PROTEIN-SHIFT IN LOW and MIDDLE INCOME COUNTRIES

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Summary

The projected shift towards the consumption of more animal-based protein in Lower-Middle Income Countries (LMIC) is troublesome when considering its environmental impact. Therefore, using currently available food consumption data, this report investigates protein source changes with respect to plant or animal-based proteins in selected countries. To this end, the ratio between proteins derived from animal-, and plant-based foods is calculated. Results show that Ecuador and Algeria show an average annual increase in the percentage of proteins derived from plant-based sources between 2010 and 2020 (+1,38% and +0,21%, respectively), whereas India and South Africa show an average annual decrease (0,38% and -0,49%, respectively). These results should be interpreted with care; the timespan may be regarded too short to detect a clear trend. Future policies should promote diets that prioritize a higher intake of plant-based foods.

1 Introduction

Proteins are the building blocks of the human body, and therefore pivotal in a healthy and balanced diet. However, the current global protein consumption is deemed unsustainable and unhealthy, which urges for a shift towards the consumption of more plant-based protein (De Eiwittransitie: Een Beweging Van Iedereen[1]). In promoting this shift, one should not overlook the position of Low- and Middle-Income Countries (LMICs), as Bennett's law predicts that when household income increases, the intake of animal-based foods increases (Rathu Manannalage, Chai, & Ratnasiri, 2023). Consequently, the OECD-FAO Agricultural Outlook 2023-2032 projected that the growth in consumption of animal-based food will grow until 2040 for upper middle-income countries, and until 2075 for lower middle-income countries (OECD/FAO, 2023).

So, despite the fact that diets in LMICs have been renowned for their reliance on plant-based foods, increased levels of welfare are projected to drive a shift toward more animal-based consumption. It is therefore important to quantify the protein shift in LMICs using available data in order to verify this hypothesis, to then be able to make judgements on its environmental impact and potential transition pathways. Therefore, the research question of this factsheet is as follows:

"What is the impact of changing consumer dietary intake in LMICs (covering four countries) on environmental indicators and what are potential pathways?"

[1] https://www.wur.nl/nl/onderzoek-resultaten/onderzoekprogrammas/onderzoeks-en-investeringsprogrammas/eiwittransitie.htm

2 Methodology

2.1 Data

In order to quantify the changing consumer dietary intake, the Nutrient Database of Supply Chain Development (SCD, Wageningen Food and Biobased Research) is used. This database builds on the Food Balance Sheets (FBS) of the FAO, which draw a complete picture of the global food system, specifically the food supply per country. In the Nutrient Database, the macro-nutrient composition of the food products is provided, as well as the amount of any food commodity that is available for human consumption in a country in a reference period (ESS: Food Balance Sheets[2]). By coupling the data on food availability with food composition tables, the protein supply in the available food can be derived. For the purpose of this project, the database is extended by labelling the commodities being either 'plant-based' or 'animal-based'. After aggregating the commodity-level data, this database gives the amount of animal- and plant-based protein per year, per country.

2.2 Calculations

In order to detect a dietary shift and make comparisons across years and countries, the data is normalized. This is done by calculating the proportion of animal- and plant-based protein in relation to the total amount of protein (for a given country c, in a given year y). Naturally, these proportions add up to 1. In the remainder of this factsheet, the proportion of plant-based protein will be used for further calculation, because the narrative focuses on dietary shifts towards plant-based protein.

$$plant\_pr_{c,y} = \frac{plantbased\ protein\ (g)_{c,y}}{plantbased\ protein\ (g)_{c,y} + \ animalbased\ protein\ (g)_{c,y}}$$

For the purpose of identifying a trend, the average growth over N years (2010-2020) in the proportion of plant-based protein ($plant\_pr_{c,y}$) is calculated. To this end, first the growth per year is calculated.

$$growth_{c,y+1} = \frac{plant\_pr_{c,y+1} - \ plant\_pr_{c,y}}{plant_{pr_{c,y}}}$$

$$avg\_growth_c = \frac{\sum_{y=1}^{N} growth_{c,y+1}}{N}$$

For further understanding, it will be investigated which food item categories may have caused the increase or decrease in protein derived from plant-based sources (avg_growth_c). To this end the data is first (dis)aggregated at food item categories (indexed by i). Similar to the previous calculations, the yearly growth and the average growth is calculated. However, here the growth in the actual protein supply is calculated instead of the growth in the proportion because it is more informative to use the actual volume to discover the root causes for the growth.

