To link to this article : DOI:10.1016/j.meatsci.2015.05.012
URL : http://dx.doi.org/10.1016/j.meatsci.2015.05.012

Sans, Pierre and Combris, Pierre *World meat consumption patterns: An overview of the last fifty years (1961–2011).* (2015) Meat Science, vol. 109. pp. 106-111. ISSN 0309-1740

World meat consumption patterns: An overview of the last fifty years (1961–2011)

P. Sans [a,b], P . C o m b r i s [b]

[a] INP-Ecole Nationale Vétérinaire de Toulouse, 23 chemin des Capelles, F-31076 Toulouse, France
[b] Institut National de la Recherche Agronomique, UR1303 Aliss, 65 boulevard de Brandebourg, F-94205 Ivry-sur-Seine, France

A B S T R A C T

Driven by economic development and urbanisation, protein consumption has surged world-wide over the last 50 years, rising from 61 g per person per day in 1961 to 80 g per person per day in 2011. This contribution analyses the apparent convergence of dietary models worldwide with respect to the proportion of ABP and especially meat in intake. By using FAO data for 183 countries over the period 1961–2011, the authors show the connection between annual per capita GDP and the level of ABP ($R2 = 0.62$) and meat consumption ($R2 = 0.62$). They emphasise the surge in ABP intake in emerging countries (China, Brazil) which has partly re-placed plant protein. However, for similar degrees of economic development, the composition of ABPs and the position of meat within this category vary significantly among countries, suggesting that historical, geographical, cultural and religious factors may be involved.

1. Introduction

Actual access to food determines the development of human societies and shapes dietary models (dietary quantities and patterns). Observations over long time spans make it possible to pinpoint the various stages of change in these models in most countries. After a subsistence economy stage, the dietary transition is characterised by quantitative growth in consumption of traditional foods, essentially of plant origin, through the combined effect of higher agricultural output and lower prices (Combris & Soler, 2011; Grigg, 1995a). Then came a nutritional transition characterised by a radical change in dietary structure when calorie saturation occurred: more expensive foods such as meat, fruit and vegetables superseded in part traditional foods as mean per capita income rose (Popkin, 2006).

Indeed, over the last 50 years, meat consumption rose worldwide from 23.1 kg per person per year in 1961 to 42.20 kg per person per year in 2011. The same is true of proteins from dairy foods. The most developed countries have thus achieved on average levels of animal-based protein (ABP) consumption that exceed needs. Various authors have shown a degree of convergence in dietary models, especially as regards the boom in ABP consumption, first in groups of countries with high purchasing power (Blandford, 1984; Gil, Gracia & Perez y Perez, 1995; Herrmann & Röder, 1995) then in countries with intermediate incomes (Regmi, Takeshima & Unnevehr, 2008): when incomes rise, the proportion of food-budget spending on proteins rises concomitantly with the share of ABPs in the diet and approaches the proportion in developed countries. Over the last 20 years, emerging countries have experienced a livestock revolution characterised by a surge in meat consumption especially meat from monogastric livestock (pork and poultry) (Delgado, 2003; Speedy, 2003). This observation, which seems to accredit the claim that dietary models are converging or at least evolving along parallel courses, raises questions about the levels of ABP consumption such countries will reach. Could it be that they will approach the levels of the most developed countries or will they hit a consumption ceiling before that? This question relates to the determination of an inflection point in the consumption curve, as in the models described by Kuznets (1955). There would seem to be an income level beyond which ABP consumption falls off. By using data from 150 countries for the period 1980–2009, Rivers Cole and McCoskey (2013) confirm that there is a turning point for meat (bovine meat, pig meat and poultry) consumption. However, that point is at a high per capita income level (estimated at US$36,400) that few countries in the world have reached. The authors therefore conclude that policy makers need to curb the increase in individual consumption. The inverted U-shaped relation between meat consumption and the level of income is confirmed by Vranken, Avermaete, Petalios, and Mathijs (2014) for data on 120 countries for the period 1970–2007: according to the specifications in the model chosen, the turning point lies between US$32,000 and US$55,000. For countries below the inflection point, a 1% rise in GDP expressed in constant 2005 international dollars would engender a 0.5% rise in meat consumption whereas a 1% rise in the same GDP for countries beyond the inflection point would generate a 1.2% reduction in consumption.

