Memo: Report on BUS ticket no B18
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Influence of agricultural practice on biomass availability

Introduction
Different studies show that the availability of land for the growth of dedicated energy crops will depend on the food requirements (population growth and diet). The future land requirement for food production might influence also the total available area for forestry and the amount of forestry residues that could be used for biofuels. Furthermore the kind of agricultural farming and techniques used influence the sustainable removal of agricultural residues. Food / feed production will therefore determine on large scale which and much lignocellulosic biomass becomes available for the use in the energy sector.

Questions
1. How would a sustainable food production look like and how does it influence future biomass availability?
2. What are the consequences of future food production needs for the availability of biomass for energy (residues and dedicated crops)?
3. Is there a win-win situation for the production of food and biomass?

What is sustainable food production?
We consider sustainability as being founded on triple-P: people, planet and profit, which means that sustainability has three important principles: social equity, environmental quality and economic development.

Social equity refers to the well-being of individuals and the stability of society. Social equity therefore includes eliminating poverty so that everyone has their basic needs met. Although "basic needs" can be defined in various ways, here they are construed to include such needs as clean water, adequate food, sanitation, shelter, the opportunity to earn a living, and access to health care.

Environmental quality refers to the long-term health and stability of natural systems. Natural systems provide natural resources and a range of ecosystem services that support human life (Daily 1997). Conserving natural resources, and protecting ecosystem services such as biodiversity, stabilizing atmospheric composition and global climate is necessary to protect the stability and productivity of earth systems.

Economic development includes economic growth. However, development is broader and includes other aspects such as reducing illiteracy and poverty. Economic development need not be in conflict with social needs or environmental protection, in fact, social equity and a healthy environment are supported by economic development and support it in turn.

Sustainable food production means that when food is produced, all three principles are taken into account.

Sustainable food production in relation to biomass
The FAO has produced comprehensive studies on the state of the World Agriculture. Its latest study (Bruinsma, 2003) makes a forward assessment of possible future developments in world food, nutrition and agriculture, including the crops, livestock forestry and fisheries sectors. taking a long term perspective (2015/2030). We will review the most important conclusions, with respect to future projections, and what they imply for the production of biomass.

Population, income and poverty

The UN (2001) has estimated the world population of 5.9 billion (1997/99) will grow to 7.2 billion in 2015, 8.3 billion in 2030 and 9.3 billion in 2050. The growth rates are projected to fall from 1.35 percent in the mid 1990s to 1.1 percent by 2015, to 0.8 percent by 2030 and 0.5 percent by 2050. This deceleration in demographic growth and the gradual saturation in per capita food consumption for parts of the world population are important factors that will slow the growth of food demand and, at the world level, also of production.

Practically all of the increases in world population will be in the developing countries. Within the developing countries themselves there will be increasing differentiation. East Asia will be reaching a growth of under 0.5 percent per year towards 2050. At the other extreme, sub-Saharan Africa's population will still be growing at 2.1 percent per year in 2025-30. The growth of incomes is the other major determinant of the growth of food demand and of changes in food security and nutrition. The outlook for income growth is mixed. The latest World Bank assessment for the period 2000-15 (cited in Bruinsma, 2003) anticipates higher growth rates in per capita GDP than in the 1990s for all regions and country groups. However, there is great contrast as regards the prospects of two regions with high relative concentrations of poverty and food insecurity, South Asia and sub-Saharan Africa. In the former region, a continuation of the relatively high GDP growth holds promise of positive impact on poverty alleviation and increases in per capita food consumption. But progress in sub-Saharan Africa may be very limited and far from sufficient to have a significant impact on poverty and food insecurity. The Bank assessment concludes that the proportion (not absolute numbers) of the population living in poverty in the developing countries as a whole may fall from 32 percent (1990) to 13.2 percent (2015). However, the absolute numbers in poverty in the developing countries will remain high and will have effect on the number of undernourished people.