$$growth\_item_{c,y+1,i} = \frac{plantbased\ protein\ (g)_{c,y+1,i} - \ plantbased\ protein\ (g)_{c,y,i}}{plantbased\ protein\ (g)_{c,y,i}}$$

$$avg\_growth\_item_{c,i} = \frac{\sum_{y=1}^{N} growth_{item_{c,y+1,i}}}{N}$$

[2] https://www.fao.org/faostat/en/#data/FBS

2.3 Country selection criteria

This factsheet provides detailed information on four hotspot LMICs. It is chosen to select one country from the four FAO LMIC regions, being 1) South and South East Asia, 2) Sub-Saharan Africa, 3) North Africa, West and Central Asia and 4) Latin America. For South and South East Asia and Sub-Saharan Africa, it was decided to align with case studies in WP2, and therefore choose for India and South Africa, respectively. For the other two FAO regions, other (soft) selection criteria are used. First, criterium: substantial (average) increase or decrease in the percentage of protein derived from plant-based sources in the country(avg_growth_c). Second criterium: LMIC. According to the World Bank, a country is classified as a LMIC, if its GDP per capita is between $1,136 and $4,465. Since this criterium significantly narrows down the number of countries that can be selected, a higher upper limit is accepted. Third criterium: the population size of the country should not be too small (> 15 million).

3 Results

3.1 Trend analysis

Figure 1 shows the results for the proportion of plant-based protein ($plant\_pr_{c,y}$) per FAO region for the years 2010-2020. These results are retrieved by aggregating the country-level data to region-level. It can be observed that diets in more developed regions (e.g. North America & Oceania) are more relying on animal-based protein, compared to less developed regions (e.g. Sub-Saharan Africa).

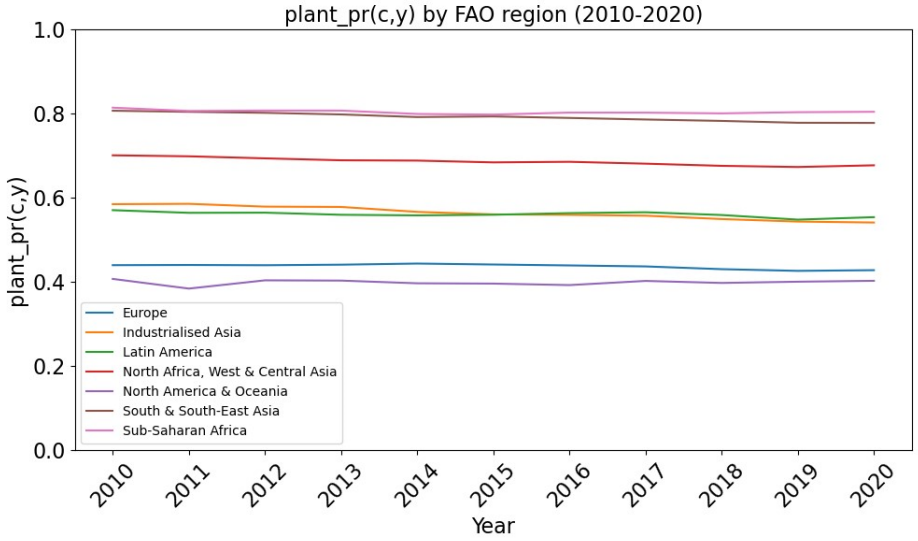

Figure 1 The proportion of plant-based protein (plant_prc,y) per FAO region for the years - 2020.

Table 1 shows an overview of the selected hotspot countries, whereas Figure 2 shows the trend of each individual hotspot country. Between 2010 and 2019, India and South Africa show a decreasing trend in $plant\_pr_{c,y}$. However, from 2019 to 2020, for both countries an increase in $plant\_pr_{c,y}$ is noted. Whereas in Algeria and Ecuador, From 2013/2014 onward, a rising trend is noted for both countries.

Table 1 The overview of analytical results for the four hotspot countries.

FAO region	Hotspot country	Average growth (avg_growth_c)	GDP per capita (World Bank Open Data, n.d. -a)	Population size (x1000) (World Bank Open Data, n.d.-b)
South and South East Asia	India	-0,38%	2,389	1,417,173
Sub-Saharan Africa	South Africa	-0,49%	6,777	59,894
North Africa, West and Central Asia	Algeria	+0,21%	4,274	44,903
Latin America	Ecuador	+1,38%	6,391	18,001

