What if meat consumption would decrease more than expected in the high-income countries?

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Summary

As a complement to the analysis of the baseline scenario used for the European Commission agricultural market outlook, a first alternative scenario envisaging a lower meat consumption trend have been elaborated. It shows that a decrease in per capita meat consumption in developed countries and selected Latin American countries would impact on the world and EU meat markets, and consequently on markets of crops used as feed, prices being under pressure despite the continuing increase of meat consumption in the rest of the world. In a second scenario where the decrease of meat consumption is compensated by an increase intake of plant products and certain other animal products such as dairy or eggs, the impact on markets other than the meat ones is mitigated, although the beef meat sector is even more affected by an increase of dairy products outputs. This possible evolution would be a challenge for farmers, who can rely for this on the CAP policy tools, in their diverse implementation among Member States.

Keywords: meat consumption, agricultural markets, agro-economic modelling, agricultural commodities

JEL Classification codes: Q13, Q17, Q18

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1. INTRODUCTION

The nutrition transition worldwide has been extensively described since Popkin's seminal article (Popkin, 1994). Associated with income growth and higher food availability, predominantly starchy diets firstly diversify with the integration of fruits and vegetables as well as animal proteins. It then ensures a new stage of the nutrition transition characterised by increased per capita consumption of fat (particularly animal fat), refined carbohydrates and sugar. This stage of the nutrition transition has been first observed in western countries in the first half of the 20th century. It then occurred in low- and middle-income countries from the early 1980's onwards, and by then it is often referred to as a "westernisation of diets". Here, the adoption of a "western" dietary pattern is mainly an urban phenomenon associated with the adoption of sedentary lifestyles, although it is increasing also in rural areas. As a consequence, many regions and countries, both in the developing and developed world, are experiencing a lower dietary intake of legumes, vegetables and coarse grains and a higher intake of refined carbohydrates, added sugars, fats, processed foods and animal-source foods (Popkin *et al.*, 2012). Sign of economic development and opening markets, it has also been subject to early warnings with regards to its corollary health effects: development of overweight, obesity, diabetes and coronary heart diseases (Popkin, 1994; Popkin, 1999; Tsolekile, 2007; Schmidhuber, 2004).

In response, "health conscious behavioural changes" emerged, especially among better educated groups of population who tend to substitute part of their animal-based consumption by plant-based products (Popkin, 1994). Ethical concerns in relation to animal welfare in farming / marketing practices or the growing uptake of philosophical and/or religious conceptions recognising a *status* to animals were other reasons for a growing number of people to exclude meat in their diet. Moreover, especially with the release of the FAO livestock's long shadow report (Steinfeld *et al.*, 2006) and with the spread of life-cycle assessments (LCA) in the early 21st century, the adverse effects of intensive meat production systems - in terms of land use, greenhouse gas emissions and biodiversity losses – were pointed out in environmental assessments, determining the scaling up of the vegetarianism linked to concerns with the environmental and ecological impact (Ruby, 2012).

In the wake of such concerns , medias and NGOs conveyed the health, environmental and ethical benefits of lowering individual meat consumption including 'Meatless day campaigns', pro-vegetarianism and pro-flexitarianism communications (Laestadius *et al.*, 2013). The rationale of the meatless day campaigns was to rely on responsible citizen to achieve mass effects from small individual changes. In other

[1] The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

words, cutting out meat only one day a week equals to a 14% reduction in meat consumption, which can be highly significant in terms of health, environmental and animal welfare impacts. These campaigns also claimed for governmental support to educate and inform the targeted "responsible citizens" (Gold, 2004). But, this strategy has been later judged at risks in the sense that "a simple 'eat less meat' message alienates some people and could have unintended consequences, not least on farmers' livelihoods" (Sutton and Dibb, 2013). That led to the emergence of 'less-but-better' recommendations still oriented towards a reduction of individual meat consumption but jointly with purchases favouring meat proceeding from extensive grazing systems (de Boer *et al.*, 2014; Sutton and Dibb, 2013; National Food Administration, 2009).

The impact of current western diets also moved up the policy agenda. This was motivated by a context of implementation of sustainability principles, of fixing greenhouse gas reduction targets, and of growing costs for public health systems. In 2009, the government of Sweden was the first government to officially recommend to lower meat consumption as one 'environmentally effective food choice' among others and to notify such a proposal to the European Union[2] (National Food Administration, 2009). In this case, the health perspective argument was not put forward but reducing meat consumption appeared as a win-win option for both human health and the environment in the recommendations to government of the Sustainable Development Commission of the United Kingdom (2009) as well as the ones of the Health Council of the Netherlands (2011) and more recently the recommendations of the Dietary Guidelines Advisory Group (GDAP) of USA (2015) (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2015; Sustainable Development Commission, 2009; Health Council of the Netherlands, 2011).

In this paper, we try to assess the possible impact of such growing trend toward a stronger concern of consumers in high-income countries on their food choices, especially over meat consumption, on the agricultural commodity markets developments at global and European level. In a first section, we will describe the model used and the 'baseline' projections resulting from them and then reflect upon alternative scenarios to be implemented in order to capture the nutritional pattern changes anticipated. The model ouputs for the main agricultural markets concerned by the alternative scenarios will be discussed in a second section. We will reflect in a third section on policy implications, before concluding on the limitations of the present work.

2. SCENARIO AND METHODOLOGY

2.1. Market simulations: the Aglink-Cosimo model and its baseline scenario 2014

The Aglink-Cosimo model, cornerstone of the EU prospects for agriculture

The OECD and the FAO jointly release annually a ten-year horizon assessment of medium-term projections of national, regional and global agriculture commodity markets (OECD/FAO, 2014). The European Commission feeds this process on the EU level with annual "prospects for EU agricultural markets and income" (European Commission, 2014). Such projections are built upon a certain number of exogenous assumptions deemed most plausible at the time of the analysis concerning macro-economic and energy conditions, agricultural and trade policies arrangements in force, as well as yield trends under 'normal'

[2] Proposal notified to the EU 15.05.2009.

climatic conditions. This process results in a reference scenario (or 'baseline' scenario) for the production, consumption and trade of the main agricultural commodities (arable crops such as cereals, oilseeds and sugar, biofuels, dairy products and meat products) within the ten coming years in the EU and at global level. The 'baseline' reflects expert knowledge on the possible developments of each agricultural commodity markets in view of the recent trends and anticipated developments and the Aglink-Cosimo model ensures that the overall set of equations balances with plausible outcomes.