The potential consequences for the environment and the use of farmland of an individual increase in meat consumption combined with strong demographic growth on the scale of the planet (9 billion individuals in 2050) are incentives to change dietary practices in developed countries. Changes to nutritional recommendations (Reynolds, Buckley, Weinstein & Boland, 2014) and the promotion of individual behaviour intended to cut down on how often meat is consumed ('meatless days') or portion sizes are some of the levers recently proposed in these countries (Dagevos & Voordouw, 2013; de Boer, Schosler & Aiking, 2014). The search for new sources of both plant and animal protein is also recommended (Boland et al., 2013). Recent studies have tried to measure the impact of such a reduction of meat and milk consumption in Europe (Tukker et al., 2011; Westhoek et al., 2014) and the world (Hedenus, Wirsenius & Johansson, 2014) on the environment, climate and land use. For example, Westhoek et al. (2014) report that replacing 25 to 50% of current EU consumption of meat, eggs and dairy products would cut animal production by 50% and lead to reductions of 25 to 40% in greenhouse gases and about 40% in reactive nitrogen.

Given the scale of the challenge, it seems worth revisiting one of the assumptions underpinning much of this work, namely the increase in ABP consumption in conjunction with the growth in income in emerging or developing countries. This contribution proposes a detailed analysis for the period 1961–2011. We shall begin with a snapshot of world ABP consumption at the end of the period for the purpose of identifying the main trends. Then we shall analyse the evolution of ABP and meat-based protein (MBP) for the entire period.

2. Material and methods

We have used quantitative data from FAO food balance sheets (FAO, 2014) for the period currently available (1961–2011) and for all countries individually. FAOSTAT supply data refer to national per capita supply at a retail level. This is calculated as (national production + import + stocks) − (exports + feed + non-food usage + usage input for food + wastage + closing stocks). Per capita availability is calculated by dividing total availability by the country's population size. Given the losses after the distribution stage, these are not quantities actually consumed by individuals. Besides, as availability is the outcome of a calculation, it depends on how well production is evaluated (Hawkesworth et al., 2010), even if the FAO corrects certain data (Hallström & Börjesson, 2013). Despite these shortcomings, the source indicates intake in the form of time series and it is useful for measuring changes and for highlighting differences between countries or geographical regions.

The data are for daily per person calorie and protein intake and the proportions of plant and animal products in those intakes. Four groups are formed for animal products: (i) Meat (including offals), (ii) Milk products, (iii) Fish and Seafood products and (iv) Others (mainly eggs). This information has been enhanced by World Bank indicators about the geographical region to which the country belongs, annual per capita Gross Domestic Product (GDP), income group, population and urbanisation rate (for the period 2005–2011). The combination of the two data sets covers 183 countries (for 155 of which we have full data for the period 1961–2011).

First we analysed the variation of indicators extracted from the two bases and indicators calculated from each country's income group. This analysis was made for an average of the latest three years available (2009–2011) so as to smooth inter-annual variations. Simple regressions were calculated between the chosen indicator and per capita GDP (in natural log form) and the adjusted R-squared (R2) recorded. Then we analysed the change in calorie and protein intake and the contribution of the various groups (plant and animal) or sub-groups for the periods 1961–1963 (noted 1961 in what follows) and 2009–2011 (noted 2011). Only those countries for which complete data are available were included. Lastly, a closer analysis of ABP was conducted for six countries selected either because of their atypical consumption in their geographical or income-level sub-group (Argentina, India, Japan), or for the marked change in this aspect over the period (Spain, Brazil, China)

3. Results

3.1. Analysis by income group (2009–2011)

By using the World Bank's nomenclature of groups of countries by income, it can be observed that the number of kcal consumed by person per day on average over the period 2009–2011 tracks GDP (R2 = 0.92) and the urbanisation rate. The wealthiest groups consume 1.5 times more kcal per person per day than the poorest (Table 1). The number of grams of proteins consumed follows the same trend (R2 = 0.98), with a higher ratio between extreme groups (1.79). For the same period, the percentage of calories from ABP varies by a ratio of 3.4 between the extreme groups and is also closely related to GDP (R2 = 0.98). Expressed as percentage of total protein intake, ABPs make up between 21.9 and 59.5% for the poorest and richest countries, respectively (ratio 2.7, R2 = 0.99). Lastly the share of meat in ABP supply varies from 6 to 30 g per person per day for the extreme income groups (R2 = 0.98). This ratio of 1 to 5 between the intake levels of poorest and richest countries is the highest among the indicators studied.

3.2. Changes in protein consumption between 1961 and 2011

3.2.1. Proportion of protein in calorie intake

The proportion of protein in the calorie intake is stable between the two extremes for the period under study: 10.7% (min = 6.1, max = 16.1) in 1961 versus 11.2% in 2011 (min = 6.6, max = 15.7). This proportion is weakly correlated with per capita GDP even if it rose slightly over the period (R2 = 0.12 in 1961 versus 0.35 in 2011). Over the period, the share of plant protein in calorie intake falls (from 6.9% to 6.3%) to be replaced by ABP intake (which rises from 3.8% to 4.9%). The first exhibits a weak negative correlation with per capita GDP (R2 = 0.44 in 1961 versus 0.49 in 2011) in contradistinction to the second (R2 = 0.57 in 1961 versus 0.68 in 2011).