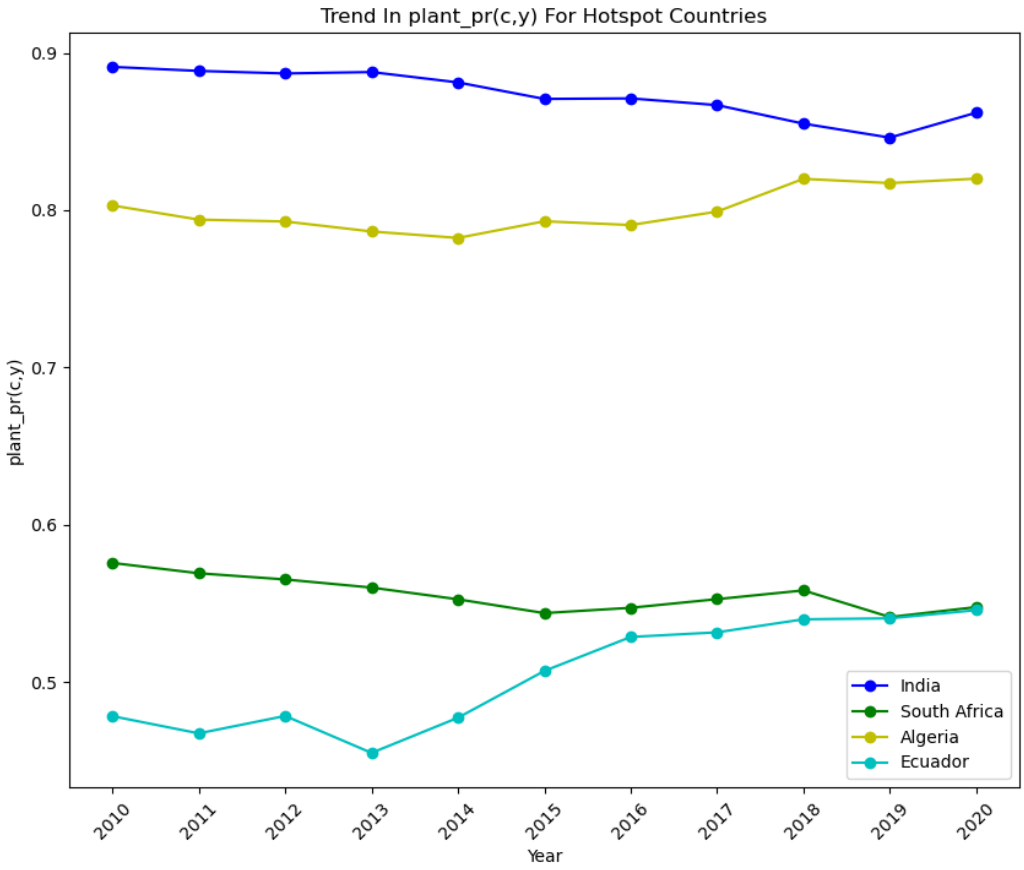

Figure 2 Trend in plant_pr(c,y) for the four hotspot countries (2010 - 2020).

For India, the (average) increase in the consumption of Fish and Eggs has caused a relative decrease in the protein derived from plant-based sources (+10,8% and +6,7% per year, respectively). For South Africa, no clear driver could be identified. For Algeria, vegetables and fruits have relatively notable growth rates (+6,4% and +4,3% per year, respectively). Lastly, for Ecuador the main reason for the increase in $plant\_pr_{c,y}$ is the substantial decrease of protein derived from Fish (-9,2%).

3.2 Driver analysis

In order to further understand what *drives* the dominance of plant-based protein in countries' diets, a driver analysis is conducted. More specifically, it is investigated if GDP per capita and urbanization rate (percentage of urban population in relation to the total population) correlate with the proportion of plant-based protein in a countries' diet. Figure 3 show the respective scatter plots. The Spearman's rank correlation coefficient between GDP per capita and $plant\_pr_{c,y}$ was found to be $r= -0.84$ ($p<0.05$). This strong negative correlation indicates that as GDP per capita increases, the proportion of plant-based protein in a countries' diet ($plant\_pr_{c,y}$) decreases. The Spearman's rank correlation coefficient between urbanization rate and $plant\_pr_{c,y}$ was found to be $r= -0.71$ ($p<0.05$). This strong negative correlation indicates that as urbanization rate increases, the proportion of plant-based protein in a countries' diet ($plant\_pr_{c,y}$) decreases.