This Aglink-Cosimo model is a recursive-dynamic, partial equilibrium, supply demand model of world agriculture, integrating the OECD's Aglink and FAO's Cosimo sub-modules. It is used to simulate development of annual supply, demand and prices for the main agricultural commodities produced, consumed and traded worldwide. The Aglink-Cosimo model covers 44 individual countries and 12 regions, 93 commodities and 40 world market clearing prices. The governance of the model is shared between OECD and FAO member countries under the supervision of the two secretariats. Member countries are responsible to ensure the proper equations and parameters are included in each year's model release, based on declarative questionnaires by its members. In total, around 36000 equations make it one of the most complete and complex agricultural partial equilibrium model. Most behavioural equations in Aglink-Cosimo are "double-log", including for estimating production and demand functions, where the underlying relationship between Y and X resembles a logarithmic function (e.g. Y experiences diminishing marginal returns with respect to increases in X):

$$Log(Y) = \xi \cdot \log(X) + \beta_0 + \log(R)$$

This is only altered by the introduction of an intercept (β_o), also called 'constant' to be looked at together with the the error terms (R), and a slope (ξ), which we call 'elasticity' (Araujo Enciso *et al.*, 2015).

Concerning specifically meat consumption, consumption is modelled as the total food use of meat products, food use being modelled in Aglink-Cosimo as a function of the relative ratio consumer prices $(CP_{c,r,t})$ for each commodity and the total consumer price index $(CPI_{r,t})$, the GDP index and the population $(POP_{r,t})$ with a constant, a trend and an error term such that

$$Log\left(FO_{c,r,t}\right) = \mathrm{c} + \sum^{c} \xi_{FO_c,CP_c} \cdot Log\left(\frac{CP_{c,r,t}}{CPI_{r,t}}\right) + \xi_{FO_c,DGPI} \cdot Log\left(\frac{GDPI_{r,t}}{POP_{r,t}}\right) + Log\ (POP_{r,t}) + trend + Log\ (R_{CR,r})$$

The baseline 2014 of the European outlook in a nutshell

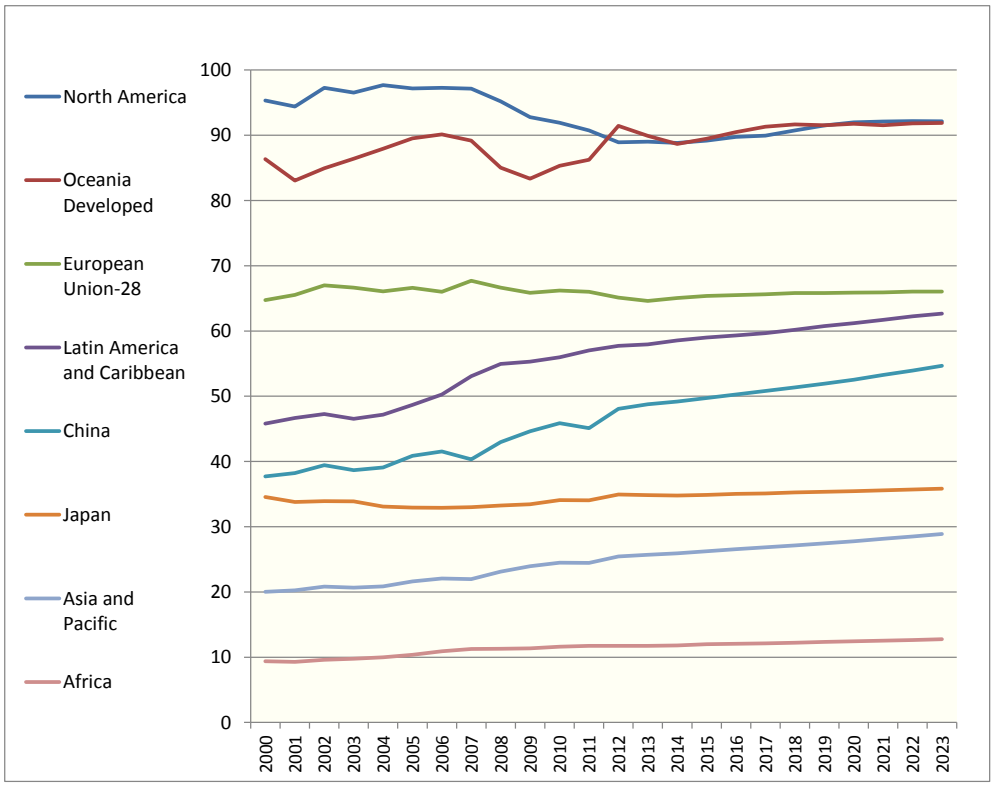
On the food consumption side, the assumptions of the baseline reflect a stabilisation or lower growth of per capita meat consumption in the richest countries (a limited growth in meat consumption is exclusively attributable to a continuing increase of consumption of poultry meat) and, on the other hand, a further development of the nutrition transition in developing countries (i.e. an upward trend in sweeteners and animal-based products consumption). These assumptions are reflected by the trends in the model for different meat consumption and selected countries identified in **Table 1**. Accordingly, in terms of total meat consumption, the 'baseline' projections foresee some relative stability in developed countries, while the total consumption per capita is projected to keep on increasing in the ten coming years in developing countries (**Figure 1**).

Table 1 – Trend for meat consumption in selected countries.

Trend	Beef and veal	Poultry	Pig meat
EU15	-1%	+0.6%	-1%
EU13	-1%	+1%	-2%
USA	-0.06%	-0.6%	-1.1%
Brazil	-0.04%	-0.7%	+0.7%
China	+0.3%	+7%	+6%
Russia	+1.2%	+3.9%	+5.1%

Source: Aglink-Cosimo model 2014

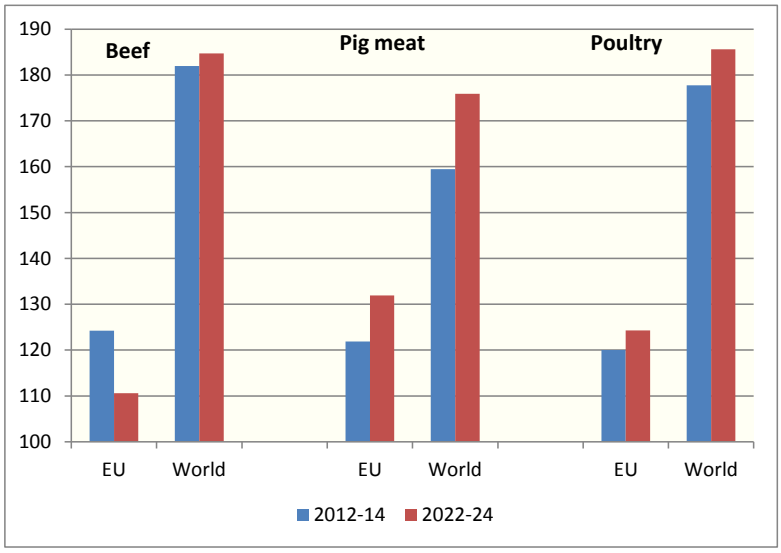
Figure 1 – Total meat consumption (kg per capita).



