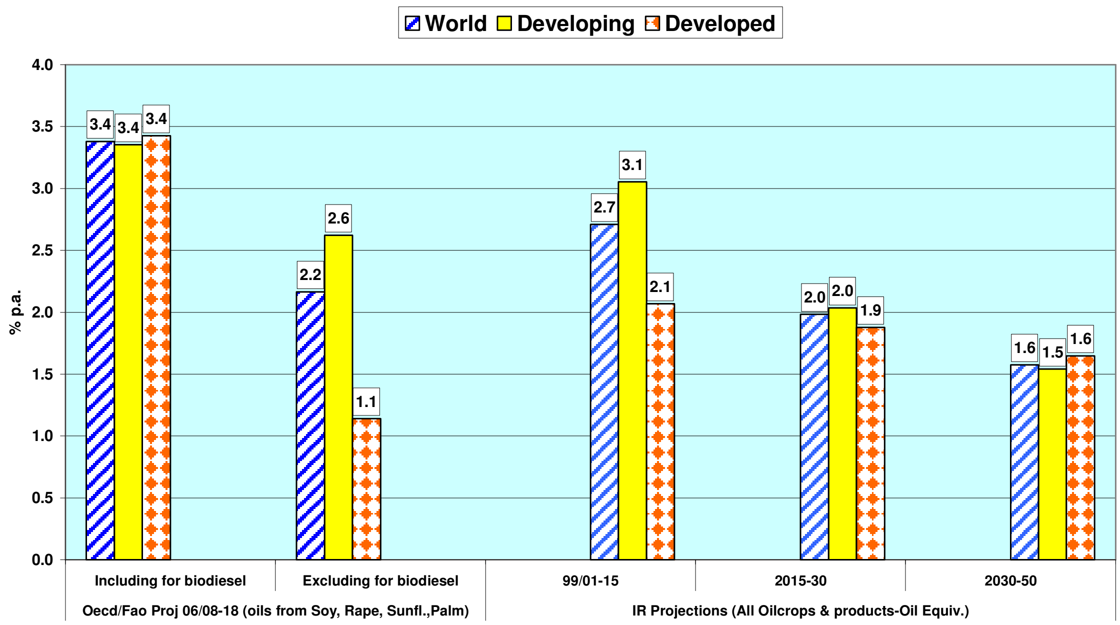
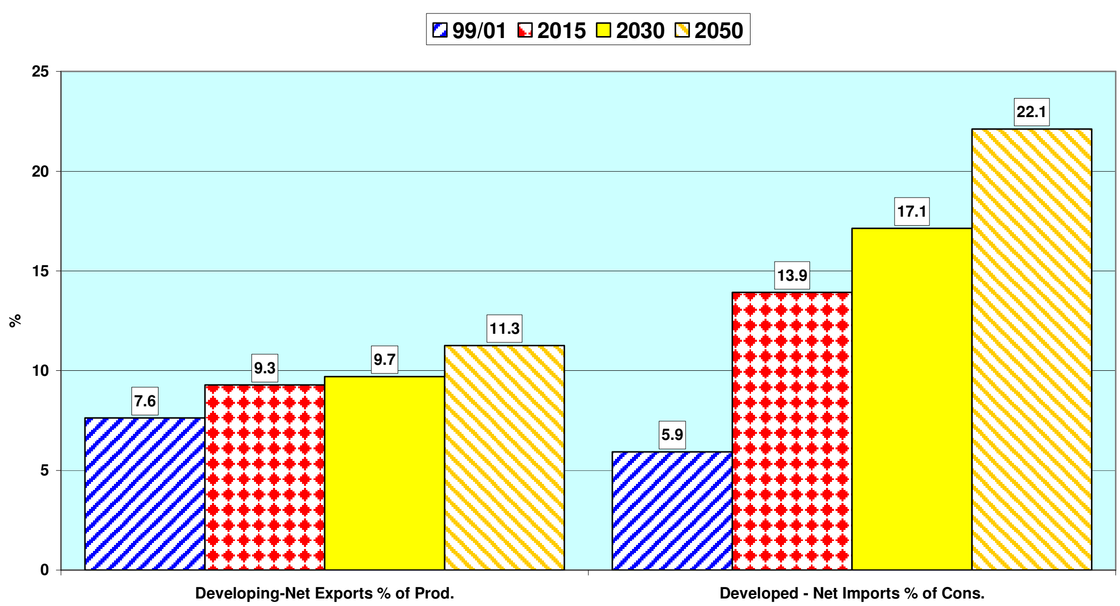


Fig. 5 Oilseeds, Veg. Oils and Products (oil equivalent), IR Projections : Growing Exports of the Developing Countries (% of production) and Imports of the Developed Countries (% of consumption)



3. BIOFUELS: SIGNIFICANCE FOR THE LONG-TERM OUTLOOK

The potential of using crops to produce biofuels had its moment of glory during the recent price surges of both energy and food commodities. At the one extreme biofuels were vilified as causing the food price surges and, occasionally, of being destructive of the environment and the land and water resources. At the other extreme, they were seen as offering great opportunities for boosting farm incomes and energy independence, as well as mitigating adverse environmental effects by reducing the burning of fossil fuels.

With the collapse of the oil prices the debate subsided. These days headlines are more often than not concerned with the woes of the biofuels industry following its rapid expansion during the boom years. The industry is largely kept alive by the mandates and subsidies, with the possible exception of that of sugar ethanol, mainly in Brazil.

Yet, the issue is hardly dead. High energy prices are likely to return (IEA, 2008; Stevens, 2008; McKinsey Global Institute, 2009) and the geopolitical causes driving the quest for energy security are not going away. Add the strength of the farm lobbies and those of the biofuels industry, the continuing relevance of environmental concerns and the prospects of technological change in converting biomass to liquid fuels and we can expect the debate to re-ignite again. It follows that any assessment of long term food prospects cannot ignore the possibility that the expected “normal” slowdown in the growth of demand for agricultural produce (and the underlying claims on agricultural resources and technology development) may not materialize. Therefore, we need one or more projection alternatives accounting for the biofuels effects. This is easier said than done. As noted, with the possible exception of Brazil’s sugar ethanol, the use of grains and vegetable oils for biofuels has largely been driven by mandates and subsidies. Therefore, the historical data do not provide an adequate basis from which to glean valid relationships concerning the role of energy/crop relative prices as triggers of demand growth.

Currently, biofuels projections are commonly an integral part of most projections of food and agriculture. The latest attempts in this area which contain (in varying degrees) sufficient detail of the biofuels modules are all medium-term (10 years), not long-term. They include the latest annual issues of the ten-year outlooks by the USDA (2009), FAPRI (2009) and OECD/FAO (2009). The latter provide the most detail, so we use it below to illustrate the orders of magnitude involved. Figures 6 and 7 show the volumes of biofuels (ethanol and biodiesel, respectively) projected to be produced by 2018.