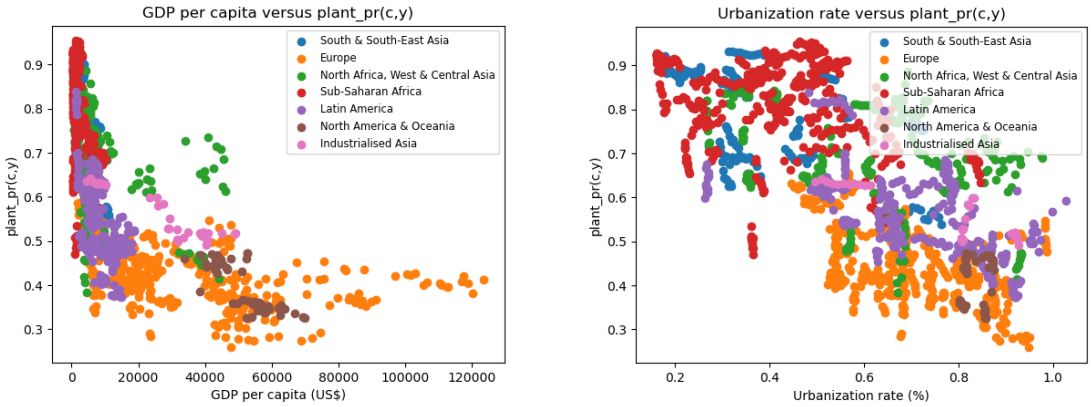

Figure 3 ***The Spearman's rank correlation between plant_pr(c,y) and two drivers: GDP per capita and urbanization.***

3.3 Literature validation

Currently, the developments regarding the protein transition are twofold. For example, in Europe the ratio of animal and plant-based protein sources seem to reach a plateau, whereas growing LMIC economies in Asia like India and China are increasing their consumption of animal-based protein (Aiking & De Boer, 2020). As stated by Alae-Carew et al. (2019), in countries with booming economies there is a transition towards diets with greater consumption of animal products and processed foods. In China, there was a 30% increase in animal product consumption from 1980-2000. And even though the growth in these economies is becoming less extreme, there still is an ongoing increasing preference for animal-based foods (Oita et al., 2020).

When comparing the EAT-Lancet diet with the Indian diet, the latter is understood to be relatively unbalanced. Namely, it is being characterized by high levels of cereals, and inadequate amounts of proteins, fruits, and vegetables (Sharma et al., 2020, Oita et al., 2020). Consumption of animal-based products is low (World Bank Open Data[3]). However, even though the intake of animal-based protein is low, it is increasing (Tak et al., 2019). This is in line with the results in Figure 2. When focussing on the dietary transition in India from 1993 to 2012, key observations are that there is a decreased dependency on cereals, an increased dairy consumption and a low intake of micronutrient-rich foods (e.g. fruits, vegetables, meat and eggs) (Tak et al., 2019). Looking at future projections, it is estimated that the consumption of vegetables, fruits and dairy products will increase with growing incomes. Meat consumption is projected to remain low (Alae-Carew et al., 2019). This may imply that cultural/religious influence exists on meat consumption but not on dairy consumption.

In general, according to McMichael et al. (2007), data from FAO indicate that an increase in a country's income is associated with more energy dense diets, with a higher calory intake, an increase in the consumption of animal products and a decrease regarding the more complex carbohydrates. This is in line with the finding in Figure 3. The higher-income households of the population are usually the ones that change their diets the most towards being animal-based. So, the dietary changes often occur unevenly within a country's population. This is also prevalent in the populations of LMIC, where they are consuming more animal products, especially poultry. Poultry demand in Sub Saharan Africa will grow substantially (Erdaw & Beyene, 2022). Also, the red meat intake continues to rise, especially in China and Brazil (McMichael et al., 2007).

In a 2022 study by Miller et al. (2022) the consumption of animal-source foods between 1990 and 2018 was studied in the Global Dietary Database. This study shows the overall differences between global regions similar to this factsheet, as well as regional differences within these global regions. Notably, South-East and East Asia show the largest absolute change in the consumption of animal sourced foods. Also, Latin America

[3] https://data.worldbank.org/

and the Caribbean show a strong increase between 1990-2018. Likewise, the Middle East and North Africa show a slight increase. Sub-Saharan Africa, on the other hand, has a large decline in the consumption of seafood, which is not compensated by a similar increase in other animal sourced foods. The absolute change for that region is negative (Miller et al., 2022).