Source: OECD-FAO world outlook, 2014

As a result, according to the baseline scenario 2014, EU meat demand and exports are expected to increase by 2024, mainly due to the increment of population and economic growth in low-income countries and driven by a sustained growth in poultry meat. The outlook of EU and world prices is also accordingly rather bullish, in particular for EU poultry and pig meat. The past gap between EU and world prices is projected to be significantly reduced over the projection period.

Figure 2 – Meat price development indices (base 100 = 2005-2007) in the baseline (EU in EUR, World in USD).



Source: own elaboration from European Commission (2014)

2.2. Alternative meat consumption scenarios: rationale and implementation

Considering a number of evidences hereafter presented, the purpose of this article is to present the impacts on EU and global agricultural markets of alternative protein consumption scenarios, mainly resulting in a stronger reduction of per capita meat consumption in developed countries, compared to the baseline.

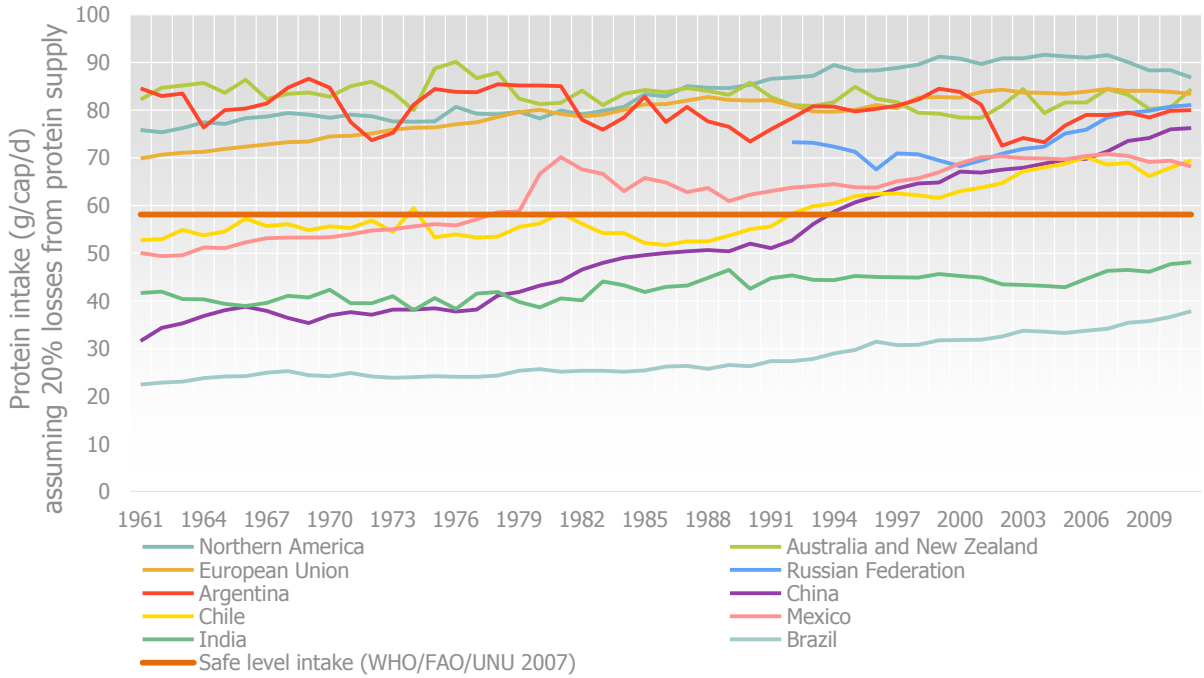
A protein intake far above the "safe level of protein intake" in high-income countries

A theoretical "sustainable" level of meat consumption cannot be defined concretely separately from its substitutes in terms of nutrient content (mainly fish, seafood and animal products, but also vegetable proteins). Indeed, the former inversely varies with the level of the latter, also resulting from the combination of miscellaneous external factors (cultural, economic, familial, time management, etc.). This explains the wide range of national recommendations for meat consumption among European countries in 2003: from around 50 g/cap/day in Germany to more than 300 g/cap/day in Spain (World Health Organization Europe, 2003). Also because a healthy diet can only be defined taking into account the sum of its components, no absolute level of human meat requirements has been officially established. Nevertheless, the comparison of the protein supply with the "safe level of protein intake[3] defined by WHO/FAO/UNU (2007) illustrates the deficiencies and excesses of protein intake in the world. Since data is recorded, the average protein intake per capita in Northern America, the European Union, Argentina, and Australia and Canada has continuously been 20% to 30% above the safe level of protein intake. This threshold is exceeded in Mexico and possibly in Russia since the early 1980's, as well as in Chile and China since the early 1990's (see **Figure 3**). These statistics clearly point out an excess of protein consumption in high-income countries, which is by extension a sign of excessive per capita meat consumption. Various dietary guidelines for high-income countries confirm this statement considering that in general the average per capita level of meat consumption is high

[3] The safe level for a population is defined as the average protein requirement of the individuals in the population, plus twice the standard deviation (SD) (WHO/FAO/UNU 2007).

enough to recommend lower meat consumption without putting people at risks of nutrient deficiencies (National Food Administration, 2009; Health Council of the Netherlands, 2011).

Figure 3 - Estimated protein intake[a] in high and middle-countries (g/cap/day) compared to the safe level of protein intake (1961-2011).