Fig. 6 Ethanol Production (th. t.), Oecd/Fao Projections

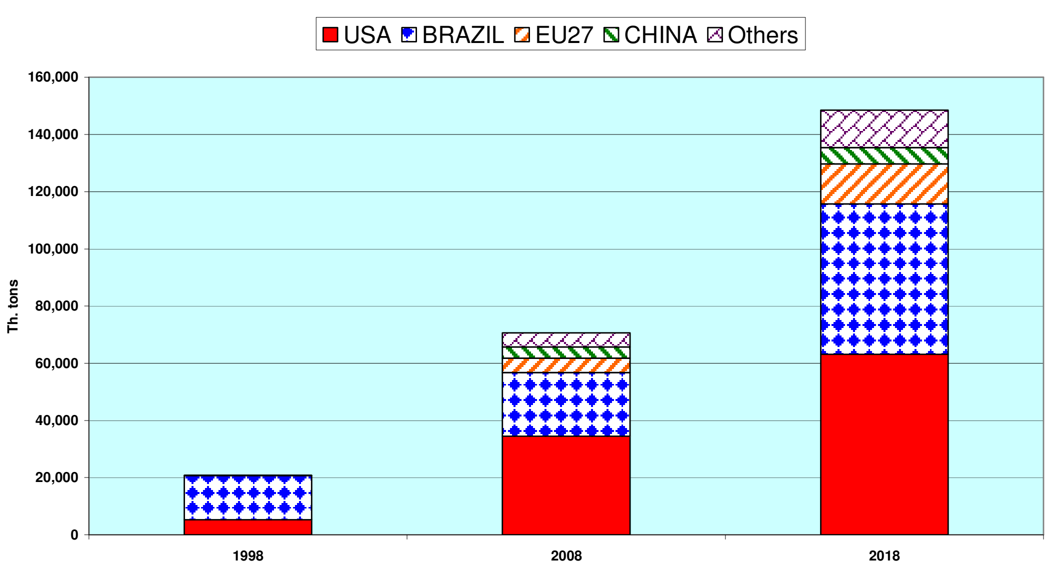
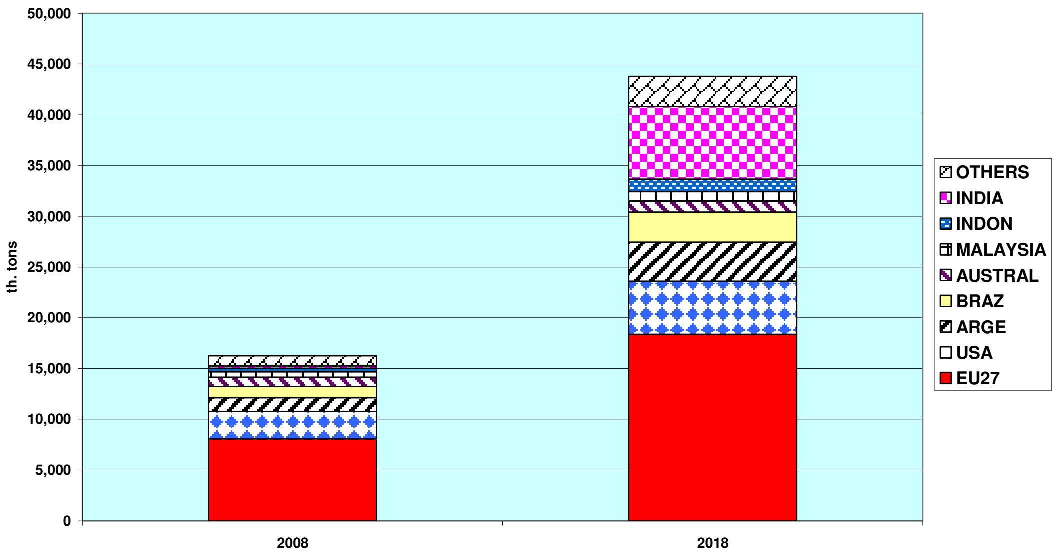


Fig. 7 Biodiesel Production (th. t.), Oecd/Fao Projections



Concerning ethanol, world production is projected to just over double from 2008-18, with the United States of America, Brazil and the EU27 being the major players. Both Brazil and the EU would increase their share in the world total. The share of the United States of America would be somewhat reduced (from 43 percent to 37 percent) and will lose its top post to Brazil whose share increases from 34 percent to 39 percent. Biodiesel production is seen as growing even faster than ethanol, by 170 percent in the 10-year period. The EU would continue to hold top place with 42 percent of world production (down from the some 50 percent currently). The great revelation (according to these projections) could be India, with biodiesel production going from very little today to some 7 million tons in ten years, all of it from jatropha, becoming the world's second largest producer with a share of 16 percent. This reflects the mandate of a 20 percent biofuels blend in gasoline and diesel by 2017.

The key issue is, of course, what all this may imply for food security and nutrition. Concretely, would food consumption be lower than it would be without the use of food crops for biofuel production? We cannot be very concrete about this matter without running counterfactual scenarios, which is not practicable at the moment. It is not just a question of whether world consumption of food and feed would be lower because of the price rises caused by, mainly, the biofuels. We can take it for granted that this would be the case, given that diversion of grain to biofuels affects most directly the feed/livestock sector in the developed countries which is more sensitive to price changes than other components of the food system. However, issues of food security and nutrition have to do with the food consumption of those countries that have large proportions of their population undernourished and also large proportions just above the threshold (the MDER – see next section on nutrition). In such cases, food price rises could aggravate the situation of those below the threshold and push some of those above it to the class of undernourished.

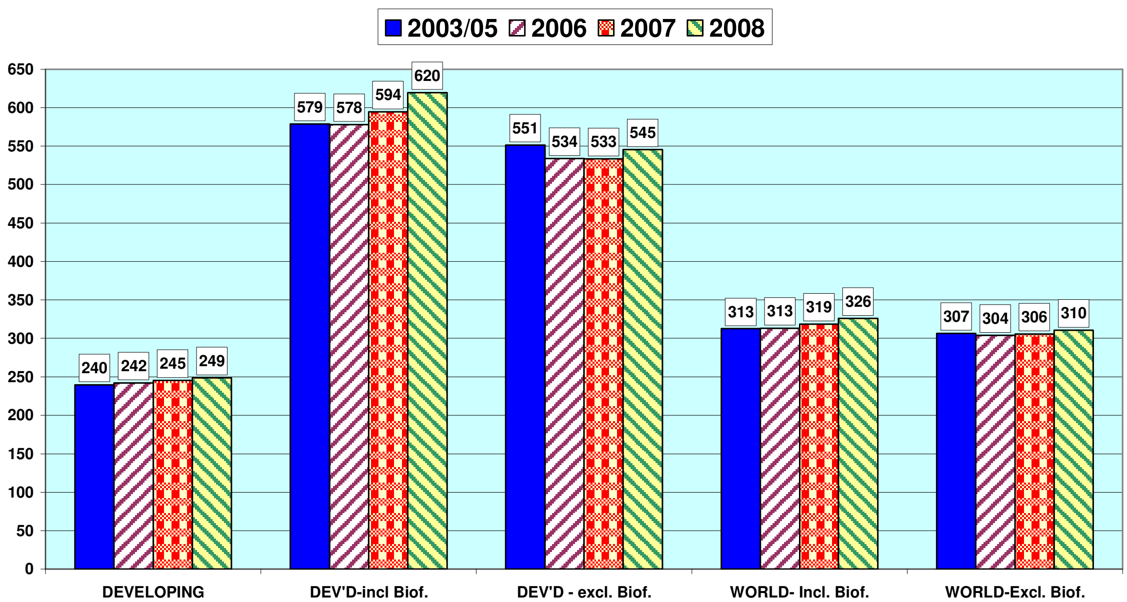
None of the aforementioned ten-year projection studies offers scenarios with and without biofuels[15]. Developments in the last few years of price surges embody information that can help go some way towards answering the question at hand. That is, do they tell us anything about the impact of biofuels on per capita food consumption? And in which country groups? We have seen earlier (Table 1) that some 84 mt of cereals were used for biofuels in the 3-year average 2006/08, 105 mt in 2008 alone. Has this led to a reduction in per capita

[15] A recent IIASA study for the OPEC Fund for International Development (OFID, 2009, Part III, Box 3.4-1) indicates that 66 percent of the additional demand for cereals generated in 2020 by scenarios with growing biofuels use (over and above such use in 2008) would be met by increased production and the rest by reduced consumption of feed (24 percent) and of food (10 percent).

consumption? In the absence of FBS data beyond 2005, we cannot know what happened to the per capita food consumption of all commodities expressed in kcal/person/day. We can only use the CBS data to figure out how per capita consumption of cereals for all uses evolved over the last few years. Figure 8 plots the kg/capita consumption (all uses, with and without the cereals use for biofuels). It is seen that:

1. There have been no declines, but rather small increases, in the per capita consumption of the developing countries (cereals use for biofuels in these countries – some 4 mt in China - is too small, so the entire change can be attributed to non-biofuel uses); and
2. The only declines occurred in the developed countries in 2006-07 in the consumption of food and feed (i.e. all consumption minus the part going to biofuels). With biofuels, their per capita consumption rose significantly.

Fig. 8 Cereals Consumption (all uses, kg/Cap), including & excluding Use for Biofuels



Sources: Cereals Cons.: CBS data (03July09); Population: UN (2007); The developing countries are those with estimates of undernourishment in FAO (2008); the developed countries are the rest of the world.

