Dietary change in Asia, sub-Saharan Africa, and North Africa: historical changes and future food consumption perspectives

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Rationale and objective

Diets have been constantly changing across the world. Many factors have been considered as principal forces driving transitions and changes in dietary composition and food supply (Khoury et al., 2014). The levels of economic development, urbanization, modernization, and globalization (Pingali, 2007) all affect transitions in dietary intake patterns. It is universally understood that with lifestyle changes induced by increases in income and urbanization, the dietary intake patterns of a nation typically evolve toward higher-value foods (Mottaleb et al., 2018; Pingali, 2007; Reardon et al., 2019). For some countries, expected transitions towards higher-value food commodities (for example red meat and legumes, etc.) justify a reduced investment in the research and development of major cereals for example, which are expected to be consumed less as urbanization and income grow in emerging countries. This may hinder the improvement in productivity of some of these commodities in the future. Furthermore, while the overall trend of these dietary changes depend on a country's level of economic development, some specificities remain. Foresight studies on future diets in different countries are thus extremely important to enhance current decision-making on policies, research, and development investments (Pinstrup-Andersen, 2009). Current production, trade, and health policies, in addition to technology development, also need to consider the future demand for different commodities.

The objective of this technical brief is to provide an outlook on historical dietary changes and future trends of diets by 2050 in selected Asian, SSA, and MENA countries. The

Highlights

- Per capita wheat consumption in Middle East and North African (MENA) countries is not expected to increase by 2050. The growth of wheat demand in the region is going to be mostly driven by population growth. Per capita wheat consumption is however expected to increase in many Asian and sub-Saharan African (SSA) countries.
- While a dominant future trend of substituting grain cereals with higher-value energy-dense foods, such as fish and meat protein, is clear in most countries, the opposite trend, with the decreasing relative importance of animal source foods by 2050, has been identified in many SSA countries.
- Per capita legume consumption has been decreasing in most analyzed MENA and SSA countries, including India.

study further focuses on the anticipated importance of major cereals, particularly wheat, barley, rice and maize, in these future diets. The sampled countries are presented in Table 3.

Calculation methods, commodities and countries

This study calculated diet composition, expressed by average per capita food commodity consumption (Table 1 and 2) in 1961 and 2018, and estimated projected

Table 1. Commodities considered in the diet change analysis.

Sources	Sub-category
Animal	■ Dairy ■ Red meat, poultry, seafood ■ Eggs
Plant	■ Cereals ■ Legumes and pulses ■ Oil seeds

Table 2. Typical protein content of animal sources food.

Animal source	Protein (%)
Egg	12
Milk	3-4.4
Chicken	20-25
Turkey	21-28
Beef	21-28
Lamb	16-25
Pork	21-30
Fish	18-23
Crop source	**Protein (%)**
Wheat	8-15
Rice	7-9
Maize	7-9
Barley	10.5
Oats	16.9
Soybean	36.5
Pea	24.6
Chickpea	19.3
Lentils	25.8

Table 3. List of countries.

Zone	Countries
MENA	Egypt, Morocco, Saudi Arabia, Tunisia, Turkey, Yemen
SSA	Ethiopia, Kenya, Mali, Mozambique, Nigeria, Senegal
Asia	Bangladesh, India, Nepal, Sri Lanka, Thailand, Vietnam

values for 2050. We focused on food commodities (both crop and animal) which are an essential source of protein macronutrients which constitute 50% of the human body's dry weight. We considered a wide range of both animal and crop foods, and calculated the level of their integration in the average daily diet of a person in different countries (Table 3). Projections were conducted based on times series data (from 1961 to 2018) and using different time series regression methods which were applied depending on the data quality for a given commodity and country, to generate future consumption values up to 2050. Overall, simple exponential smoothing, Holt's linear trend, Brown's linear trend, and the Autoregressive Integrated Moving Average (ARIMA) estimation models were used to fit data quality and variability patterns.[1] The SPSS.25 software was used in the estimation and forecasting process. After generating the future consumption levels of each food commodity, the percentages of their respective contribution to the 'protein' diet were calculated following Waid et al. (2018) and reported. For 2018, the analysis provides both estimated and real values to check the consistency of the projection method.