[a] The protein intake is calculated deducting 20% of losses from the protein supply (Westhoek *et al.*, 2011).
Source: DataM from FAO – Food balance sheets

A non-linear relationship between individuals' wealth and meat consumption

Even though at the global level a strong relation is observed between per capita meat consumption and income (refer to the introductory section on the nutrition transition), recent evidences stress that this relationship weakens or even become negative when considering high levels of income or other wealth indicator. For example, the 1995 National Nutrition Survey in Australia reported a decreasing daily intake of "meat, poultry and game" across least disadvantaged quintiles (i.e. 4th and 5th quintiles of social disadvantage with respectively 155 and 158 d/day) compared to the medium one (3rd quintile with 164 g/day) (National Health and Medical Research Council, 2013). Also the 1996 Continuing Survey of Food Intakes by Individuals (CSFII) held in USA showed lower levels of both beef and total meat consumption among high-educated people, as well as among service and professional occupations compared to labourer occupations (Gossard and York, 2003). At global level (i.e. 125 countries between 1975 and 1997), Keyzer et al. identified a non-linear Engel curve that links per capita consumption and income: when income exceeds a threshold, the Engel curve becomes concave-increasing (Keyzer *et al.*, 2005). This means that beyond this threshold per capita meat consumption increases less rapidly according to income gains than before. It doesn't indicate a decreasing level of meat consumption in absolute terms. The interpretation of the authors is that above the threshold, individuals are satiated and experiment a shift in their expenditures' distribution with an increasing fraction of income spent on lifestyle rather than on meat consumption. Finally, inspired by environmental sciences and the Kuznets curve theory, other very recent studies have pointed out the existence of an inverted U-shaped relationship between income (measured with per capita GDP) and meat

consumption between and within countries, meaning decreasing per capita meat consumption in absolute terms above a certain threshold. This relationship is observed both in a cross-section sample of high-income countries and in full panel data samples combining high- and low-income countries (Vranken *et al.*, 2014; Rivers Cole and McCoskey, 2013). Nevertheless, the turning point ranges between 32 000 and 55 000 USD/cap. Then, according to these functions, even with assumptions of income growth in the 10 coming years, the disconnection between income and meat consumption will apply to a very small proportion of the population only (the very well-offs).

Number of vegetarians and flexitarians on the rise

Data on the development of vegetarianism and / or flexitarianism behaviour is scarce. First because the definition of vegetarianism is not stabilised, giving space to a co-existence of various typologies of vegetarians in the scientific literature (Phillips, 2005; de Bakker and Dagevos, 2012; Ruby, 2012). Vegetarian types range from flexitarians (still eating meat but reducing their meat consumption) to vegans (not eating any product of animal origin). In between, a large diversity of vegetable-based diets can be found: vegan, lacto-, lacto-ovo-vegetarianism, macrobiotic, and pescatarians (or pesco-vegetarians) according to the variety of personal motivations for adopting a lower meat or meat-free diet.

Few surveys have been conducted in the United States in particular by the Vegetarian Research Group, which commissions a yearly poll, showing that 4 to 5% of the adult population can be defined as vegetarian and that up to 15% of the population do not eat meat at more than half of the meals (Stahler, 2011; Casalena, 2011). Similarly, the European Vegetarian Union compiled in 2008 estimations on the number of vegetarians in developed countries. The share of vegetarians among European countries ranged between less than 1% in Poland and Portugal and close to 10% in Germany (Pichler and Blackwell, 2008). The same source estimated 3% vegetarians in Australia, 3.2% in USA and 4% in Canada.

Finally, empirical observations like the increased numbers of vegetarians in western societies (Gossard and York, 2003) and in particular growing flexitarianism (Dagevos, 2014; de Boer *et al.*, 2014; Friends of the earth, 2014) motivated the exploration of a “Lower meat consumption” scenario to better understand to which extent changes of pattern of consumption can impact agricultural markets and indirectly agriculture production systems – compared to a reference situation.

Quantitative assumptions of alternative meat consumption scenarios and their transcription into the model

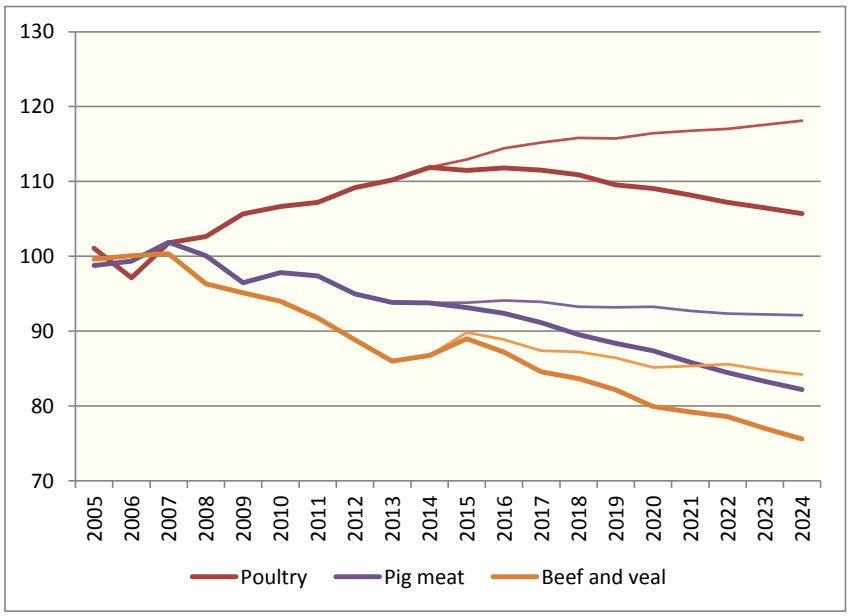
In order to assess the impact of a lower meta consumption on agricultural commodity markets, two “lower meat consumption scenarios” are designed. Both assume basically a doubling of vegetarians and flexitarians over the 10 coming years in high-income countries (North America, Europe, Oceania), as well as a certain development of such trends in countries with a high level of per capita meat consumption (Mercosur, Mexico). Baseline trends are not affected in developed Asian countries and low-income countries, meaning that per capita meat consumption, especially poultry, would continue to increase in these countries as shown in **Figure 1**.

Concretely, estimating that around 3% of the population of high-income countries is vegetarian in 2014 and does not consume any meat products, we assume that this share would double (6%) by 2024 in our alternative scenarios. Concerning flexitarians, a conservative assumption can be taken that 15% of the population of these countries eat 50% of the average per capita meat consumption and that this share would

double by 2024. Under these assumptions, the total meat consumption per capita decreases by 11% by 2024 relative to the baseline in the EU, North America, Europe and Oceania. In our alternative scenarios, it is also assumed that meat consumption in Brazil, Mexico and Argentina is not likely to decrease as strongly as in more developed countries. Therefore, per capita meat consumption is reduced by only 5% by 2024 relative to the baseline in these three countries.