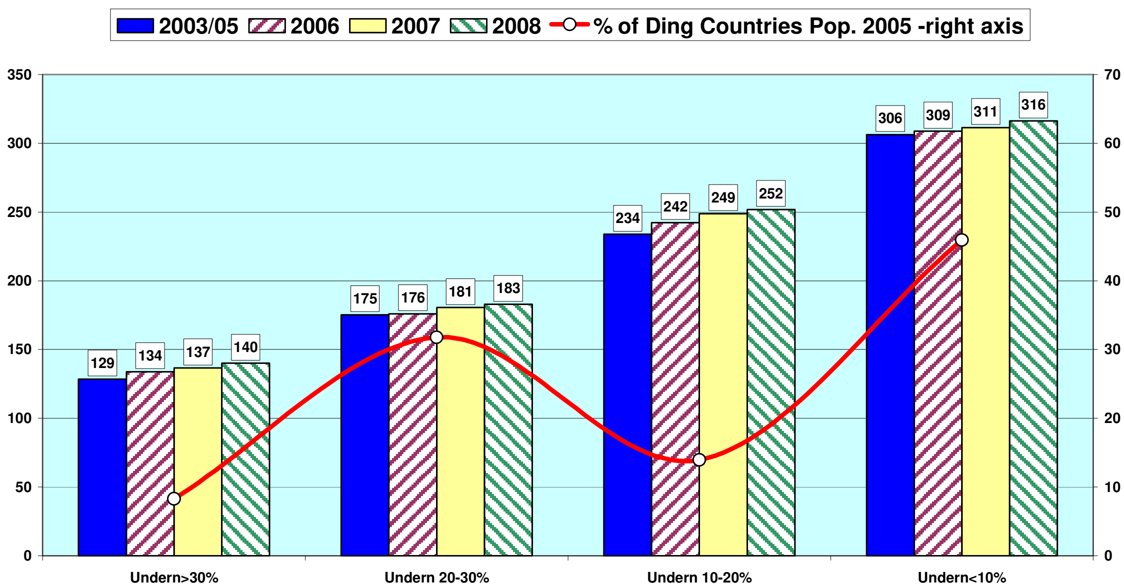
Does this mean that the diversion of cereals to biofuels and the associated price increases did not lead to a reduction in per capita consumption of food and/or to increases in the numbers undernourished in the countries with nutrition problems[16]? We cannot know in the absence of updated FBS data covering all food products. As noted, the risk of deterioration in the nutritional situation in the wake of price surges is highest and most relevant for the countries with low food consumption levels and significant proportions of their population undernourished. To shed some light on this dimension of the issue, an attempt is made in Figure 9 to unfold developments in the per capita consumption of cereals by developing country sub-groups according to their nutritional status in 2003/05 (as given in FAO, 2008). Again, it is seen that no country group suffered a decline. On the contrary, per capita consumption increased in all groups.

Naturally, this is not equivalent to saying that the diversion of grain to biofuels and the associated price rises had no impact on the numbers undernourished: it is possible that, if it were not for biofuels, the per capita consumption of cereals would have improved by more than shown in Figure 8 and 9. Naturally, not the entire amount devoted to biofuels would have been available for food and feed: part of this amount would simply not have been produced since the high prices were to a large measure responsible for the rebound in world cereals

[16] Really, the relevant question is whether per capita consumption is less than it would have been in the absence of the price surges. It is also noted that the numbers undernourished (though not the percent of population) may increase even when per capita consumption does not decline and even increases a little. This can happen because of population growth.

production in both 2007 (+5.4 percent) and 2008 (+7.3 percent). As noted, the IIASA analysis for the OFID suggests that, in the projection period to 2020, some two thirds of the cereals going to biofuels could come from increased production and the balance from reduced consumption of food and, mainly, feed[17].

Fig. 9 Developing Countries: Cereals Consumption (all uses, kg/Cap) by Status of Undern. in 2003/05



Sources: Undern. Status: FAO (2008); Cereals Cons.: CBS data (03July09); Population: UN (2007); The developing countries are those with estimates of undernourishment in FAO (2008)

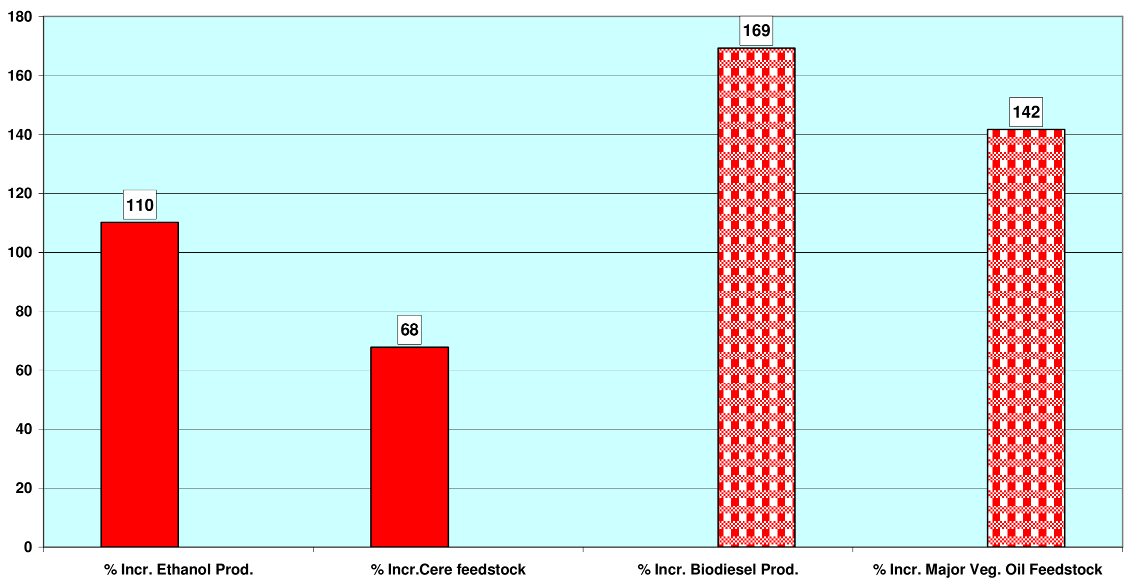
The above mentioned increases of biofuels production in the OECD/FAO 10-year projections (Figure 6, 7) imply further increases in the demand for the feedstock crops we presented earlier (cereals and vegetable oils). Naturally, not all additional ethanol will be produced from cereals and not all biodiesel will come from the four major vegetable oils covered in the OECD/FAO analyses. Even without resorting to feedstocks of non-food crop biomass (second generation biofuels), byproducts (e.g. molasses) and food crops other than cereals (mainly sugar cane, sugar beet, cassava, etc) and fats other than the major oils (e.g. tallow, coconut oil, etc) will be contributing a share to biofuels, perhaps a growing one – e.g. as implied by Brazil's increasing share in world ethanol production and India's ascendancy in the biodiesel field based on jatropha. Therefore, the increases in biofuels production will require less than proportional increases in feedstocks from cereals and the major edible vegetable oils (Figure 10). This notwithstanding, in the projections a growing share of world cereals and vegetable oils consumption will be for biofuels, as shown in Figure 11.

What about projections beyond 2018? The above mentioned IFPRI study with projections to 2050 addressed this issue in the following assumption: "We hold the volume of biofuel feedstock demand constant starting in 2025, in order to represent the relaxation in the demand for food-based feedstock crops created by the rise of the new technologies that convert non-food grasses and forest products" (Rosegrant *et al*, 2008, p.11)[18]. If we accepted this assumption we should be thinking of some 200 mt of cereals going to biofuels by 2050 (from the 105 mt in 2008 and the 175 mt in 2018 in the OECD/FAO projections). Assuming two thirds of this additional demand would be coming from increased production (as per above mentioned IIASA estimate for the OFID paper), our original projection of 3010 mt in 2050 (Table 1) would need to be raised to some 3150 mt and food/feed consumption lowered by some 60 mt to 2950 mt.

[17] See the companion paper by Fischer (2009) for revised estimates of these percentages.