3.2.2. Protein intake

Protein consumption rose 31% over the period, from 61 g per person per day in 1961 to 80 g per person per day in 2011. Although the quantity of plant protein consumed rose (from 38 g to 44 g per person per day), its proportion in total intake fell (from 66% to 58%). This can be accounted for by the surge in ABP intake, the consumption of which rose from 23 to 36 g per person per day (+50%). Total protein intake levels remain highly variable depending on the countries and positively correlated with per capita GDP (R2 = 0.5 in 1961 and 0.62 in 2011) (Fig. 1)

Table 1
Calorie and protein intake by income level.

Income group[a]	Low	Lower middle	Upper middle	High non OECD	High OECD	World
n	28	40	46	30	18	162
Population (billions)	0.69	2.31	2.25	0.06	0.99	6.88
GDP[b] (USD)	566	2025	6685	26,919	41,190	9430
Urbanisation (% population)	30.1	45.4	61.5	68.7	77.8	52.0
Total calories (kcal/pers/d)	2287	2597	2896	2987	3363	2847
Protein (g/pers/d)	58	69	82	94	104	80
Animal protein (% total calories)	2.2	3.7	5.2	7.4	7.4	4.4
Animal protein (% total protein)	21.9	34.6	45.4	58.5	59.5	39.4
Meat protein (g/pers/d)	6	12	19	30	30	15

[a] Country list is available in Supplementary data section.
[b] GDP: Gross Domestic Product.

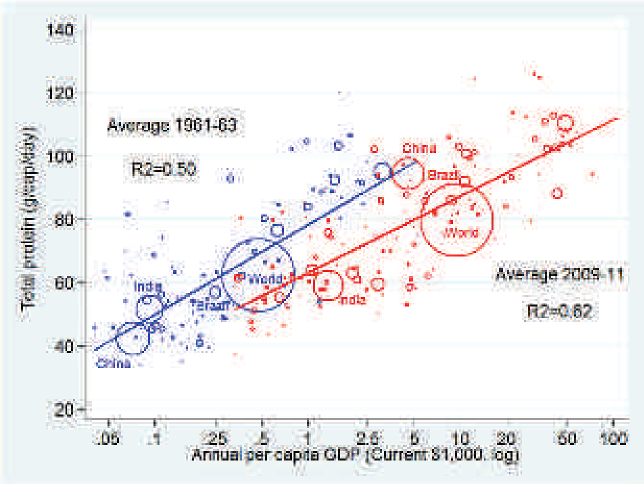

Fig. 1. Change in total protein intake versus per capita Gross Domestic Product (GDP)[a]. A circle size proportional to country population.

3.2.3. Changes in ABP consumption and its proportion in protein intake

Much as is observed for total protein intake, consumption of meat protein rose worldwide from 9 to 15 g per person per day between 1961 and 2011. This phenomenon is observed in all geographical zones defined by the FAO, with the strongest rises in absolute value (>15 g/person/d) for Polynesia, Southern Europe and Eastern Asia. However, intake levels remain very different for geographical zones (min = 2.9 g/person/day for Southern Asia; max = 39.9 g/person/day for Oceania in 2011).

These differences are also observed between countries although a few major trends can be identified: consumption is positively correlated with annual per capita GDP (Fig. 2 and Table 1) and with urbanisation ($R2 = 0.40$ in 2011). The level of protein from meat in 1961 is a poor predictor of meat consumption in 2011 ($R2 = 0.05$).

Although variations in consumption over the study period are closely related to increases in GDP, the effects are not of the same magnitude for all countries, as illustrated for the six selected countries (Table 2). This situation can be explained by (i) very different initial intake levels, (ii) differentiated progression during the study period, and (iii) the relative place of meat in protein intake in each of these countries.

And beginning from very different levels of ABP consumption, meat protein consumption surged in Spain (+23 g/person/d over the period) as well as in Brazil and China. This increase is faster than ABP protein consumption, reinforcing the place of meat as the primary source. Japan has also seen a significant rise in meat consumption (+13 g/person/d), with meat now close behind fish as the primary source of ABP. Conversely, the increased ABP consumption in India has not challenged the hegemony of dairy proteins. Lastly, Argentina has seen a change in its dietary profile: over the period it is the only country of more than 10 million inhabitants where meat protein consumption has fallen significantly (−8 g/person/day), leading to a marked fall in its position as a source of ABP (−10% over the period) and a concomitant rise in dairy protein intake.