Nevertheless, meat consumption reduction is uneven among types of meat. As the baseline foresees a stronger poultry meat consumption trend than for other types of meat (+5% above the average 2005-07 in the EU, see **Figure 4**), these assumptions result in stability of poultry meat consumption in developed countries. On the contrary, the baseline scenario implies stronger reduction in pig meat and beef meat per capita consumption, resulting in the case of the EU in 2024 level of consumption close to 20% below the average 2005-07 for pig meat and to 25% for beef and veal meat.

Figure 4 - Scenario 'lower meat consumption' (in bold) and baseline (in thin)– Meat consumption per capita index (EU-28), Base 100 = 2005-2007.



Source: own calculations from Aglink-Cosimo database

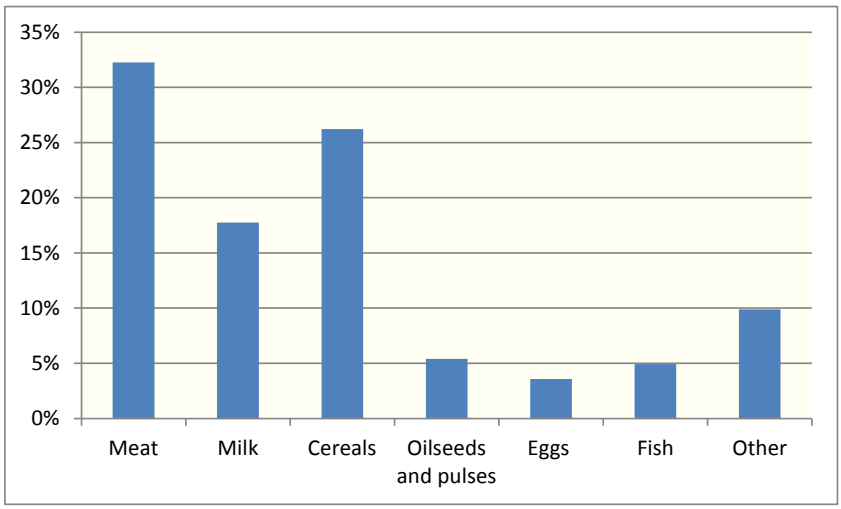
The two alternative scenarios assume the same assumptions over meat consumption (as described above). The first alternative scenario does not consider any protein compensation (Lower meat consumption with **no** protein compensation) whereas the second alternative scenario does (Lower meat consumption with protein compensation).

In the second scenario, a partial compensation of protein intake losses by other sources is envisaged, corresponding to an increased food consumption of cereals, eggs, dairy products and oilseeds-pulses. Fish, fruit and vegetables intake, although they represent around 15% of the total protein intake of high-income countries, were not considered because not covered by the modelling tool used. The aim of the assumption is to capture a partial substitution of the reduced protein intake due to meat consumption reduction by an increased intake from the other main protein sources (see

Figure 5). In total, these four groups of products represent 53% of the total protein intake in the countries concerned, therefore the increased protein intake from these products should be of 6.7% to fully compensate the 11% decrease of meat consumption. Given the fact that some commodities are richer (oilseeds and pulses in particular) than others in protein and that the scenario only aims to represent a partial

compensation, the assumption tested is of a 5% increase in cereals, dairy and eggs food use over the period and of 2% for oilseeds and pulses food use.

Figure 5 – Average protein intake in developed countries (% of total protein intake).



Source : FAO Food Balance Sheets

Technically, the scenarios are implemented by imposing an exogenous change to the error terms related to meat consumption. Cumulated to the trend and constant terms of the human consumption equations related to each meat, that results in a decreased consumption (see **Figure 4**). By analogy, consumption of dairy products, eggs, cereals, oilseeds and protein crops are increased the same way. In addition, several food use variables being exogenous (oilseeds and eggs in most cases, dairy products in Canada), the shock has been implemented exogenously for these commodities/countries.

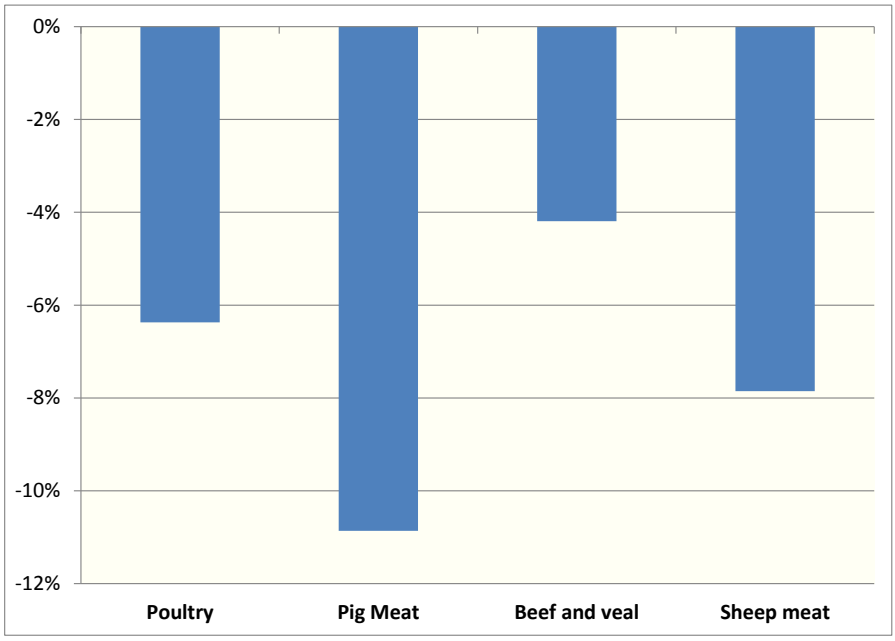
3. RESULTS AND DISCUSSION

In the first alternative scenario (Lower meat consumption with **no** protein compensation), meat consumption reduction in selected countries results on a moderate meat demand reduction at global level. In terms of world prices, the difference to the baseline trend ranges between 4 % and 12% by 2024, depending on the types of meat and markets[4] (

[4] For animal health reasons, the world market for beef meat and pig meat is split in different areas within which trade is possible under SPS regulations.

Figure 6). Lower world prices for meat provoke in return meat consumption increase in the rest of the world, mitigating overall the impact on world prices.