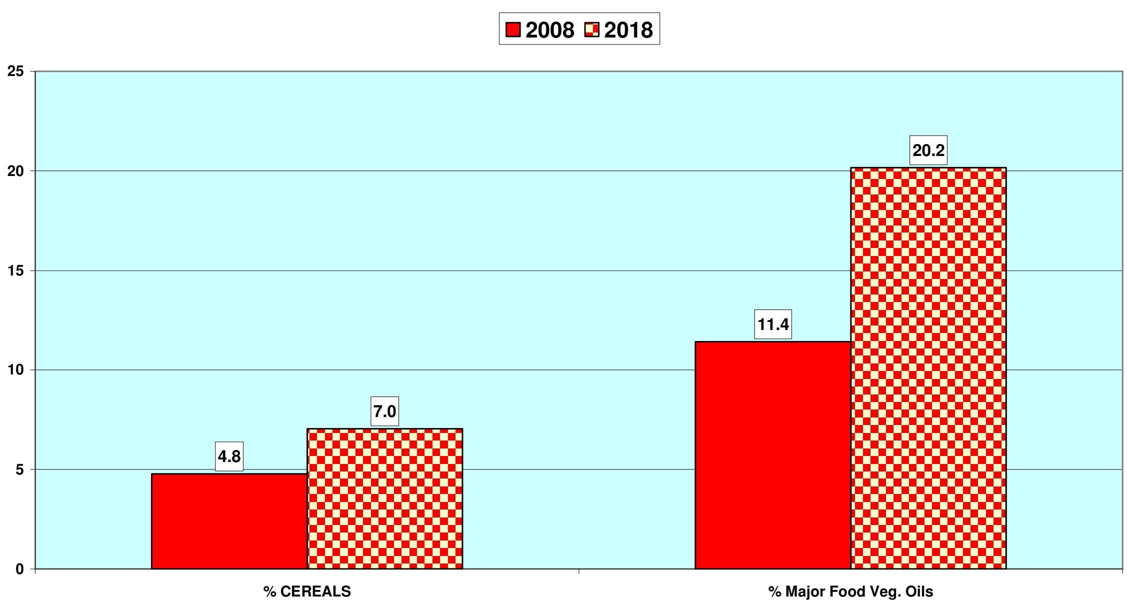
[18] The eventual advent of second generation biofuels in about two decades, might ease the food-biofuels competition but would not eliminate it, since biomass production for second generation biofuels would still compete for the common land and water resources.

Fig. 10 Increases in Biofuels Production vs. Increases in Cereals and Veg. Oils Feedstocks, 2008-18



Source: OECD/FAO (2009)

Fig. 11 Shares (%) of Cereal and Veg. Oils Biofuel Feedstocks in Aggregate World Consumption



Source: OECD/FAO (2009). Veg. Oils include those from Soybeans;rapeseed, sunflowerseed, oilpalm. Jatropha not included in Veg. Oils

These are all speculative ballpark numbers and are offered here for the sake of having some orders of magnitude[19]. If they turned out to be approximately correct, world agriculture could perhaps cope with the problem without significantly higher stress over and above that implied by the need to increase cereals production by the some 900 mt projected in the IR, in terms of the required land-irrigation-yield configurations shown in the companion paper by Bruinsma (2009).

[19] A companion paper for this Expert Meeting (Fischer, 2009) will address specifically this issue and hopefully provide a sounder basis for the discussions.

However, things may turn out quite differently if energy prices were to explode and make conversion of food crops to biofuels profitable even without subsidies and mandates. The investment frenzy that underpinned the expansion of the biofuels industry during the recent price surges of petroleum is telling. It may happen again and the energy sector must be seen as competing with the food sector for supplies if it is profitable for it to do so. The latest McKinsey (2009, p. 63) report forecasts for the period 2006-20 an annual biofuels growth rate of 14.4 percent p.a. This is higher than the 10 percent implied by the OECD/FAO projections for the period 2006-18 (sum of ethanol and biodiesel). The latest U.S. Government energy outlook to 2030[20] has world biofuels growth rates in the range 10 percent p.a. (low oil price case) - 14 percent p.a. (high oil price case) from 2006-20. Growth declines drastically in the subsequent decade to 3.7 percent - 4.6 percent p.a.

In conclusion, the food-fuel competition is likely to be with us in the future. Any analysis must address the eventuality that such competition may intensify, with adverse effects on the food security of some countries and population segments: if it happened, the purchasing power of those demanding more energy could easily overwhelm that of the poor demanding food (see further discussion in Schmidhuber, 2006; Alexandratos, 2008). One of the major tasks of any re-make of FAO's long-term projections would be to address this issue, unfold the implications for food security and explore alternatives.

4. FOOD CONSUMPTION AND NUTRITION IN THE DEVELOPING COUNTRIES: REVISITING CURRENT ESTIMATES AND THE POSSIBLE FUTURE OUTCOMES

In the Interim Report (Table 2.3) we had projected a gradual rise in per capita food consumption in the developing countries. As a result, the numbers undernourished would be gradually falling, from 811 million in 99/01 to 582 million in 2015. Further declines were projected for 2030 and 2050, with the 1996 World Food Summit target of halving the numbers undernourished by 2015 being within sight shortly after 2030. Is this happening? What do the more recent data show?

As noted, the latest food consumption data from the FBS go to 2005. They indicate that per capita consumption in the developing countries increased between 99/01 and 2003/05, from 2580 kcal/person/day to 2620 kcal (Table 4). One would have expected that the numbers undernourished in 2003/05 would be lower than in 99/01. Yet, the most recent FAO publication *The State of Food Insecurity in the World 2008* (FAO, 2008, hereafter referred to as SOFI08) estimates the numbers undernourished in the developing countries at 823 m. in 2003/05[21], i.e. the numbers increased, no matter that food consumption per capita also increased. This seems to be going against the grain of the arguments made in the IR: that rising per capita consumption and some improvement in the inequality of distribution that goes it would lead to declining undernourishment. It is, of course, quite possible for the numbers undernourished to increase because of population growth, if the increase in per capita kcal is small as is the case here (see above and Table 4). However, we cannot avoid posing the question whether the most recent estimates indicate a real reversal of the trend towards gradually and slowly declining numbers of undernourished or is it just data noise?

Trying to understand what is happening, we note that the data of per capita consumption, population, the minimum dietary energy requirements (MDERs – the threshold for classifying persons as undernourished) and the measure of inequality (coefficient of variation – CV) have all been revised rather drastically. These are the key data and parameters used to estimated undernourishment. They are now different from those in SOFI04 which were used in the preparation of the IR.

For example, the average Kcal/person/day of the developing countries for 99/01 are now 2580 kcal, down from the 2654 used in the IR and in SOFI04. For some countries, the declines are particularly sharp, e.g. Myanmar

[20] U.S. Department of Energy - Energy Information Administration (EIA, 2009), *International Energy Outlook 2009* (May 2009).

[21] The estimates for the developing countries published in SOFI08 are somewhat higher, 832 m. in 2003/05, because now SOFI includes in the developing countries also the Central and Western Asian countries of the former USSR. As noted, in the IR and in earlier SOFI issues these countries were part of the Transition countries group.

(from 2840 to 2160), Ecuador (from 2720 to 2220), Indonesia (from 2910 to 2420), Benin (from 2500 to 2190), etc. Such declines cannot but take a heavy toll of the estimates of undernourished, *ceteris paribus*.

If we had used these revised Kcal in the computation of the IR estimates with all other data equal (population[22], MDERs and CVs) as they were known then, the undernourished would have resulted as 920 m., not 811 m., in the starting 3-year average 99/01 of the IR. Again, using the new kcal of 2003/05 with the population from the UN 02 Assessment (to be compatible with that of the IR for 99/01) and unchanged MDERs and CVs, the undernourished for 2003/05 would have resulted as 910 million a small decline from the estimate for 99/01, not an increase.

The revisions of the other data (population, MDERs and CVs) are responsible for the fact the estimates of undernourishment of SOFI08 imply a small increase rather than a small decline between 99/01 and 2003/05. To better appreciate what is involved we need to look into how and why the data have been so drastically revised.

1. Regarding the population, it is just that the new data from the UN Assessment of 2006 had revised estimates for several countries, which had to be taken on board. This concerned particularly several African countries, e.g. Togo (new estimate for 2000 is 18 percent higher than the old one), Benin (16 percent), Angola (12 percent), Senegal (10 percent), Nigeria (9 percent), Mali (-16 percent), etc.
2. The reasons why the MDERs and the CVs were revised are explained elsewhere (FAO, 2004) and are not repeated here. See also the IR, Box 2.2, for more general discussion of the estimation of the numbers undernourished.
3. Concerning the revisions in food consumption per capita, for some countries the change was predominantly the direct consequence of the population revisions: approx. the same amount of food was now divided by a larger population (e.g. Togo, Benin, Angola, Senegal). In other countries both changes in population and total food supplies were responsible for the changes in per capita consumption (e.g. Nigeria, Mali). At the other extreme, for some countries the change in per capita consumption was almost entirely due to revised estimates of total food consumption in the FBSs (e.g. in Indonesia, Myanmar, Ecuador). Such changes in the data of total food consumption do not come necessarily (or only) from changed total national availabilities of food commodities (production plus imports minus exports plus stock changes). They also reflect changes introduced in the final-use allocations of total availabilities in the course of preparing the revised FBS (allocation between food, feed, stock changes, etc).