1 **Simple exponential smoothing:** This model is appropriate for time series calculations in which there is no trend or seasonality. Simple exponential smoothing is most similar to an ARIMA model with zero orders of autoregression, one order of differencing, one order of moving average, and no constant (Ostertagová & Ostertag, 2013); **Holt's linear trend** is appropriate for series calculations in which there is a linear trend and no seasonality. Its smoothing parameters are 'level' and 'trend', which are not constrained by each other's values. Holt's model is more general than Brown's model but may take longer to compute for large series. Holt's exponential smoothing is most similar to an ARIMA model with zero orders of autoregression, two orders of differencing, and two orders of moving average (Gelper et al., 2009; Khatibi et al., 2020); **Brown's linear trend** is appropriate for series calculations in which there is a linear trend and no seasonality. Its smoothing parameters are 'level' and 'trend', which are assumed to be equal. Brown's model is therefore a special case of Holt's model. Brown's exponential smoothing is most similar to an ARIMA model with zero orders of autoregression, two orders of differencing, and two orders of moving average, with the coefficient for the second order of moving average equal to the square of one-half of the coefficient for the first order (Khatibi et al., 2020); **ARIMA** is a forecasting approach using the Box-Jenkins method, to find the best fit of a time-series model to past values of a time series. ARIMA models are based on the assumption that past values have some residual effect on current or future values. It has three steps: i) a model that shows a changing variable that regresses on its own lagged, or prior, value; ii) represents the differencing of raw observations to allow for the time series to become stationary (i.e., data values are replaced by the difference between the data values and the previous values); and finally, iii) incorporates the dependency between an observation and a residual error from a moving average model applied to lagged observations

Diet analysis and projections in selected Asian countries

Historical analysis and projections of future diets in South Asia show homogenous trends and patterns across Bangladesh, India, Sri Lanka and Thailand (Figure 1). The main highlights are:

- The most important proportion of the South Asian diet is major cereals (including rice, maize, barley, and wheat).
- The trend between 1961 and 2050, in terms of diet composition, is the same for almost all countries, with increasing consumption of animal source foods by 2050.
- In all South Asian countries, the quantities of animal source foods in the diet will replace major cereals, with the exception of India where animal source foods will instead 'take the place' of legumes and pulses.

Furthermore, two main remarks can be drawn from the analysis of historical and future diet trends in terms of major cereals in Asia (Figure 2):

- The relative importance of wheat among other major cereals in average diets in Asia is different from one country to another. Wheat consumption is expected to grow in some countries such as Bangladesh, India, Nepal and Thailand by 2050, while it will remain stable in other countries such as Sri Lanka and Vietnam. This has been partly confirmed by other studies (Mottaleb et al., 2018)
- Rice remains a primary crop in the Asian diet (although in 2030 and 2050, in both India and Nepal, wheat will be a strong competitor), while barley and maize remain of low importance in most analyzed countries.

Diet analysis and projections in selected SSA countries

The evolution of SSA diets between 1961 and 2050 is characterized by the following trends (Figure 3):

- Major cereal consumption has been constantly growing and is expected to further increase by 2050.
- The overall diet trend in SSA is different from what is seen in Asia or MENA, with decreasing relative importance of animal source foods in the diet between 1961 and 2050. Mozambique is an exception, where the per capita consumption of animal source foods is expected to increase by 2050.
- Legume consumption decreased in all countries between 1961-2018, and is expected to further

Figure 1. Historical, present, and expected future diet composition for selected Asian countries, highlighting the relative importance of major cereals, animal source foods, and legumes and pulses.
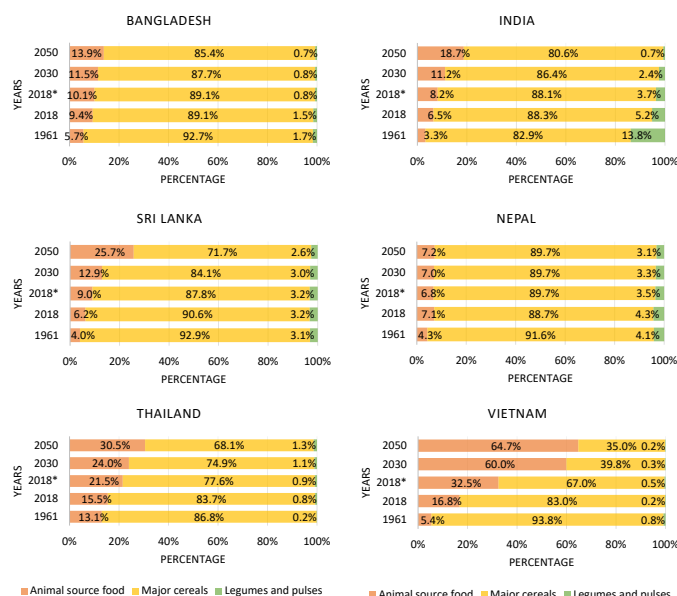
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