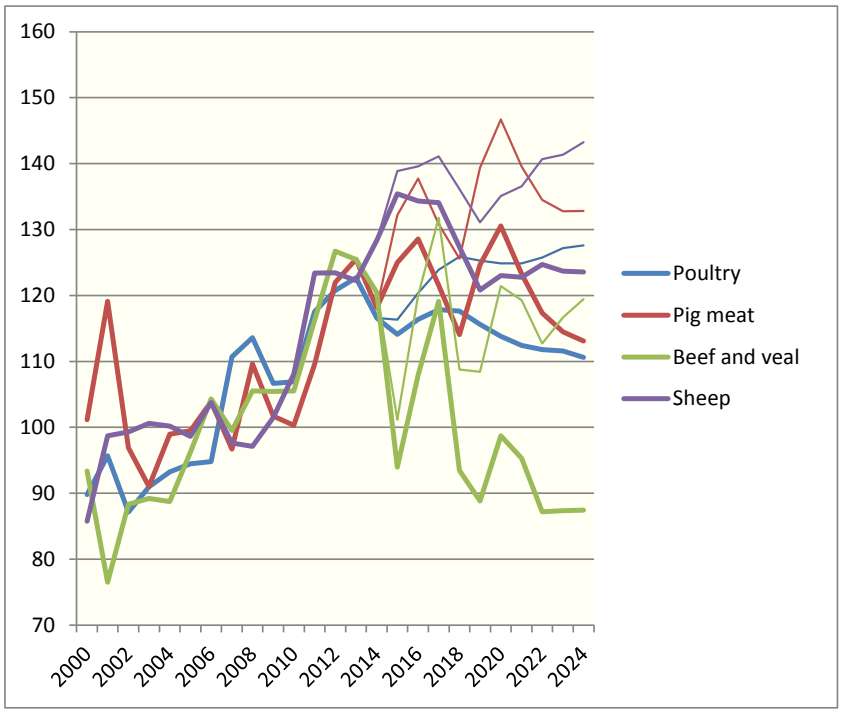
Figure 6 – Impact of the scenario on the world price for different meat (% difference to the baseline in 2024).



Source : Aglink-Cosimo

At EU level, the meat price difference to the baseline is wider than at global level. Indeed, with a decreasing domestic consumption and domestic meat prices significantly higher in general than world prices, the EU has difficulties to fully compensate losses of domestic demand by additional exports. As a consequence the price gap between the EU and world meat markets is closing down to varying extents, depending on the type of meat considered. Poultry, pig meat and sheep meat domestic prices are below the baseline level in 2024, but they remain 10 to 25 % above the average price 2005-2007. Beef and veal meat EU domestic price is more affected, but remains at levels around 10% below the average 2005-2007 domestic price levels (**Figure 7**).

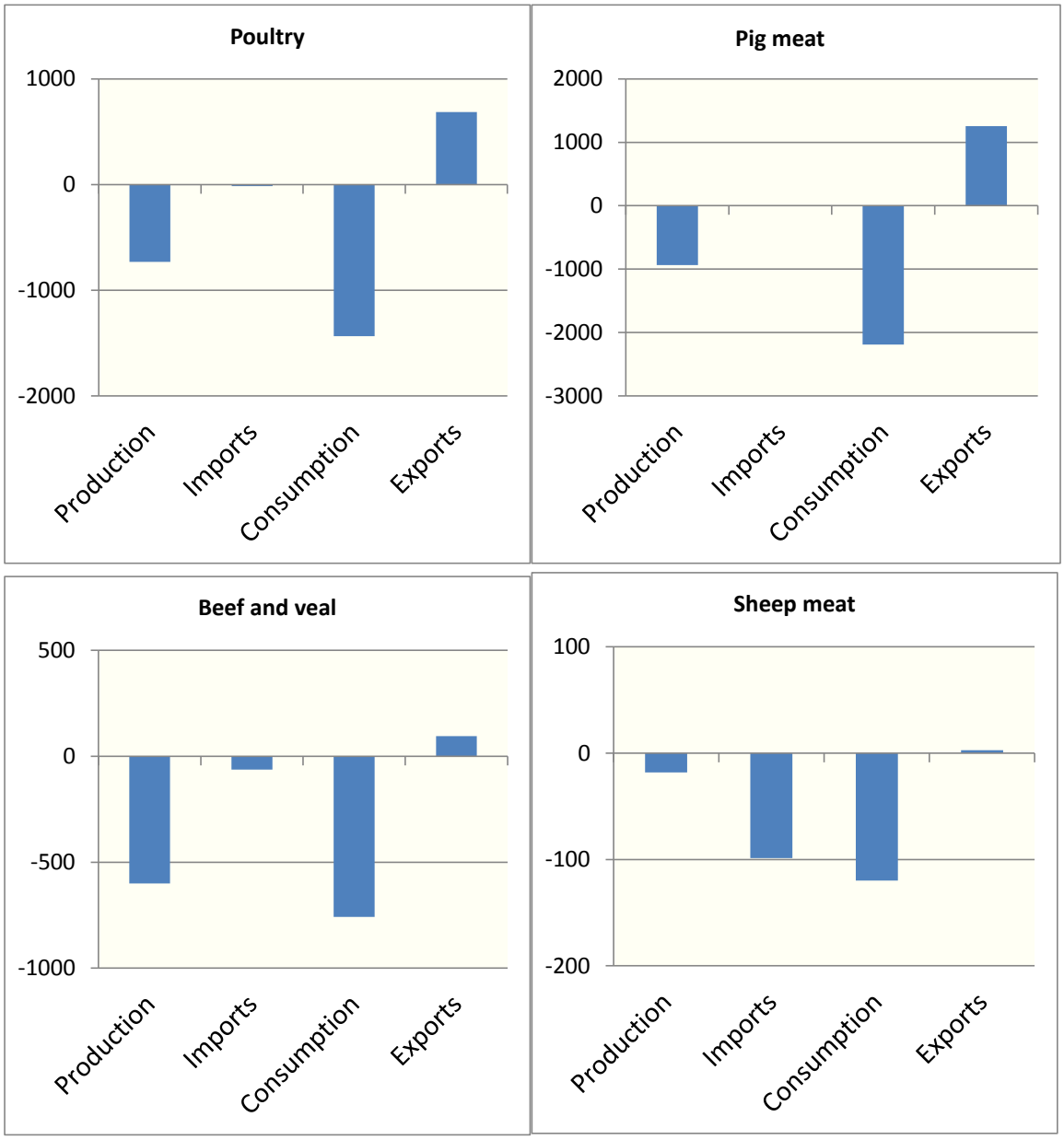
Figure 7 – Evolution of EU meat domestic price index (Base 100= 2005-07).