4.1 Generating a Revised Base Year (99/01) Data Set

The preceding discussion suggests that the IR projections of per capita food consumption (kcal/person/day, given in IR Table 2.1) and the derived projections of undernourishment (IR, Table 2.3) need to be adjusted before they can be compared with the latest situation presented in SOFI08 and provide a basis for making statements about the future course of undernourishment in relation to the present. This is assuming we accept the SOFI08 depiction as representing the reality for the latest year with estimates, i.e. 2003/05. The SOFI08 estimates are based on (a) the revised data of kcal/person/day, (b) the new population data from the U.N. 2006 Assessment and (c) the new MDERs and CVs. We use them to create new estimates of undernourishment in the starting situation of the IR (the base year 99/01). They are shown in Table 3, columns 3 and 9. It is seen that the use of the revised data generate a total estimate of undernourished for 99/01 of 810 m. for the developing countries. It is practically identical to that of the IR (themselves based on those of SOFI04), although regional estimates are somewhat different, no matter that the underlying kcal and parameters have been revised – some of them drastically. Obviously, the impacts of the revisions of the key data and parameters used in the estimation have cancelled one another.

[22] As explained later, changes in per capita food consumption for some countries were predominantly due to the revised data of population. Therefore, using the new consumption data with the unrevised data for the population is not an entirely correct procedure.

Table 3 (format: Table 2.3 of the IR) **Incidence of undernourishment, developing countries**

	Percent of Population						Million					
	90/92	2003/05	99/01	2015	2030	2050	90/92	2003/05	99/01	2015	2030	2050
	SOFI 08						SOFI 08*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Developing countries	n/a	**16.3**	**17.0**	**11.3**	**8.1**	**4.8**	**813**	**823**	**810**	**664**	**556**	**370**
sub-Saharan Africa	n/a	30.5	32.0	22.3	13.9	7.0	169	213	202	204	174	118
excl. Nigeria	n/a	35.8	37.6	26.5	16.1	7.9	*154*	200	190	196	165	110
Near East / North Afr.	n/a	7.9	8.1	6.1	5.0	3.2	19	33	31	31	31	24
Latin America & Carib.	n/a	8.3	9.7	6.9	4.4	3.1	53	45	50	43	31	24
South Asia	n/a	21.3	21.1	13.8	10.2	5.2	283	313	289	238	206	118
East Asia	n/a	11.3	12.7	7.1	5.1	3.9	290	219	237	149	115	87
excluding China	n/a	15.0	17.0	12.8	8.8	5.3	112	97	105	93	72	46

*The absolute numbers differ from those published in SOFI08 because the latter includes in the developing countries the Central and Western Asian countries of the former USSR

4.2 Adjusting the Projected Food Consumption

Obviously, if we take the SOFI08 estimates for 2003/05 as representing the actual undernourishment situation, we must make adjustments to the projections before we can make any statements how the situation may evolve in the future compared with the present, i.e. 2003/05. Required adjustments must be made to the projected values of (a) the kcal/person/day (to take into account the new starting data of 2003/05), (b) the population of the projection years from the UN 06 Assessment of population prospects which was used to generate the SOFI08 estimates (the population projections of the IR were those of the UN 02 Assessment), and (c) the revised MDERs and CVs.

Ideally, one would want to use the new historical FBS data (available in unpublished form up to 2005) and re-do the whole projections exercise by country and commodity in order to generate the new projected values for kcal/person/day. This is not practically possible at this stage, so shortcuts have to be devised to make adjustments. Box 2 describes the rules used to make the adjustments. These rules were applied directly for each country at the level of kcal/person/day (not by commodity). It is noted again that these adjustments are necessary in order to recognize that the levels of food consumption and the implications for undernourishment depicted in SOFI08 differ from those that formed the basis for the food consumption and undernourishment projections of the IR.

With these adjustments, the revised projections of kcal/person/day are shown in Table 4 (reproducing also Table 2.1 of the IR for comparison). The following comments apply:

1. With the exception of the Near East-North Africa Region, all other developing regions have revised base year data for kcal/person/day lower than in the data used in the IR. The difference is very marked in the East Asia region, particularly if China is excluded from the regional totals (see earlier discussion on the data for Myanmar and Indonesia).
2. These lower starting levels have an impact on the projected values, when the latter are adjusted as indicated above. Although projected per capita levels of the developing countries are lower than in the

IR (by 3.4 percent on average in 2050), the aggregate projected consumption in 2050[23] is virtually the same as that of the IR. This is because the new projected population of U.N.06 is higher than that of U.N.02 (used in the IR), by 3.2 percent. That the new projections of per capita consumption combined with the new population values generate aggregate food demand equal to that of the IR is rather important to note: the aggregate food demand of the IR had been derived as an integral component of the entire configuration of production, consumption (all uses, not only food) and trade. However, while this feature applies to the developing countries aggregate, it may not apply at the level of the individual countries.

3. The result is that in 2050 fewer developing countries than reported in the IR will have reached mid-high levels of per capita food consumption (over 2700 kcal/person/day): 73 countries in these revised estimates accounting for 80 percent of the developing country population in 2050 vs. 85 countries (90 percent of the population) in the IR (see Table 5).

Box 2. Rules for adjusting the IR food (kcal/person/day) projections

*1. if the FBS kcal for 2003/05 is lower than that of the IR base year (i.e. $kcal_{03/05}$< IR-$kcal_{99/01}$), then the $kcal_{03/05}$ is taken as the base year and the projected values are derived by applying the growth rates of kcal of the IR projections (49 of the 97 developing countries of the IR fall in this category). Thus, for them, $Revkcal_{2015} = kcal_{03/05}$ **x** $(1+g)^{11}$, where g is the annual growth rate between 99/01 and 2015 of the kcal in the IR. The $Revkcal_{2030}$ and $Revkcal_{2050}$ are derived applying the same rule, i.e. by applying the respective growth rates of the IR projections on the $Revkcal_{2015}$*

2. if the FBS kcal for 2003/05 is higher than that of the IR base year, but lower than the kcal for 2015 in the IR projections (i.e. IR-$kcal_{2015}$>$Newkcal_{03/05}$>IR-$kcal_{99/01}$), the IR-$kcal_{2015}$ remains unchanged and so do the IR projected kcal for 2030 and 2050 (38 countries in this category).

3. If the FBS kcal for 2003/05 is higher than the IR kcal projected for 2015, then $Revkcal_{2015}$=$Newkcal_{2003/05}$ (10 countries). An upper limit of 3500 kcal is imposed to avoid some countries with very drastic upward revisions in their Kcal exploding towards unrealistically high levels of consumption in the projection years. Cuba is a case in point: it had 2833 kcal in the IR base year 99/01. In the revised data used in SOFI08 it has 3022 kcal for the same year and 3276 kcal for 2003/05.

[23] This refers to the product (Population ***x*** Kcal/person/day, summed over all developing countries), i.e. the direct food consumption of the different commodities aggregated according to their Calorie content. It does not include uses other than for direct food, e.g. feed, non-food industrial uses, etc. This indicator of total food consumption is distinct from the conventional one (commonly used to make statements about growth of total food consumption or of total agricultural production) where quantities of diverse commodities are aggregated with prices as weights (see discussion of this topic in IR, Box 3.1).