Prospects for food and nutrition

The 2001 FAO assessment of food insecurity in the world estimates the incidence of undernourishment in the developing countries (1997/1999) at 777 million people or 17 percent of their population (FAO, 2001). This is a decrease from 20 percent of the population in 1990/1992. The projections of food demand for the different commodities suggest that the per capita food consumption (kcal/person/ day) will grow significantly. The world average will be approaching 3 000 kcal in 2015 and exceeding 3 000 kcal by 2030. These changes in the world averages will reflect above all the rising consumption in developing countries, whose average will have risen from the 2680 kcal in 1997/99 to 2850 kcal in 2015 and close to 3000 kcal in 2030.

The implication of the projected higher levels of average national food consumption per person is that the proportion of undernourished people in the developing countries as a whole could decline from 17 percent in 1997/99 to 11 percent in 2015 and to 6 percent in 2030. All regions would experience declines in these percentages and, by 2030, all of them, except sub-Saharan Africa, should be in the range of 4 to 6 percent of the population. Sub-Saharan Africa could still have 15 percent of its population undernourished in 2030.

Food production and trade

At the world level, production equals consumption. For the individual countries and country groups, however, the two growth rates differ depending on movements in their net agricultural trade positions. In general, the growth rates of production in the developing regions have been below those of demand, and as a result their imports have been growing faster than their agricultural exports. These trends led to a gradual erosion of their traditional surplus in agricultural trade. In fact, the developing countries have turned in recent years from net agricultural exporters to net importers. This trend continues in the projections. In table 1, the projections for the demand and production of the main categories of food are given.

Table 1: projections for the demand and production of the main categories of food are given.

	Demand		Production	Net Trade	Growth rate	
	Food	All uses			Demand	Production
Cereals – World (million tons)						
1997/1999	1003	1864	1889		1.4	1.4
2015	1227	2380	2387		1.2	1.2
2030	1406	2830	2838		1.3	1.3
Cereals – Developing countries (million tons)						
1997/1999	790	1129	1026		1.9	1.6
2015	1007	1544	1354		1.5	1.3
2030	1185	1917	1652		1.7	1.5
Meat – World (000 tons)						
1997/1999	215795		217898		2.7	2.7
2015					1.9	1.9
2030					1.5	1.5
Meat –developing countries (000 tons)						
1997/1999	117141		115938	-1238	6.1	5.9
2015				-3900	2.7	2.7
2030				-5900	2.1	2.1
Oilcrops – world (million tons)						
1997/1999		98.3	103.7		3.7	4.3
2015					2.7	2.5
2030					2.2	2.2
Oilcrops – developing countries (million tons)						
1997/1999		61.8	67.7	4	4.6	4.7
2015				3.4	3.2	2.8
2030				3.4	2.5	2.4

Source: Bruinsma, 2003

Cereals will continue to be by far the most important source (in terms of calories) of total food consumption. World consumption and production of cereals are projected to increase (see table 1). Of this increase, some 50 percent will be for feed, and about 42 percent for food, with the rest (8 percent) being used for other purposes (seed, industrial non-food use and waste). This supply is expected to come from the traditional cereal exporters in the industrial world (United States, Canada, the EU and Australia). The FAO expects that in the future, the production system in these countries will have the capability of responding flexibly to meet increases in demand within reasonable limits, as it has done in the past.

Livestock is becoming a more important commodity as the world food economy is being increasingly driven by the shift of diets towards livestock products, although most of the increase in meat production (especially poultry) stems from China (and to a lesser extent Brazil). For milk and dairy products, China is of less influence but also for these products, demand is expected to grow. The driving forces of rapid growth of the meat sector in the past are expected to weaken considerably, because of lower population growth, and attainment of high consumption levels in a few major countries. Consumption of milk and dairy products is expected to continue growing. The trend for the developing countries to become growing net importers of meat is set to continue.