Source: Aglink-Cosimo

Concerning meat flows, a lower domestic demand and a lower domestic price for meat at EU level is expected to induce a drop in meat production and/or in meat imports and/or a boost for extra-EU exports. However, in the first alternative scenario (Lower meat consumption with **no** protein compensation), markets respond differently according to the type of meat. For poultry and pig meat, the decrease of consumption is compensated in the EU by both a decrease of domestic production and increased exports in similar proportions (**Figure 8**), thanks to domestic prices not too far away from the world prices and a reasonable degree of competitiveness of the EU industry in these sectors. On the contrary, concerning beef and veal meat, the price wedge between the EU and world markets remains too important and the adjustment to reduced consumption is mostly achieved through a reduced EU production. Finally, sheep meat consumption reduction results almost entirely in an import reduction.

Figure 8 – EU supply balance sheet for the meat markets (change in 1000T relative to the baseline).



Source: Aglink-Cosimo

These impacts result in an improved self-sufficiency ratio and trade-balance for meat in the EU (see **Table 2**). The EU would become self-sufficient for beef meat and would be very close for sheep meat. The positive trade balance would also amplify significantly for poultry and pig meat.

Table 2 – EU Self-sufficiency ratio and net exports (in % of production).

	Self-sufficiency ratio		Net Exports	
	Baseline	Scenario 1	Baseline	Scenario 1
Poultry	113	121	+11%	+17%
Pig meat	104	110	+4%	+9%
Beef and veal	99	101	-1%	+1%
Sheep meat	88	97	-13%	-3%

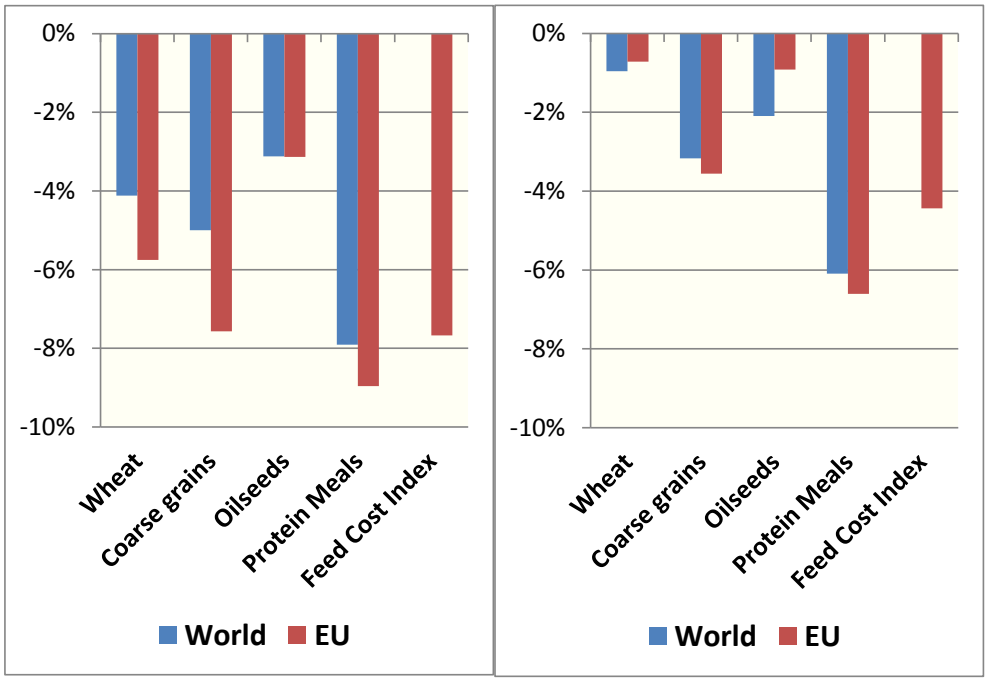
Source: own calculations from Aglink-Cosimo

A reduction in meat consumption also implies a contraction in feed demand, resulting in price decrease for these commodities. Prices are particularly affected for the commodities used in large proportion for feed (coarse grains and meals), but less for commodities the use of which is more balanced between feed and human consumption or other industrial uses (wheat, oilseeds). verall the feed cost index[5] (defined as the average price of all types of commodities potentially used as feed weighed by the actual quantities of each commodity used for feed) calculated in the Aglink - Cosimo for the EU would decrease by close to 8% over the period relative to the baseline (**Figure 9**).

The second alternative scenario (Lower meat consumption with partial protein compensation) is characterised by similar results as the first scenario concerning the meat markets, although most prices (except for beef meat) are slightly higher than in the first scenario and impacts on crop markets are significantly contrasted. As meat proteins are partially substituted in the diet with other products - crop or animal - the demand in cereals and oilseeds is less affected than in the first scenario: the increased dairy and eggs production is associated with a higher demand in feed, and food demand for cereals and oilseeds also increases. All in all, EU domestic and world prices for these commodities tend to decrease less than in the alternative scenario without compensation. The feed cost index in the EU would only be 4% below baseline in this second scenario.

[5] Only commercial feed bulks considered.

Figure 9 – EU domestic and world prices for crops and EU feed cost index (Difference to baseline in % change, 2024, scenario 1 and scenario 2).



Source: Aglink-Cosimo

It is to be noted that the second alternative scenario includes higher dairy products consumption as a compensation to the meat consumption reduction. This scenario would therefore translate into higher EU milk and cheese prices above baseline trends that are already rather bullish. This scenario with protein compensation leads to particular market stress: on the one hand the domestic demand for beef meat is reduced, but on the other hand as an output of dairy farming beef meat production is stimulated by the boost in milk domestic demand. This explains why the beef meat price is the only one more affected in scenario 2 compared to scenario 1. This is also the reason why in the EU, the herd itself would evolve towards less suckler cows (-3%) and more dairy cows (+1%) putting under pressure those livestock systems specialised in beef meat production.

4. DISCUSSION ON POLICY IMPLICATIONS FOR THE EU

These scenarios depict a ten-year transition during which individual changes in food consumption patterns induce market adjustment and changes in relative prices. The European livestock farming sector would have to cope with contradictory market signals: the reduction in feedstuffs prices is an incentive to produce more at lower costs of production as well as lower domestic price and increased demand in developing countries would open export opportunities, but at the same time domestic demand for meat is losing momentum and lower domestic price would affect profitability of meat production in the EU. Such an evolution would represent a challenging context for livestock producers.