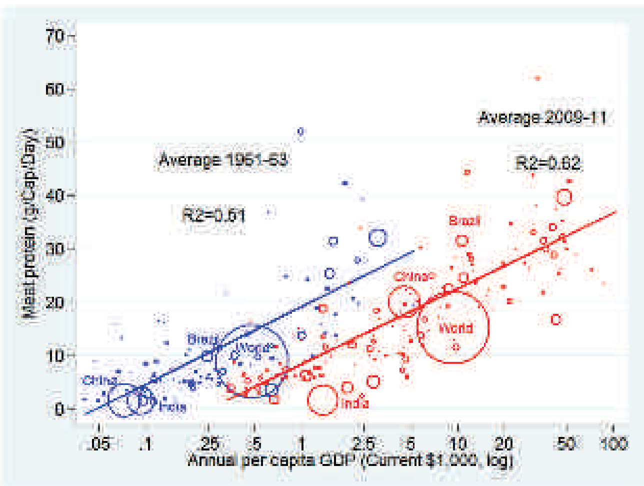

Fig. 2. Changes in protein from meat versus per capita Gross Domestic Product (GDP)[a]. A circle size proportional to country population.

Moreover, the effect of the increased annual per capita GDP is variable across countries depending on the amplitude of the variation in meat protein consumption and its timing. Similar economic growth in Argentina and Brazil (+US$10,500) is reflected by a very different variation in meat protein consumption, which may be explained, among other things, by the already high level of such intake in Argentina. The same goes for China and Japan which had very different levels of development at the beginning of the period. Besides, by subdividing the period into three sub-periods of equal lengths (P1 to P3), it can be observed that the variation in meat protein consumption is not always highest in the period with the fastest growth in annual per capita GDP: in Spain, for example, meat protein consumption surged in P1 and P2 (which together made up only 43% of the total variation in GDP) and then fell during P3 when economic growth was strongest. The same goes for China whose upturn in meat protein consumption began in the period P2.

3.2.4. Variation in meat and fish protein consumption

For most countries of more than 10 million inhabitants in 2011, meat protein consumption rose faster over the period 1961–2011 than fish protein consumption (Fig. 3). Except for North Korea and South Africa, variation of fish protein consumption has been positive.

4. Discussion

Our aim is to offer a detailed analysis of animal-based protein intake and more especially of meat intake worldwide over the period 1961–2011 in order to highlight the dynamics of change and the main factors of variation including income.

4.1. Dynamics of ABP consumption and income

In 2011, the share of calories provided by ABP varied by a ratio of about 1 to 3 between the lowest- and highest-income countries. In addition, a close correlation ($R2 = 0.91$) was found between the calorie intake and annual per capita GDP in 2009–2011 on country group data (Table 1), confirming the findings by Gerbens-Leenes, Nonhebel, and Krol (2010) for a set of 57 countries for 2001 ($R2 = 0.71$) and by (Popp, Lotze-Campen & Bodirsky, 2010) for 105 countries between 1990 and 2000. These differences may be explained by the fact that the analysis does not relate to the same number of countries but also by the use of three-yearly means in our case. Some 30 countries, mostly in sub-Saharan Africa have dietary consumption of less than 2200 kcal per person per day. By FAO estimates, by 2050 some 4.7 billion people (52% of the world population) may be living in countries with national averages of over 3000 kcal per person per day, up from 1.9 billion (28%) at the present time (OECD-FAO, 2014). In parallel, those living in countries with under 2500 kcal may fall from 2.3 billion (35% of present world population) to 240 million (2.6%) in 2050.

Protein intake has risen by 10 g per person per day worldwide from 70 g per person per day in 1986–1988 (Grigg, 1995b) to 80 g per person per day in 2009–2011 (2011). The proportion of ABP rose by 5% over the same period to 39.4% (Table 1). Our analyses confirm the connection be-tween the level of ABP consumption and annual per capita GDP: R2 values rose over the period under study (from 0.5 to 0.62) but are lower than those reported by Grigg (1995b) ($R2 = 0.8$). The situation observed in 2011 also reveals large variations in intake between high-

Table 2
Changes in ABP (including meat) consumption and variation in per capita income in six countries.