Oilcrops and products. This category of food products with a high calorie content has played an important role in the increases of food consumption in developing countries and it is expected that non-staples such as vegetable oils still have significant scope for further consumption increases. The growth of aggregate world demand and production would continue to be well above that of total agriculture, although it would be much lower than in the past. On the production side, the trend has been for four oilcrops (oil palm, soybeans,

sunflower seed and rapeseed) and a small number of countries to provide much of the increase in world output (see below). The sector accounted for a good part of cultivated land expansion in the past and in the industrial countries it made up for part of the declines of the area under cereals. There are five major net exporters among the developing countries (Malaysia, Indonesia, the Philippines, Brazil and Argentina) that increased their net exports from 4 to 21 million tonnes. However, the rapid growth of demand of the developing countries was accompanied by the emergence of several of them as major importers of oils and oilseeds, from 1 million tonnes in 1974/76 to 17 million in 1997/99. In the future, these trends are likely to continue and the net trade balance of the developing countries would not change much, despite the foreseen further rapid growth of exports from the main exporter developing countries.

Roots, tubers and plantains[1]. These products (mainly cassava, sweet potatoes, potatoes, yams, taro and plantains) represent the mainstay of diets in several countries, many of which are characterized by low overall food consumption levels and food insecurity. The great majority of these countries are in sub-Saharan Africa. Significant quantities of roots are used as feed, including potatoes (mainly in the transition countries and China), sweet potatoes (mainly China) and cassava (mainly Brazil and the EU). In Thailand, the main supplier of cassava to the EU, cassava production and exports followed closely the developments in the EU. The rapid expansion of cassava production for export in Thailand is thought to have been a prime cause of land expansion and deforestation, followed by land degradation in certain areas of the country. This link provides a good example of how the effects of policies (or policy distortions such as the high support prices in the EU) in one part of the world can exert significant impacts on production, land use and the environment in distant countries. The food products in this category will continue to 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.

Crop production and available land

By 2030, crop production in the developing countries is projected to be 67 percent higher than in the base year (1997/99). In spite of this noticeable increase in the volume of crop production, in terms of annual growth rates this would imply a considerable slowdown in the growth of crop production as compared with the past, because of the anticipated deceleration in the growth of aggregate demand. Most of this increase (about 80 percent) would continue as a result of a further intensification of crop production in the form of higher yields and of higher cropping intensities (multiple cropping and reduced fallow periods), with the remainder (about 20 percent) as a result of further arable land expansion.

The developing countries have some 2.8 billion ha of land with a potential for rainfed agriculture at yields above a “minimum acceptable level”. Of this total, some 960 million ha are already under cultivation. Most of the remaining 1.8 billion ha, however, cannot be considered as land “reserve” since the bulk of the land not used is very unevenly distributed with most of it concentrated in a few countries in South America and sub-Saharan Africa. In contrast, many countries in South Asia and the Near East/North Africa region have virtually no spare land left, and much of the land not in use suffers from one or more constraints making it less suitable for agriculture. In addition, a good part of the land with agricultural potential is under forest or in protected areas, in use for human settlements, or suffers from lack of infrastructure and the incidence of disease. Therefore, it should not be considered as being a reserve, readily available for agricultural expansion. Taking into account availability of and need for land, arable land in the developing countries is projected to increase by 13 percent (120 million ha) over the period to 2030, most of it in the “land-abundant” regions of South America and sub-Saharan Africa, with an unknown but probably considerable part of it coming from deforestation.

[1] Not in table 1 because precise figures are lacking

In terms of *harvested* land, the land area would increase by 20 percent (178 million ha) on account of increasing cropping intensity. The latter will reflect the growing role of irrigation in total land use and crop production. Irrigation is expected to play an increasingly important role in the agriculture of the developing countries. Expansion of irrigation would lead to a 14 percent increase in water withdrawals for agriculture, although this depends crucially on the projected increase in irrigation water use efficiency (from 38 to 42 percent on average). Without such efficiency improvements it would be difficult to sustain the necessary expansion of irrigated agriculture.

Conclusions

The projections show that future production of food will most likely be able to meet demand, although distribution will not be even. Many developing countries will become net importers of food, and the number of people who are undernourished will still be high.