Figure 2. Historical, present, and future expected importance of major cereals in the diet of selected Asian countries.
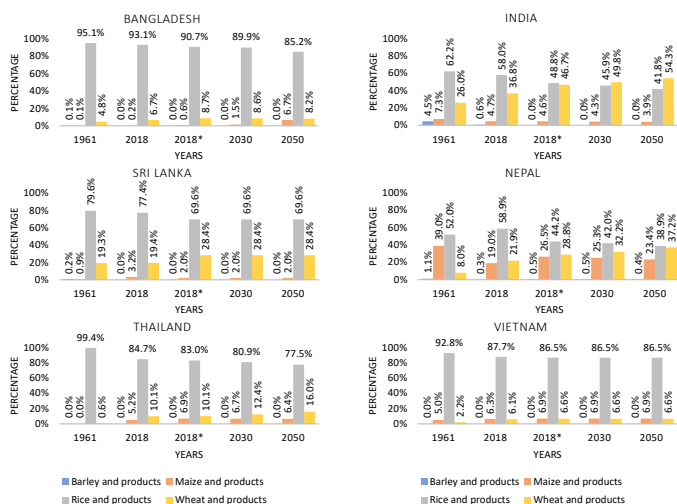
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

decrease by 2050. Ethiopia is an exception in this regard, with the opposite trend.

Regarding major cereals consumption, the following are suggested by the projection analysis:

- Wheat is expected to gain further importance as a major cereal in the diet of SSA countries by 2050 (Figure 4); with increasing rates higher than other

cereals. Ethiopia, Mozambique and Nigeria are not showing an increasing per capita consumption of wheat by 2050 compared to other cereals, but the overall proportion of wheat in diets remains high.

■ The consumption of barley has been dramatically decreasing over the years and this trend is expected to be maintained by 2050.

Figure 3. Historical, present, and expected future diet composition for selected SSA countries, highlighting the relative importance of major cereals, animal source foods, and legumes and pulses.
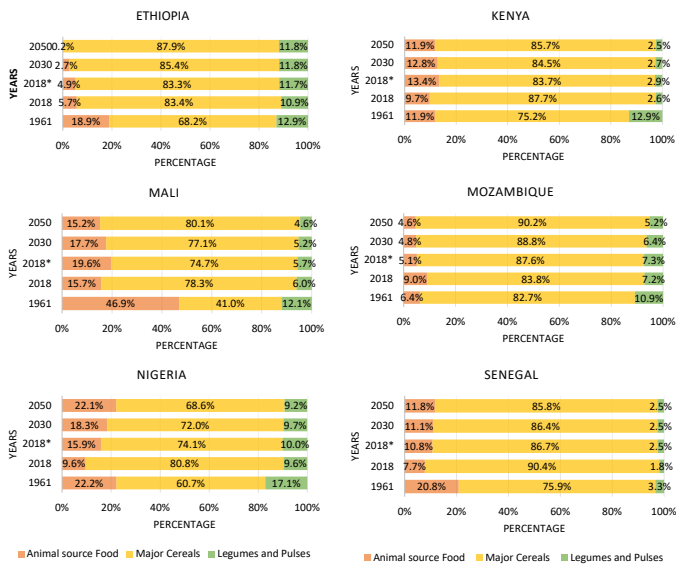
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

Figure 4. Historical, present and future expected importance of major cereals in the diet of selected SSA countries.
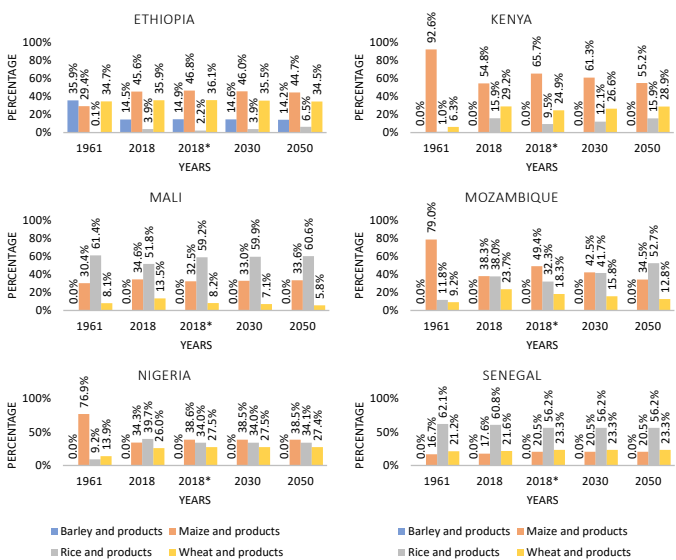
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

## Diet analysis and projections in selected MENA countries

The evolution of diets in MENA countries between 1961 and 2050 is characterized by the following trends (Figure 5):

■ The relative diet trend in most MENA countries is similar to South Asia, with an expected increase in the relative importance/inclusion of animal source foods by 2050.