	Argentina	Brazil	China	India	Japan	Spain
Animal protein (g/pers/day)						
1961	65.9	18.0	4.2	6.1	26.1	28.1
2011	64.1	49.0	37.2	11.9	48.7	65.8
Major animal protein source[a] (*% of total animal proteins*)						
1961	M *(79)*	M *(55)*	M *(41)*	Mi *(63)*	F *(63)*	M *(35)*
2011	M *(69)*	M *(64)*	M *(53)*	Mi *(64)*	F *(38)*	M *(50)*
Meat protein (g/pers/day)						
1961	51.9	10.0	1.7	1.7	3.7	9.8
2011	44.3	31.6	20.0	1.8	16.9	33.1
Variation of meat protein (g/pers/day)						
P1	2.3	3.2	2.3	− .1	6.7	14.8
P2	− 9.6	8.6	7.4	.2	5.0	11.1
P3	− .3	9.8	8.6	.0	1.5	− 2.5
Overall	−7.6	21.6	18.3	.1	13.2	23.3
Overall variation of annual per capita GDP (current US$1000)	10.5	10.4	44.7	12.8	42.3	30.2
Share of the overall annual per capita GDP variation (%)						
P1[b]	11.8	14.2	2.2	9.0	17.3	13.0
P2	57.8	18.6	6.9	11.0	73.2	30.7
P3	30.4	67.2	90.1	80.0	9.5	56.3
Overall						

[a] M = Meat; Mi = Milk; F = Fish & Seafood products.
[b] P1: 1961–1977 P2: 1977–1993 P3: 1993–2011 Overall: 1961–2011.

and low-income countries: ABP represents just 21.9% of total protein intake (versus almost 60% for the richest countries) and meat protein just 6 g per person per day in the poorest countries (versus 30 g per person per day in rich countries). The increase in this intake is a major challenge for combatting malnutrition in these countries, especially in Africa because of the nutritional quality of ABP (Schonfeldt & Hall, 2012).

Meat proteins are the major contributors worldwide to the increase in ABP. The growth in meat protein consumption has not occurred to the detriment of other protein sources (such as fish—Fig. 3) but contributes to a rise in overall ABP consumption. We confirm the positive correlation between meat protein consumption and per capita income ($R2 = 0.62$) and urbanisation ($R2 = 0.40$ in 2011), as in (Kearney, 2010). Over the study period, the patterns of increase in consumption vary markedly from country to country. They are not related to the initial low consumption of meat proteins, which reflects the fact that the level of meat protein consumption in 1961 is a poor predictor of its 2011 level ($R2 = 0.05$). Growth is strong in a number of emerging countries (China, Brazil) which have seen both their mean income per inhabitant and their rate of urbanisation rise strongly over this period. So by using data from the China Health and Nutrition Survey for nine Chinese provinces and three megalopolises (Beijin, Shanghai and Chongqing), Zhai et al. (2014) show how the change in food supply, related to new forms of distribution (supermarkets, catering outside the home) and urbanisation of population have contributed to the change in the Chinese diet. The share of cereals and legumes in the calorie intake declined for the period 1991–2011 in all categories of households while that of animal products and edible oils rose. This trend is more prominent, however, in urban areas and can be explained by the fall in the relative price of those products and the rise in the average household purchasing power (Popkin & Du, 2003). The same trends are observed in other SE Asian countries such as Vietnam (Nguyen, Olivier Salvagnac, Sans, Sautier & Duteurtre, 2014). For Brazil, in their study of changes in diet of the urban population over the period 1962–1988, Mondini and Monteiro (1994) show that meat consumption rose essentially from the second half of the 1970s onwards. This was reflected by a 50% increase in the relative proportion of meat in the population's calorie intake between 1975 and 2003 (Levy-Costa, Sichieri, Pontes & Monteiro, 2005). This trend has been confirmed over the last decade, particularly with the effect of increased mean income per inhabitant and urbanisation, and has essentially involved chicken meat (Schneider, Duro & Assunção, 2014).

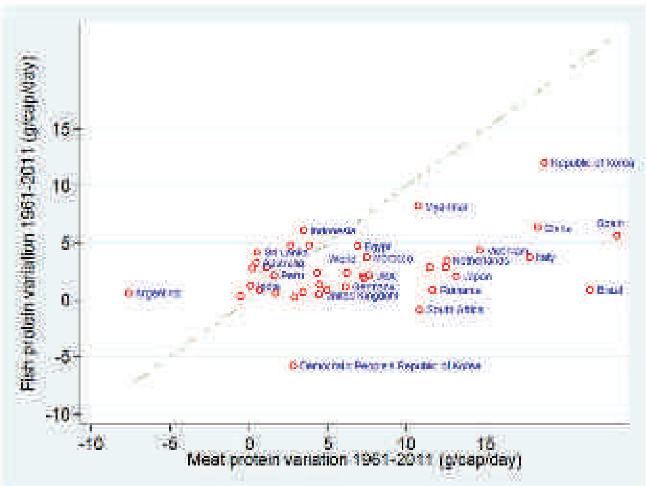

Fig. 3. Variation in meat protein and fish protein consumption over the period 1961–2011 in countries of more than 10 million inhabitants in 2011[a]. a: from 1961–1963 consumption level (1961) to 2009–2011 one (2011).