Table 4 Per capita food consumption (kcal/person/day)

	Interim Report Table 2.1				New data and adjusted Projections				
	99/01	**2015**	**2030**	**2050**	**99/01New**	**03/05**	**2015**	**2030**	**2050**
World	2789	2950	3040	3130	2725	2771	2884	2963	3047
Developing countries	2654	2860	2960	3070	2579	2622	2770	2864	2966
sub-Saharan Africa	2194	2420	2600	2830	2128	2167	2319	2494	2708
- excluding Nigeria	*2072*	*2285*	*2490*	*2740*	*2016*	*2061*	*2206*	*2406*	*2643*
Near East / North Africa	2974	3080	3130	3190	2991	2995	3072	3134	3197
Latin America & Carib.	2836	2990	3120	3200	2798	2899	2953	3084	3151
South Asia	2392	2660	2790	2980	2334	2344	2532	2656	2843
East Asia	2872	3110	3190	3230	2764	2839	3034	3112	3144
- excluding China	*2698*	*2835*	*2965*	*3100*	*2475*	*2538*	*2614*	*2740*	*2870*
Industrial countries	3446	3480	3520	3540	3429	3462	3501	3548	3569
Transition countries	2900	3030	3150	3270	2884	3045	3043	3159	3283

Table 5 Population living in developing countries with given per caput food consumption (million)[1]

		IR Table 2.2			**Revised**		
Kcal/person/day		**1999/01**	**2030**	**2050**	**2003/05**	**2030**	**2050**
<2200	Population (m.)	584	29		515	217	
<2200	Aver. Kcal	2001	2060		1928	2087	
<2200	No Countries	32	2		32	6	
2200-2500	Population (m.)	1537	785	128	2087	785	381
2200-2500	Aver. Kcal	2403	2380	2460	2365	2368	2367
2200-2500	No Countries	26	17	3	26	20	9
2500-2700	Population (m.)	201	510	618	368	2575	1148
2500-2700	Aver. Kcal	2547	2605	2625	2616	2653	2632
2500-2700	No Countries	14	23	12	13	26	20
2700-3000	Population (m.)	1925	2336	1622	1372	801	3035
2700-3000	Aver. Kcal	2933	2835	2870	2987	2854	2856
2700-3000	No Countries	16	31	42	14	25	35
>3000	Population (m.)	484	3049	5140	735	2495	3185
>3000	Aver. Kcal	3174	3280	3200	3163	3309	3262
>3000	No Countries	14	29	45	17	25	38
All Developing	Population (m.)	4731	6709	7509	5077	6873	7748
All Developing	Aver. Kcal	2654	2960	3070	2622	2864	2966
All Developing	No Countries	102	102	102	102	102	102
[1]Only countries with Food Balance Sheets							

4.3 Revised Estimates of Undernourishment in the Future

The implications of the changes indicated above for undernourishment in the future are unfolded in Table 3. The following comments apply:

1. SOFI08 indicated that the numbers undernourished in the developing countries increased from 90/92-2003/05, although the percent of the population affected declined. We saw above that the same applies to changes in the period 99/01-2003/05. However, we noted that revisions in the data of kcal/person/day alone would have produced a small decline, not an increase. It is the application of the whole package of data and parameter revisions that generates a small increase. Should we take this as indicating that the problem is getting worse rather than improving towards the WFS target of halving absolute numbers by 2015 (from those in 90/92)? We can only note that the increase in the estimate of the absolute numbers is small and may well not be significant, given the data noise.
2. Comparing the new projected numbers of undernourished in Table 3 with those in table 2.3 of the IR, it is evident that projected undernourishment is now higher, both in absolute numbers and as percent of the population. Concerning the higher percentage of the population, it is the result of lower projected per capita kcal (Table 4). The impact is reinforced for the absolute numbers because now the projected population of the developing countries (from UN 06, shown in Table 5) is higher.
3. The revised projections indicate a slow decline in undernourishment. However, in the IR the rate of decline was such that the achievement of the WFS could be within reach shortly after 2030. In the revised estimates, the achievement of the target is shifting further into the future – to just before 2050.

5. CONCLUSIONS

In this paper we examined whether the long-term projections to 2050 in the FAO Study (prepared in the years 2003-05 from historical data to 2001 and base year 99/01), were still valid as predictions (for selected broad country- and commodity-aggregates) of what may be in store in world food and agriculture to mid-century. We tested the projections against (a) actual outcomes, as far as data permitted, in the first eight years of the projection period (to 2008), and (b) against the just completed 10-year projections 2009-2018 of OECD/FAO, both with and without the quantities used as biofuels feedstocks. We concluded that, on both counts and disregarding biofuels, the Study's projections are still broadly valid at the level of the aggregates considered.

The advent of biofuels requires a fresh look at the long-term picture. The existing medium-term biofuel production projections and, in some cases, also of the corresponding crop quantities to be used as feedstocks, indicate that further growth is in prospect, though not at the very high rates of the last few years. The quantities of cereals by which, in these projections, world aggregate consumption would be higher because of biofuels would be still relatively modest (7 percent of world consumption in 2018, up from the current 4.8 percent – Figure 11), much of which will likely come from increased production over and above what it would be without biofuels. However, the potential exists for biofuels to be a major disruptive force conditioning agricultural futures because of the growing integration of the energy and agriculture markets. This is a theme which, together with the possible impact of climate change, must inform all future attempts to speculate about long-term futures of world food and agriculture.

We have also examined the Study's projections of food consumption and the numbers undernourished in the developing countries in the light of some drastic revisions in the historical data and parameters used to compute such numbers, as well as in the projected populations. We had to adjust the projected food consumption levels to account for such revisions and make possible comparability of the projections with the latest published estimates (in SOFI08) of per capita consumption and numbers undernourished. These adjustments indicate that rate at which the numbers undernourished were projected to decline, slow and inadequate as it was in the Study's projections, may turn out to be even slower. Achievement of the 1996 World Food Summit target of halving the numbers undernourished in the developing countries by 2015 (from that in 1990/92) may recede well further into the future.

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APPENDIX

Table A1. Developing Countries with Cereals Production Growth > 4.0% p.a., 99/01-2006/08*						
	Th. tons			% p.a.		
	89/91	99/01	06/08	80-90	90-00	99/01-06/08
Sierra Leone	353	181	913	0.2	-7.2	26.0
Iraq	2,456	1,379	3,471	2.8	-9.0	14.1
Paraguay	787	1,236	2,531	6.8	4.1	10.8
Guinea	521	955	1,888	0.0	7.9	10.2
Afghanistan	2,645	2,311	4,493	-3.8	0.8	10.0
Algeria	2,481	1,871	3,337	-1.2	-4.4	8.6
Chad	647	1,103	1,952	4.6	5.0	8.5
Ethiopia&Eritrea	6,370	8,858	15,378	1.7	4.0	8.2
Cambodia	1,649	2,740	4,663	8.6	6.3	7.9
Madagascar	1,779	1,910	3,183	1.9	0.4	7.6
Uruguay	1,101	1,568	2,600	2.1	5.8	7.5
Morocco	7,452	3,478	5,649	8.7	-5.1	7.2
Mali	1,999	2,350	3,578	7.1	2.3	6.2
Niger	1,898	2,690	4,093	0.4	2.9	6.2
Myanmar	9,110	14,002	20,934	-0.2	3.8	5.9
Sudan	2,918	3,988	5,818	-1.3	2.0	5.5
Venezuela	1,834	2,565	3,722	5.6	2.6	5.5
Iran	12,248	13,224	19,139	3.8	0.0	5.4
Zambia	1,461	1,137	1,615	6.6	0.3	5.1
Brazil	34,910	46,873	65,483	2.8	2.5	4.9
Yemen	700	689	958	0.4	0.3	4.8
Tanzania	3,897	3,826	5,311	3.8	0.8	4.8
Angola	297	546	754	-2.5	7.1	4.7
Philippines	10,781	12,732	17,312	3.3	1.0	4.5
Burkina Faso	1,961	2,660	3,613	6.2	1.9	4.5
Nigeria	16,896	20,045	27,223	10.4	2.1	4.5
El Salvador	764	781	1,055	2.1	-0.4	4.4
Bolivia	801	1,142	1,541	2.4	3.3	4.4
Malawi	1,543	2,347	3,096	1.1	7.1	4.0
Sum Above	**132,257**	**159,187**	**235,303**	**3.4**	**1.7**	**5.7**
Other Developing	**737,239**	**866,952**	**969,742**	**2.7**	**1.8**	**1.6**
All Developing	**869,496**	**1,026,138**	**1,205,045**	**2.8**	**1.8**	**2.3**
*Only countries with 2006/08 Production>500 th. tons						

ANNEX

WORLD AGRICULTURE: TOWARDS 2030/50 – INTERIM REPORT (FAO, 2006)

EXCERPT FROM CHAPTER 1 - OVERVIEW

1.2 Main findings

Continued growth of world agriculture even after the end of world population growth

The main reason is that zero population growth at the global level will be the net result of continuing increases in some countries (e.g. by some 31 million annually in 2050 in Africa and South and Western Asia together) compensated by declines in others (e.g. by some 10 million annually in China, Japan and Europe together)[24]. Nearly all the further population increases will be occurring in countries several of which even in 2050 may still have inadequate food consumption levels, hence significant scope for further increases in demand. The pressures for further increases of food supplies in these countries will continue. Much of it will have to be met by growing local production or, as it happened in the past and is still happening currently, it may not be fully met – a typical case of production-constrained food insecurity. The creation of slack in some countries with declining population (e.g. the transition economies, when growth of aggregate demand will have been reduced to a trickle - .01 percent p.a. in the final two decades 2030-50) will not necessarily be made available to meet the still growing demand in countries with rising population, e.g. demand growth at 2.0 percent p.a. in sub-Saharan Africa.