■ Legume consumption per capita is expected to increase by 2050 in some countries such as Tunisia and Turkey. However, the consumption of legumes and pulses will remain very low in terms of relative importance in the overall diet. We can conclude that the future diet in MENA countries will primarily be based on cereals and animal source foods.

■ As a conflict country, Yemen remains an exception to the above trends, where both animal source foods, and legume and pulse consumption per capita have decreased between 1691 and 2018 and are expected to continue decreasing by 2050.

A comparison of major cereal consumption in selected MENA countries in the projection analysis data suggests a continuous dominance of wheat. Other highlights are:

■ Wheat consumption per capita, which is already high in MENA countries, is not expected to further increase by 2050. Thus, overall wheat demand will grow due to population growth only.

Figure 5. Historical, present, and expected future diet composition for selected MENA countries, highlighting the relative importance of major cereals, animal source foods, and legumes and pulses.
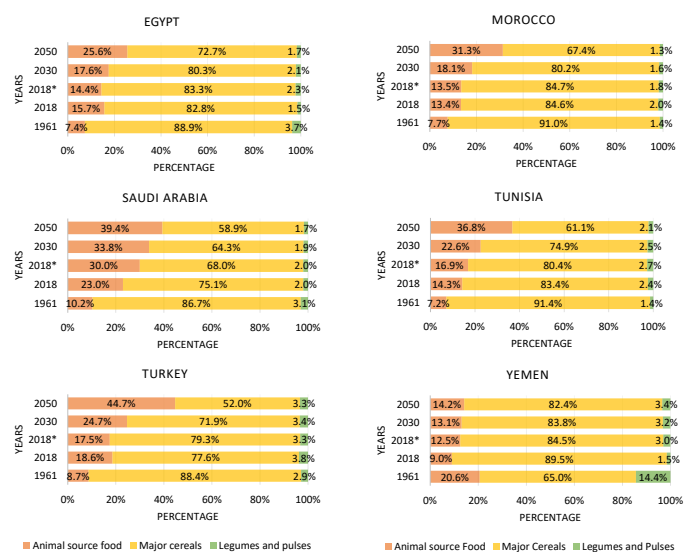
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

Figure 6. Historical, present, and future expected importance of major cereals in the diet of selected MENA countries.
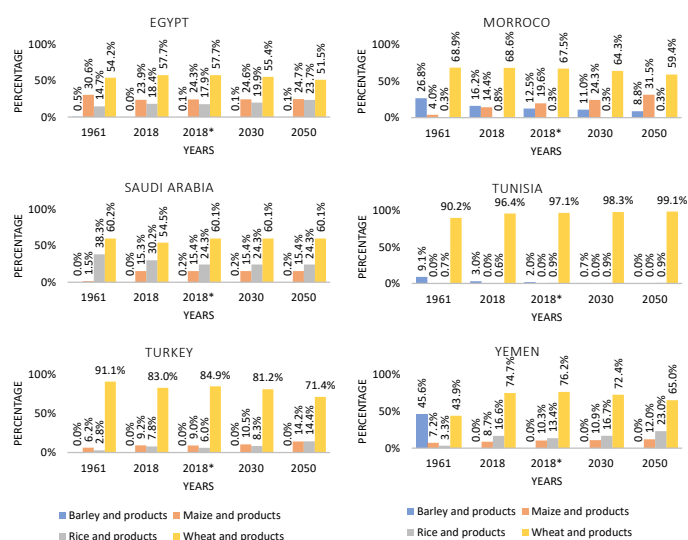
Note: 2018 is the real observed data; 2018* is the estimated value of 2018 by the regression based on historical data.

- Barley will gain some interest by 2050 in some MENA countries such as Morocco and Turkey (Figure 6).
- Maize products will also gain some relative importance by 2050 in the diet of some MENA countries such as Egypt, Morocco, Saudi Arabia and Turkey.

Conclusions

This study shows that future diets will evolve differently across regions and countries. While a dominant pattern of the substitution of grain cereals with higher-value energy-dense foods, such as fish and meat protein, is clear in most studied countries, still other specific trends are identified, especially in SSA where the future consumption of meat products will be growing at relatively lower rates compared to other cereals and dry legumes. Another trend is also related to the increasing future demand of wheat in most analyzed countries and regions; where wheat is expected to take a higher share of the diet in most of the countries by 2050.

Results of this foresight analysis help to better guide future research and development investments in food security and these commodities which will be highly demanded and will constitute a major part of diets in the future. For example, the future growing demand for wheat in SSA and South Asia need careful consideration for filling the agronomic and varietal research gaps in these new geographies. Further investment efforts for the development of legume production and consumption (found to be declining in

much regions) will also be needed given the high nutritional and environmental benefits of these crops.

Acknowledgement

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