Should the growth in the two drivers of meat protein consumption China and Brazil slow in the coming decades, it will be offset by upturns in consumption in other parts of the world such as the Middle East and North Africa where per capita meat consumption (in kg per person per year) should double by 2030 compared with its 2000 level according to the IFPRI's IMPACT model projection (Msangi & Rosegrant, 2011, February 10–12).

The strong growth in meat protein consumption is not confined to emerging countries, though. Some OECD countries, especially in Europe (Spain, Italy, Netherlands) have seen their meat protein intakes rise at twice the world average. Thus, the Spanish diet has change radically since the 1960s shifting away from the Mediterranean diet (Grigg, 1999). As our analysis shows, it is the country that has experienced the greatest upturn in meat consumption worldwide, although ABP intakes were already quite high. However, this increase could not continue (Chamorro, Miranda, Rubio & Valero, 2012), in keeping with what is observed in many developed countries. Over the period 1991–2001, ABP intake has declined by 2.5 g per person per day for Western Europe (whereas it rose by 5 g per person per day for the period 1961–2011), under the impetus of a movement of decline in individual consumption observed in the main EU countries (France, Germany, Italy, etc.). Lastly and counter-intuitively, the pattern of meat protein consumption does not always follow the pattern of rising annual per capita GDP, as attested by the Spanish example (Table 2).

4.2. Dynamics of ABP consumption and country

Approaches by geographical region or by income group can identify the main trends in dietary patterns. However, they must be supplemented by studies at finer geographical levels. Our study shows, for example, that countries in the same sub-continent and the same income group (such as Argentina and Brazil) have very different meat protein intakes at the beginning of the period (1961) for similar annual per capita GDP levels. Likewise, Japan has a meat protein intake far below the average of developed countries. These examples reflect the fact that while the income approach reflects a large proportion of the variability in meat protein consumption it must be supplemented by other factors. Among these are cultural and religious differences (Grigg, 1995b) that affect dietary practices within a geographical area or within a country. Nam, Jo, and Lee (2010) have illustrated the diversity of behaviour for meat consumption in various countries of Asia, including China, Vietnam and Japan. In Western Europe, de Boer, Helms, and Aiking (2006) compare spending on meat in predominantly Catholic countries (Italy, France, Spain, etc.) with predominantly Protestant countries (Netherlands, United Kingdom, Finland, Germany, etc.). Observing that levels are higher in the first group, they suggest that the difference might be explained in part by the relationship of Catholics with meat eating (pleasure and social status marker). It is also by mobilising cultural and religious factors that one can better understand the very low position of ABP other than milk in the nutritional intake of Indians. In India, animal and fish protein make up just 9 to 10% of daily calories and less than 30% of protein intake. Despite a significant rise in annual per capita GDP, essentially over the period 1993–2011 (Table 2), ABP intake has increased little, although starting from a very low level, and meat protein consumption has not moved. Lastly, as shown by the studies of Wang, Beydoun, Caballero, Gary, and Lawrence (2010) and Daniel, Cross, Koebnick, and Sinha (2011) in the USA, meat protein consumption and composition vary from one ethnic group to another.

5. Conclusion

In the space of a few decades, that is, at a far faster rate than in developed countries in the twentieth century, dietary structure of many emerging and developing countries has changed radically (Combris, Maire & Réquillart, 2011). The increase in animal protein consumption is a marker of the nutritional transition affecting these countries. It is largely related to growing consumption of meat protein. The FAO (2014) expects this trend to continue for the next ten years at an average rate of 1.6% per year and essentially in developing countries because of increased per capita income (OECD-FAO, 2014), continuing urbanisation and demographic growth (Msangi & Rosegrant, 2011, February 10–12). While initially reserved to the wealthiest classes in a country's population, meat protein consumption trickles down to the entire population with changes in the dietary offer and distribution circuits and is promoted by the development of international trade. It thus contributes to improved cover of nutritional needs. This 'westernisation' of diet takes on various forms in different countries especially because of cultural and religious factors that affect the dissemination of the model. The prospect of generalisation of ABP consumption raises the question of its sustainability and invites us to explore the influence of new determinants of dietary behaviour (environmental awareness, human health, animal welfare, etc.).

References

Blandford, D. (1984). Changes in food consumption patterns in the OECD area. *European Review of Agricultural Economics*, *11*(1), 43–65.

Boland, M. J., Rae, A. N., Vereijken, J. M., Meuwissen, M. P. M., Fischer, A. R. H., van Boekel, M., …, & Hendriks, W. H. (2013). The future supply of animal-derived protein for human consumption. *Trends in Food Science & Technology*, *29*(1), 62–73. http://dx.doi.org/10.1016/j.tifs.2012.07.002.