In conclusion, zero population growth at the global level will not automatically translate into zero growth in demand and cessation of the building-up of pressures on resources and the wider environment. The need for production to keep growing in several countries will continue to condition their prospects for improved nutrition. In those among them that have limited agricultural potential, the problem of production-constrained food insecurity and significant incidence of undernourishment may persist, even in a world with stationary population and plentiful food supplies (or potential to increase production) at the global level. Nothing new here: this situation prevails at present and it will not go away simply because population stops growing at the global level. Projections to 2050 provide a basis for thinking about this possible outcome.

Food and nutrition

The historical trend towards increased food consumption per capita as a world average and particularly in the developing countries will likely continue, but at slower rates than in the past as more and more countries approach medium-high levels. The average of the developing countries, that rose from 2110 kcal/person/day 30 years ago to the present 2650 kcal, may rise further to 2960 kcal in the next 30 years and on to 3070 kcal by 2050. By the middle of the century the great bulk of their population (90 percent) may live in countries with over 2700 kcal, up from 51 percent at present and only 4 percent three decades ago. As in the past, the great improvements in China and a few other populous countries will continue to carry a significant weight in these developments.

However, not all countries may achieve food consumption levels consonant with requirements for good nutrition. This may be the case of some of the countries which start with very low consumption (under 2200 kcal/person/day in 1999/01), high rates of undernourishment, high population growth rates, poor prospects for rapid economic growth and often meagre agricultural resources. There are 32 countries in this category, with rates of undernourishment between 29 percent and 72 percent, an average of 42 percent, Yemen and Niger among them. Their present population of 580 million is projected to grow to 1.39 billion by 2050, that of Yemen from

[24] Other reasons include the likely continuation of changes in the structure of consumption towards more livestock products following growth in incomes and urbanization, particularly in the developing countries.

18 million to 84 million and that of Niger from 11 million to 53 million. Their current average food consumption of 2000 kcal/person/day is actually a little below that of 30 years ago. Despite the dismal historical record, the potential exists for several of these countries to make gains by assigning priority to the development of local food production, as other countries have done in the past. Under this fairly optimistic assumption, the average of the group may grow to 2450 kcal in the next 30 years, though this would still not be sufficient for good nutrition in several of them. Hence the conclusion that reducing undernourishment may be a very slow process in these countries.

Notwithstanding the several countries with poor prospects for making sufficient progress, the developing countries as a whole would record significant reductions in the relative prevalence of undernourishment (percent of population affected). However, these will not be translated into commensurate declines in the numbers undernourished because of population growth. Reduction in the absolute numbers is likely to be a slow process. Numbers could decline from the 810 million in 1999/01 to 580 million in 2015, to 460 million in 2030 and to just over 290 million by 2050. This means that the *number* of undernourished in developing countries, which stood at 823 million in 1990/92 (the 3-year average used as the basis for defining the World Food Summit target), is not likely to be halved by 2015. However, the *proportion* of the population undernourished could be halved by 2015 – from 20.3 percent in 1990/92 to 10.1 percent in 2015 and on to 6.9 in 2030 and to 3.9 by 2050. It is noted that the U.N. Millennium Development Goals (MDG) refer not to halving the numbers undernourished but rather to a target to “halve, between 1990 and 2015, the *proportion* of people who suffer from hunger”. In this sense, the MDG goal may be achieved.

Despite this slow pace of progress in reducing the prevalence of undernourishment, the projections do imply considerable overall improvement. In the developing countries the numbers well-fed (i.e. not classified as undernourished according to the criteria used here) could increase from 3.9 billion in 1999/01 (83 percent of their population) to 5.2 billion in 2015 (90 percent of the population), to 6.2 billion (93 percent) in 2030 and to 7.2 billion (96 percent) by 2050. That would be no mean achievement. Fewer countries than at present will have high incidence of undernourishment, none of them in the most populous class. The problem of undernourishment will tend to become smaller in terms of both absolute numbers affected and, even more, in relative terms (proportion of the population), hence it will become more tractable through policy interventions, both national and international.

The progress in raising per capita food consumption to 3000+ kcal/person/day in several developing countries is not always an unmixed blessing. The related diet transitions often imply changes towards energy-dense diets high in fat, particularly saturated fat, sugar and salt and low in unrefined carbohydrates. In combination with lifestyle changes, largely associated with rapid urbanization, such transitions, while beneficent in many countries with still inadequate diets, are often accompanied by a corresponding increase in diet-related chronic Non-Communicable Diseases (NCDs). In many countries undergoing this transition, obesity-related NCDs tend to appear when health problems related to undernutrition of significant parts of their populations are still widely prevalent. The two problems co-exist and these countries are confronted with a “double burden of malnutrition” resulting in novel challenges and strains in their health systems.

Growth of agriculture and main commodity sectors

Aggregate agriculture: World agriculture (*aggregate value of production*, all food and non-food crop and livestock commodities) has been growing at rates of 2.1-2.3 percent p.a. in the last four decades, with much of the growth originating in the developing countries (3.4-3.8 percent p.a.). The high growth rates of the latter reflected, among other things, developments in some large countries - foremost among them China. Without China, the rest of the developing countries grew at 2.8-3.0 percent p.a. They also reflected the rising share of high value commodities like livestock products in the total value of production: in terms of quantities (whether measured in tonnage or calorie content), the growth rates have been lower (see Box 3.1).

The future may see some drastic decline in the growth of aggregate world production, to 1.5 percent p.a. in the next three decades and on to 0.9 percent p.a. in the subsequent 20 years to 2050. The slowdown reflects the lower population growth and the gradual attainment of medium-high levels of per capita consumption in a growing number of countries. The latter factor restricts the scope for further growth in demand per capita in several countries which had very high growth in the past, foremost among them China. In contrast, developing countries that experienced slow growth in the past (and as result still have low per capita consumption - less than 2700 kcal/person/day) and potential for further growth, should not experience any slowdown but rather some acceleration. Increasingly, world agriculture will have to depend on non-food uses of commodities if growth rates are not to be sharply lower compared with the past. As noted, the biofuels sector may provide some scope, perhaps a significant one, for relaxing the demand constraints represented by the declining rates of increase in human consumption.

Cereals: All the major commodity sectors should participate in the deceleration of agricultural growth. The cereals sector (sum of wheat, milled rice and coarse grains) has already been in such downward trend for some time now, with the growth rate having fallen from 3.7 percent p.a. in sixties, to 2.5 percent, 1.4 percent and 1.1 percent p.a. in the subsequent three decades to 2001. In this latter year world production stood at just under 1.9 billion tons. It has grown further since then to some 2 billion tons in 2005 (preliminary estimate). We project increases to some 3 billion tons by 2050 and this would afford some increase in world per capita availability to around 340 kg (for all food and non-food uses), some 10 percent over present levels. It is noted that the current level of per capita consumption (309 kg in 1999/01) is lower than what was achieved in the past mainly due to the sharp declines in the transition economies (the former socialist countries of the USSR and Eastern Europe) in the 1990s. Recovery in their consumption as well as continued growth in the developing countries should raise the world average to levels it had attained in the past (in the mid-80s). A good part of the increase in world cereals consumption should be for animal feed (mostly coarse grains), with the bulk of such consumption increases originating in the developing countries to support the expansion of their livestock production.

The decline in the growth rate notwithstanding, the absolute increases involved should not be underestimated: an increase of world production by another 1.1 billion tons annually will be required by 2050 over the 1.9 billion tons of 1999/01 (or 1 billion tons over the 2 billion of 2005). Achieving it should not be taken for granted, as land and water resources are now more stretched than in the past and the potential for continued growth of yield is more limited.