This is particularly the case for beef producers specialised in meat, who cannot take advantage of the higher demand for milk and dairy products. Some elements of the new CAP might be relevant to help producers facing such challenges. Indeed, the CAP 2014-2020 provides support possibilities specific to livestock farming systems in general and for grazing livestock farming systems in particular. Its rural development component also embeds measures that can come in support to sectorial restructuration.

First, the CAP 2014-2020 provides recoupling possibilities to EU member states for livestock and protein crops (regulation (EU) No 1307/2013[6]). Considering that in 2014, 24 out of 28 member states[7] opted for the voluntary coupled support for Beef and Veal (Agra Europe, 2015), it is likely that the majority of EU cattle farmers will receive coupled direct support in the future. Beef and veal meat would represent over 40% of the total voluntary coupled support granted by Member States to farmers and sheep and goat meat around 12%. Other meat sectors would not represent a significant share (European Commission DG-AGRI, 2015). Thus, recoupling supports could play a role of partial safety net for livestock farmers and especially for suckler-cow based farming systems - the more at risk under our Lower meat consumption scenarios. However, at the same time, such recoupling possibilities might delay the structural adaptations needed by possible structural trends in meat consumption.

Second, as highlighted in the introductory section, civil society organizations are conveying the message to eat "less-but-better" meat. Thus, extensive grazing system might benefit from niche markets, based on specific voluntary labelling or quality schemes. Extensive grazing systems are also acknowledged to deliver substantial environmental positive externalities. Some instruments of the new CAP other than recoupled support can then also play a role in the reorientation of the EU meat sector. Grazing livestock systems should first mechanically be the prime beneficiaries of the redistribution of direct payments for internal convergence envisaged in the new CAP 2014-2020. According to an impact assessment study commissioned by the European Commission, an increase by 10% of the Farm Net Value Added (FNVA) is expected in this sector thanks to the redistribution of direct payments by 2020 at EU27 level (European Commission, 2011). Also, grassland-based farms are over-represented in less-favoured areas (LFAs) and areas of natural constraints (ANCs) eligible for specific CAP supports, which may therefore indirectly contribute to foster the extensive livestock systems. In addition, the rural development component of the current CAP contemplates a list of measures relevant for the development of "high quality" livestock systems (Regulation (EU) No 1305/2013[8]), just to mention support to quality schemes and the promotion of their products, support to organic farming, and agri-environment-climate measures (e.g. on the maintenance or introduction of extensive farming practices and extensive livestock management).

It should be mentioned that most policy measures presented above will be implemented differently in the member states which will decide to what extent they will make use of each of them and on the concrete implementing modalities. The ability to target financial resources to different categories of breeders according to specific policy or local objectives is the strength of RDPs as a policy tool. However the impact assessment CAP 2020 showed that RDPs sometimes suffer from path dependence (authorities tend to favour past successful measures over new ones) and unbalanced ability of areas/groups to weight in the process of defining RDPs (European Commission, 2011). From these observations, we can anticipate that in our scenarios livestock producers will receive uneven support across member states, according to their implication and efficiency in representing their case at local, national and regional policy level.

The situation of farmers involved in other meat sectors (pig, poultry) is different as most of the policy tools mentioned above are either not designed in a such a way that they benefit from them because of their meat activity or not targeted by Member States to such sectors. EU farmers active in these sectors would find

[6] Regulation (EU) No 1307/2013 of the European Parliament and the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009.
[7] Only Ireland, Germany, Cyprus and Luxembourg did not recouple support for beef and veal.
[8] Regulation (EU) No 1305/2013 of the European Parliament and the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005.

less policy tools in the CAP than the ones involved ruminant livestock breeding, with the exception of tools for restructuration of holdings toward a diversification of outputs. The risk management tools integrated in the CAP are aiming to cope with sudden and unexpected shocks. Thus, they would not be relevant to support a possible continued trend toward a reduction of meat consumption considered in our scenarios.

5. UNCERTAINTIES AND LIMITATIONS

The work presented in this paper consists in scenario exploration, analysing the possible impacts on agricultural markets of a significant change in meat consumption in high income and selected Latin American countries. The scenarios described here have to be considered as two single and subjective alternative pathways among many other possible and plausible ones. The level of uncertainty concerning the pace and features of future development of meat demand and of the development of alternative sources of protein intake in the EU, in other developed countries or in developing countries remains high. Also, the baseline and the two scenarios presented consider a certain set of macroeconomic and yield conditions and the absence of any 'black swan' events, like the emergence of new zoonoses or food scares.

Furthermore, the scenarios have been elaborated with the same modelling tool as the baseline. Since the alternative scenarios encompass nutritional issues, they could justify that the model is improved by including relevant missing commodities for this purpose.

Actually, including the fish commodity would allow for a deeper analysis of protein substitution in lower meat consumption scenarios. But fish inclusion is not straightforward. It would also require further investigation to correctly integrate fish linkages with feed in aquaculture. The integration of fruits and vegetable commodities would also be an asset to better model alternative diets. Another model improvement could be the conversion of quantity of commodities produced and trade into quantities of calories or nutrient equivalent. This would allow to better assess the nutritional value in each scenario: are we modelling healthy purchase behaviours/diets or not? are we correctly simulating protein substitution options? Linking the different food uses of the different commodities by specific equations (developing nutritional module) could be a way forward.

Finally, as one of the drivers of a lower meat consumption choice is the individuals' concerns of their food impact on the environment, an interesting field of research would be to couple the agro-economic model with environmental indicators like the commodities' virtual content in water or land (like for example in (Wirsenius *et al.*, 2010)) . In the same perspective, agricultural production could be linked to with greenhouse gas emissions (as in (Garnett, 2011; Tukker *et al.*, 2011; Wolf *et al.*, 2011)) or biodiversity losses and other environmental impact indicators (as in (Tukker *et al.*, 2011)) is another area of research.

As a conclusion, it is clear that a shift in the meat consumption trends in developed countries would impact on global meat markets, with stronger consequences at EU level. The impact appears to be stringer for beef and veal meat than for non-ruminant livestock sectors, in particular because of the linkage of this sector with dairy products. There are also significant spill-overs to the crops markets through the feed use (and to a lesser extent possible increased human consumption). A broad range of policy tools could be of importance for farmers affected at EU level by such evolutions. Some tools might allow a swifter transition and/or facilitate a redistribution of the production at EU level between geographical areas and/or farming

systems; others might be used for reinforcing competitiveness of the EU meat sectors and/or manage diversification where needed.

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