Chamorro, A., Miranda, F. J., Rubio, S., & Valero, V. (2012). Innovations and trends in meat consumption: An application of the Delphi method in Spain. *Meat Science*, *92*(4), 816–822. http://dx.doi.org/10.1016/j.meatsci.2012.07.007.

Combris, P., Maire, B., & Réquillart, V. (2011). Consommation et consommateurs. In C. Esnouf, M. Russel, & N. Bricas (Eds.), *duALIne—Durabilité de l'alimentation face à de nouveaux enjeux. Questions à la recherche* (pp. 26–43). Paris: Inra-Cirad.

Combris, P., & Soler, L. G. (2011). Consommation alimentaires: Tendances de long terme et questions sur leur durabilité. *Innovations Agronomiques*, *13*, 149–160.

Dagevos, H., & Voordouw, J. (2013). Sustainability and meat consumption: Is reduction realistic? *Sustainability Science, Practice, & Policy*, *9*(2), 60–69.

Daniel, C. R., Cross, A. J., Koebnick, C., & Sinha, R. (2011). Trends in meat consumption in the USA. *Public Health Nutrition*, *14*(4), 575–583. http://dx.doi.org/10.1017/s1368980010002077.

de Boer, J., Helms, M., & Aiking, H. (2006). Protein consumption and sustainability: Diet diversity in EU-15. *Ecological Economics*, *59*(3), 267–274. http://dx.doi.org/10.1016/j.ecolecon.2005.10.011.

de Boer, J., Schosler, H., & Aiking, H. (2014). "Meatless days" or "less but better"? Exploring strategies to adapt Western meat consumption to health and sustainability challenges. *Appetite*, *76*, 120–128. http://dx.doi.org/10.1016/j.appet.2014.02.002.

Delgado, C. L. (2003). Rising consumption of meat and milk in developing countries has created a new food revolution. *The Journal of Nutrition*, *133*(11), 3907S–3910S.

FAO (2014). FAOSTAT: Food supply—livestock and fish primary equivalent. Retrieved 10/01, 2015, from http://faostat3.fao.org/download/FB/CL/E

Gerbens-Leenes, P. W., Nonhebel, S., & Krol, M. S. (2010). Food consumption patterns and economic growth. Increasing affluence and the use of natural resources. *Appetite*, *55*(3), 597–608. http://dx.doi.org/10.1016/j.appet.2010.09.013.

Gil, J. M., Gracia, A., & Perez y Perez, L. (1995). Food consumption and economic development in the European Union. *European Review of Agricultural Economics*, *22*, 385–399.

Grigg, D. (1995a). The nutritional transition in Western Europe. *Journal of Historical Geography*, *21*(3), 247–261. http://dx.doi.org/10.1006/jhge.1995.0018.

Grigg, D. (1995b). The pattern of world protein consumption. *Geoforum*, *26*(1), 1–17.

Grigg, D. (1999). Food consumption in the Mediterranean region. *Tijdschrift voor Economische en Sociale Geografie*, *90*(4), 391–409. http://dx.doi.org/10.1111/1467-9663.00081.

Hallström, E., & Börjesson, P. (2013). Meat-consumption statistics: Reliability and discrepancy. *Sustainability Science, Practice, & Policy*, *9*(2), 37–47.

Hawkesworth, S., Dangour, A. D., Johnston, D., Lock, K., Poole, N., Rushton, J., …, & Waage, J. (2010). *Feeding the world healthily: The challenge of measuring the effects of agriculture on healthVol. 365*, .

Hedenus, F., Wirsenius, S., & Johansson, D. J. A. (2014). The importance of reduced meat and dairy consumption for meeting stringent climate change targets. *Climatic Change*, *124*(1–2), 79–91. http://dx.doi.org/10.1007/s10584-014-1104-5.

Herrmann, R., & Röder, C. (1995). Does food consumption converge internationally? Measurement, empirical tests and determinants. *European Review of Agricultural Economics*, *22*(3), 400–414.

Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, *365*(1554), 2793–2807. http://dx.doi.org/10.1098/rstb.2010.0149.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, *45*(1), 1–28.

Levy-Costa, R. B., Sichieri, R., Pontes, N. d. S., & Monteiro, C. A. (2005). Household food availability in Brazil: Distribution and trends (1974–2003). *Revista de Saúde Pública*, *39*, 530–540.

Mondini, L., & Monteiro, C. A. (1994). Changing diet patterns in Brazil (1962–1988). *Revista de Saúde Pública*, *28*, 433–439.