The increased production will stem mostly from an increase in productivity, by using improved technologies. This might have implication for the sustainability of food production. There is an ongoing discussion[2] on whether future food production could be sustained by biological agriculture and whether this would be more a environmentally friendly option than intensive agriculture. We will not repeat the discussion here, but highlight the question of whether, and if so how intensive agriculture could be made (more) sustainable. Intensification implies using inputs such as fertilisers, pesticides or (genetically modified) seeds, which are known to have had negative impacts on the environment and human health. Although much progress has been made in this area by banning toxic pesticides, better targeting fertiliser use (e.g. through precision farming), not all problems have been solved, especially in developing countries. Biological agricultural technologies make less (or no) use of these external inputs, relying on the use and recycling of resources available on the farm. This may mean, however, that there is less scope for using residues for biomass, because these will have a function in the biological agriculture system (for instance as feed for livestock, or green manure). However, promising solutions for sustainable agriculture might be found in combining technologies that are used in the biological agriculture with those of intensive agriculture.

Additionally, more needs to done in improving the efficiency of natural resources use, especially that of water. In developing countries, irrigation will be crucial to facilitate the required agricultural productivity increase. However, this will need additional water, which may be problematic for arid regions, or other regions where water is already scarce. In general, many irrigation systems in developing countries are still extremely inefficient with high water losses. An important point to take into account when increasing the production of biomass crops is how many additional inputs these crops need in terms of soil nutrients, pest protection and water. Although in principle intensification of agriculture seems to be possible with minimising environmental damage, in practice this is often difficult to attain in developing countries.

With respect to available land for biomass production, the FAO study has calculated that there appears to be land available, especially in Latin America and Sub-Saharan Africa (Bruinsma, 2003). However, most of this land is not suited, either for agronomic reasons, or it is reserved as nature (e.g. The Amazon)[3]. It is therefore expected that any future increases in agricultural land will be through deforestation. We can conclude that there is no additional land available

[2] See for instance NRC Handelsblad: Louise Fresco, Joost van Kasteren en Rudy Rabbinge "Verbeter vooral de gangbare landbouw" (19-04-2005) and Kees van Veluw en Boudewijn van Elzakker "Biologische landbouw is succes in Afrika" (26-04-2005)

[3] A recent study by CIFOR has calculated that most of the growth of area devoted to commodities (such as soybeans, oil palm, cocoa, and coffee) in developing countries came at the expense of forests, including the Amazon (Niesten et al., 2005).

that could potentially be used for biomass production. Making available additional land will be at the expense of natural habitats (deforestation), which is incompatible with our definition of sustainable development or sustainable food production.

Therefore, solutions must be found in combining existing agricultural production (including food) with the production of biomass. Possible win-win situations can be found in using residues of (food)crops for biomass production. However, not all residues may be freely available for biomass production. In developing countries, many residues already have a use, for example for livestock feed, green manure, other food purposes. Residues may not always be "free" and there will be opportunity costs involved, and this needs to be well analysed beforehand. And generally speaking, in case of substitution, residues should be used for most economic use taking into account the triple P principle.

Another possible win-win option is substitution of existing crops for biomass crops. If biomass crops are more profitable, or have other advantages over existing crops, this may induce farmers to switch to biomass crops. This is a good possibility for cash crops that are no longer profitable due to price decreases. Many commodities such as coffee, cocoa, and cotton have experienced fluctuating but steadily decreasing price levels. Providing better alternatives to poor farmers in developing countries will certainly address the "people" dimension in the triple P. However, to analyse these possibilities, economic analysis is needed that takes into account opportunity costs, substitution effects and trade policies of major players such as the EU and US. Again, the triple P principles should be taken into account – what negative impacts does biomass production have on the agricultural sector (higher use of inputs), natural areas (increased deforestation), incomes (does biomass production offer better alternatives to poor people) etc.

We have directed this outline to include generally all biomass crops, but the type of biomass crop will have implications for the extent to which it can be combined with sustainable food production. Cassava, a food crop, will have different implications than sugarcane, an annual cash crop. The BUS card 18 mentions specifically using forestry residues as biomass. Forestry residues need a different analysis than agricultural crops, because this topic will lie in the area of sustainable forestry rather than sustainable agriculture. A win-win situation for using forestry residues can be in combining reforestation or afforestation projects with biomass projects. Care should be taken that forestry biomass production will not lead to further deforestation.

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