Not all countries will be able to increase cereals production *pari passu* with their consumption. Therefore, past trends of ever growing net cereal imports of the developing countries should continue and grow to some 300 million tons[25] by 2050 a 2.7-fold increase over the 112 million tons of 1999/01. This is a much lower rate of increase compared with the past when they had grown more than 5-fold in 40 years. The novel element in the projections is that transition economies are transforming themselves from the large net importers of cereals they were up to the early 1990s (net imports of 43 million tons in 1993) to net exporters (18 million tons net exports annual average in 2002-04). Such net exports could increase further in the future and, therefore, the traditional cereal exporters (North America, Australia, the EU and the developing exporters) would not have to produce the full surplus needed to cover this growing deficit.

Livestock: Production and consumption of meat will also experience a growth deceleration compared with the high growth rates of the past, though the milk sector should accelerate, mainly because of growth in the developing countries demand. The growth of the meat sector had been decisively influenced upwards by the rapid growth of production and consumption in China, and to a smaller extent also Brazil. This upward influence on the world totals was counterbalanced in the 1990s by the drastic shrinkage of the livestock sector in the transition economies, leading to a growth rate in the decade of 2.1 percent p.a. vs. 3.1 percent if the transition economies data are excluded from the world totals. These influences will not be present with the same force in the future - with the exception of continued rapid growth of production in Brazil (mainly for export). The decline in the transition economies has already been reversed while the growth of meat consumption in China, which grew from 9 kg per capita to more than 50 kg in the last three decades, cannot obviously continue at the same high rates for much longer (see, however, Chapter 3 for uncertainties concerning the reliability of the livestock data of China).

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[25] To 380 million tons if we exclude from the developing countries the traditional exporters among them - Argentina, Thailand and Vietnam.

The rest of the developing countries still has significant scope for growth, given that their annual per capita meat consumption is still a modest 16 kg. Some of this growth potential will materialize as effective demand and their per capita consumption could double by 2050, i.e. faster than in the past. It is unlikely that other major developing countries will replicate the role played by China in the past in boosting the world meat sector. In particular, India's meat consumption growth may not exert anything like the impact China had in the past, notwithstanding its huge population and good income growth prospects. The country may still have low levels of consumption (though significantly above the current 5 kg) for the foreseeable future.

Vegetable oils: The sector has been in rapid expansion, fuelled by the growth of food consumption and imports of the developing countries. The growth of the non-food uses (including in recent years for the production of biofuels in some countries) was also a major factor in the buoyancy of the sector, as was the availability of ample expansion potential of land suitable for the major oilcrops - mainly soybeans in South America and the oilpalm in South-East Asia. Indeed, oilcrops have been responsible for a good part of the increases in total cultivated land in the developing countries and the world as a whole. These trends are likely to continue as the food consumption levels of the developing countries are still fairly low and the income elasticity of demand for vegetable oils is still high in most countries. In parallel, the growing interest in using vegetable oils in the production of biofuels may provide a significant boost. In this respect, concerns have been expressed that the rapid expansion of land areas under oilcrops can have significant adverse impacts on the environment, mainly by favouring deforestation. This is just another example of the trade offs between different aspects of sustainability that often accompany development: benefits in terms of reduced emissions of greenhouse gases when biofuels substitute petroleum-based fuels in transport vs. the adverse impacts of land expansion.

Sugar: There are a number of features that characterize the evolution of the sector and determine future prospects: (a) rapidly rising food consumption in the developing countries (3.2 percent p.a. in the last 30 years); (b) the emergence of several of them as major net importers (net imports of the deficit developing countries rose from 10 million tons to 29 million tons over the same period); (c) the growing dominance of Brazil as the major low-cost producer and exporter (production rose from 7.5 million tons to 32 million tons[26] and net exports from 1 million tons to 11 million tons over the same period); (d) the growing use of sugar cane as feedstock for the production of biofuels (ethanol, mainly in Brazil, which now uses some 50 percent of cane production for this purpose); and (e) the prospect that after many years of heavy protectionism of the sugar sector and declining net imports in the industrial countries (which turned into net exporters from the mid-80s, mainly due to the protection of the sector in the EU and the substitution of corn-based sweeteners for sugar in the United States of America), the stage may be set for a reversal of such trends and the resumption of growth in their imports.

Many developing countries, including China, have still low or very low sugar consumption per capita (28 countries have less than 10 kg p.a. and another 18 have 10-20 kg). Therefore, the potential exists for further growth in consumption, though it will not be as vigorous as in the past when 60 developing countries had less than 20 kg in 1969/71. Depending on the evolution of petroleum prices, sugar cane use as feedstock for the production of biofuels may keep growing in several producing countries (or those that have the resource potential to become major producers). Already several countries have plans to do so. It is possible that this development would contribute to keeping the growth rate of world aggregate demand (for all uses) and production from declining in line with the deceleration in the demand for food uses.

Roots, Tubers and Plantains: These products play an important role in sustaining food consumption levels in the many countries that have a high dependence on them and low food consumption levels overall. Many of these countries are in sub-Saharan Africa. In some countries (e.g. Nigeria, Ghana, Benin, Malawi) gains in production following the introduction of improved cultivars have been instrumental in raising the per capita food consumption levels. There is scope for other countries in similar conditions to replicate this experience. This prospect, together with the growing consumption of potatoes in many developing countries, should lead to a reversal of the trend for per capita food consumption of these products to decline – a trend that reflected largely

[26] Raw sugar equivalent of sugar cane production

the decline of food consumption of sweet potatoes in China. In addition, the potential use of cassava in the production of biofuels (actively pursued in Thailand) would further sustain the demand growth for this sector.

Agricultural trade of the developing countries

The growing imports of, mainly, cereals, livestock products, vegetable oils and sugar of many developing countries has resulted in the group of the developing countries as a whole turning from net agricultural exporters to net importers in most years after the early 1990s reaching a deficit of US$ 12 billion in 2000, before recovering in subsequent years to 2004. The recovery of recent years reflected above all the explosive growth of Brazil's agricultural exports, including oilseeds and products, meat, sugar, etc. Without Brazil, the deficit of the rest of the developing countries, already present from the late 1980s onwards, grew further from US$ 20 billion in 2000 to US$ 27 billion in 2004. Their traditional export commodities (tropical beverages, bananas, natural rubber, etc) did not exhibit similar dynamism and for long periods stagnated or outright declined (in value terms), with the exception of the group fruit and vegetables.

The structural factors underlying these trends are likely to continue. The growing food demand in the developing countries will continue to fuel the growth of import requirements of basic foods in many of them, while the scope is limited for growth of consumption and imports of their traditional exportables to the developed countries. If anything, the growing competition among the developing exporters to supply those nearly saturated markets will continue to put pressure on prices (levels and instability) and lead to shifts in market shares at the expense of the weakest exporters among them, as it happened with coffee in recent years. It may happen with sugar if the preferences protecting the weakest developing exporters were to be diminished or outright removed under the thrust of trade reforms. What will be somewhat different from the past is that the traditional dichotomy developed (net importers)-developing (net exporters) will be further blurred: the markets facing the major developing exporters will be increasingly those of the importer developing countries, as it is already happening with commodities such as sugar and vegetable oils.

1.3 Conclusions

The slowdown in world population growth and the attainment of a peak of total population shortly after the middle of this century will certainly contribute to easing the rate at which pressures are mounting on resources and the broader environment from the expansion and intensification of agriculture. However, getting from here to there still involves quantum jumps in the production of several commodities. Moreover, the mounting pressures will be increasingly concentrated in countries with persisting low food consumption levels, high population growth rates and often poor agricultural resource endowments. The result could well be enhanced risk of persistent food insecurity for a long time to come in a number of countries in the midst of a world with adequate food supplies and the potential to produce more.

The slowdown in the growth of world agriculture may be mitigated if the use of crop biomass for biofuels were to be further increased and consolidated. Were this to happen, the implications for agriculture and development could be significant for countries with abundant land and climate resources that are suitable for the feedstock crops; assuming, of course, that impediments to biofuels trade do not stand on the way. Several countries in Latin America, South-East Asia and sub-Saharan Africa, including some of the most needy and food-insecure ones, could benefit. Whether and to what extent this will happen is very uncertain, but the issue deserves serious analysis and evaluation. Of particular interest are (a) possible adverse effects on the food security of the poor and the food-insecure if food prices were to rise because of resource diversion towards the production of feedstock crops for biofuels; and (b) the environmental implications of cultivated land expansion into pasturelands and forested areas. As noted, this is a typical case of possible trade-offs between different aspects of the environment and sustainability: benefits from the reduction in greenhouse gas emissions when biofuels substitute fossil fuels in transport and adverse effects from the expansion and intensification of agriculture.