Msangi, S., & Rosegrant, M. W. (2011, February 10–12). Feeding the future's changing diets: Implications for agriculture markets, nutrition, and policy. *Paper presented at the 2020 Conference: Leveraging agriculture for improving nutrition and health, New Delhi, India.*

Nam, K. C., Jo, C., & Lee, M. (2010). Meat products and consumption culture in the East. *Meat Science*, *86*(1), 95–102. http://dx.doi.org/10.1016/j.meatsci.2010.04.026.

Nguyen, D. T., Olivier Salvagnac, V., Sans, P., Sautier, D., & Duteurtre, G. (2014). Transition alimentaire et essor économique: Portrait en régions de la consommation de viandes au Vietnam. *Economie et Sociétés, Série Systèmes Agroalimentary*, *XLVIII*(10), 1559–1578.

OECD-FAO (2014). Agricultural outlook 2014In OECD-FAO (Ed.), http://dx.doi.org/10.1787/agr_outlook-2014-en.

Popkin, B. M. (2006). Global nutrition dynamics: The world is shifting rapidly toward a diet linked with noncommunicable diseases. *The American Journal of Clinical Nutrition*, *84*(2), 289–298.

Popkin, B. M., & Du, S. (2003). Dynamics of the nutrition transition toward the animal foods sector in China and its implications: A worried perspective. *The Journal of Nutrition*, *133*(11), 3898S–3906S.

Popp, A., Lotze-Campen, H., & Bodirsky, B. (2010). Food consumption, diet shifts and associated non-CO_2 greenhouse gases from agricultural production. *Global Environmental Change*, *20*(3), 451–462. http://dx.doi.org/10.1016/j.gloenvcha.2010.02.001.

Regmi, A., Takeshima, H., & Unnevehr, L. (2008). Convergence in food demand and delivery: Do middle-income countries follow high-income trends? *Journal of Food Distribution Research*, *39*(1), 116–122.

Reynolds, C. J., Buckley, J. D., Weinstein, P., & Boland, J. (2014). Are the dietary guidelines for meat, Fat, fruit and vegetable consumption appropriate for environmental sustainability? A review of the literature. *Nutrients*, *6*(6), 2251–2265. http://dx.doi.org/10.3390/nu6062251.

Rivers Cole, J., & McCoskey, S. (2013). Does global meat consumption follow an environmental Kuznets curve? *Sustainability Science, Practice, & Policy*, *9*(2), 26–36.

Schneider, B. C., Duro, S. M. S., & Assunção, M. C. F. (2014). Consumo de carnes por adultos do sul do Brasil: Um estudo de base populacional. *Ciência & Saúde Coletiva*, *19*, 3583–3592.

Schonfeldt, H. C., & Hall, N. G. (2012). Dietary protein quality and malnutrition in Africa. *British Journal of Nutrition*, *108*, S69–S76. http://dx.doi.org/10.1017/s0007114512002553.

Speedy, A. W. (2003). Global production and consumption of animal source foods. *The Journal of Nutrition*, *133*(11), 4048S–4053S.

Tukker, A., Goldbohm, R. A., de Koning, A., Verheijden, M., Kleijn, R., Wolf, O., …, & Rueda-Cantuche, J. M. (2011). Environmental impacts of changes to healthier diets in Europe. *Ecological Economics*, *70*(10), 1776–1788. http://dx.doi.org/10.1016/j.ecolecon.2011.05.001.

Vranken, L., Avermaete, T., Petalios, D., & Mathijs, E. (2014). Curbing global meat consumption: Emerging evidence of a second nutrition transition. *Environmental Science & Policy*, *39*(0), 95–106. http://dx.doi.org/10.1016/j.envsci.2014.02.009.

Wang, Y. F., Beydoun, M. A., Caballero, B., Gary, T. L., & Lawrence, R. (2010). Trends and correlates in meat consumption patterns in the US adult population. *Public Health Nutrition*, *13*(9), 1333–1345. http://dx.doi.org/10.1017/s1368980010000224.

Westhoek, H., Lesschen, J. P., Rood, T., Wagner, S., De Marco, A., Murphy-Bokern, D., …, & Oenema, O. (2014). Food choices, health and environment: Effects of cutting Europe's meat and dairy intake. *Global Environmental Change-Human and Policy Dimensions*, *26*, 196–205. http://dx.doi.org/10.1016/j.gloenvcha.2014.02.004.

Zhai, F. Y., Du, S. F., Wang, Z. H., Zhang, J. G., Du, W. W., & Popkin, B. M. (2014). Dynamics of the Chinese diet and the role of urbanicity, 1991–2011. *Obesity Reviews*, *15*, 16–26. http://dx.doi.org/10.1111/obr.12124.