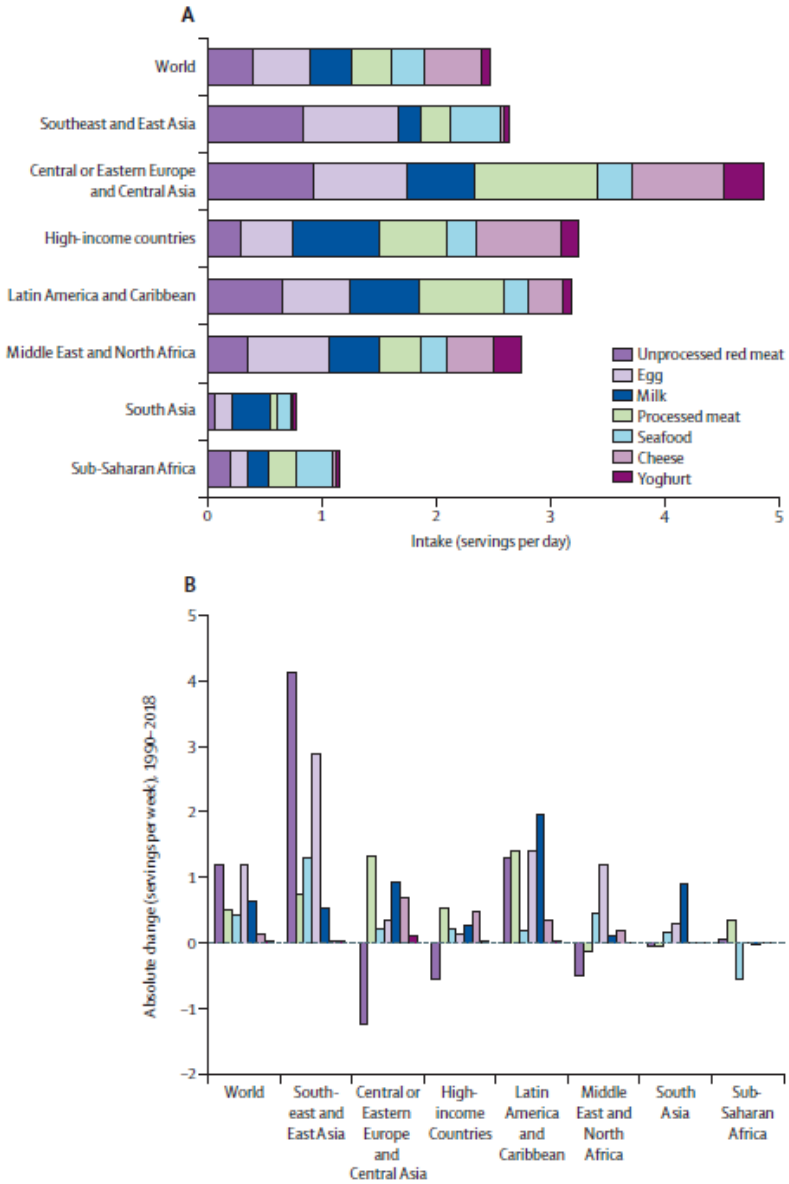

Figure 4 Source: Miller et al. (2022): Absolute intake (servings per day) of animal-source foods (A), and change between 1990 and 2018 (B).

4 Discussion and conclusion

India and Algeria have significantly higher plant_pr(c,y) than South Africa and Ecuador. This reflects the fact that a higher GDP per capita leads to more consumption of animal-based products, which is proven by the analysis in Figure 3. This is further confirmed by the declining pattern of plant-based protein consumption in India whose GDP per capita increases significantly during the same period. Moreover, the increase of dairy product consumption and (projected) low meat consumption may have to do with the cultural and religious influences in India. The unclear patterns and correlations for the remaining 3 hotspot countries may be due to the short time period for the analysis and the fluctuating GDP per capita during the short period. In addition to the GDP per capita, the strong correlation between the urbanization rate and plant_pr(c,y) also indicates national wealth drives the animal protein consumption.

The production of animal-based protein results in significantly higher greenhouse gas emissions compared to plant-based protein production (Porter et al., 2016). Moreover, the natural resources such as land and water required to produce one kilogram of animal-based protein far exceed those required for plant-based proteins. A transition from the animal-based protein to plant-based protein is thus a promising pathway to be enabled by policies and initiatives. This should be enabled not only by making the plant-based protein economically more accessible to the people living in the low-Middle-income countries but also adapt to the flavour and tastes to account for local consumers' preferences. In this sense food design with the linkage to the end consumers will be an important future research direction.

Finally, we have to point out the limitation of this study. First of all, the data used in study is at the country level, which ignores the fact that there are regional differences as well as amongst consumer groups in access and availability, caused by various socio-economic factors. Secondly, more drivers and factors other than the ones we used in this study may have influences on the plant-animal protein consumption ratios. Future research can focus on derive more data at the regional level and on more drivers/factors.

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