# Nutrition Driven Meat Demand in the Future in China

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Abstract-Great changes have taken place in food consumption demand, consumption structure and consumption pattern over the past fifty years in China with the increase of per capita income level, meat products has increased significantly. The supply of meat growth decline with the constraints of limited resource in China. contradiction between supply and demand obviously. At the same time, although the nutritional situation is improved greatly, malnutrition and nutrition surplus coexisted among residents. Research on nutrition driven meat demand, establish the mode of nutrition guide consumption, consumption guide production under the contradiction on meat production and consumption, consumption and nutrition. It has the vital significance to the limited resources, the balance of meat supply and demand, nutrition and health improvement. The research indicates that recommended meat consumption levels calculated from reasonable nutrient standard below current meat consumption of both urban and rural residents. Nutrition driven meat consumption requires much less resources than that without the guidance of nutrition objectives. This paper recommends that policy should seek to reflect and enforce current nutrition goals to regulate meat consumption, restructure meat production and promote the development of the livestock industry to achieve social and economic benefits.

Index Terms—meat demand, forecast, nutrition driven

#### I. INTRODUCTION

The implementation of "Reform and Opening-up" since 1978 not only puts more money into Chinese people's pockets, but also changes what they eat, with the most significant shifts being a decrease in grain consumption and gradually increasing demands for meat products.

This growing appetite for meat, however, threatens to strain China's resource conditions, as an ever larger population fights for a limited amount of arable land, water and environment. Ensuring a balance between supply and demand of meat is difficult. Meanwhile, though nutrition improvement has been declared a success in China, there remain both malnutrition and over-nutrition. How to strike a balance between meat production, meat consumption and people's nutrition has become an important task for China's economic and social development. Given the conflicts between meat production and consumption, and between consumption and nutrition, to study meat supply and demand for the purpose of achieving nutrition balance, and to build a model where nutrition guides consumption and consumption leads production, will be of strategical and practical significance to our efforts in optimizing resource utilization, ensuring supply-demand balance of meat products, and enhancing people's nutrition and health.

For a long time, analysis on the points of meat consumption or nutrition research is more, but crossover study is less, scholars have already begun comprehensive studies on nutrition and food consumption in recent years, but research on

#### II. DATA AND METHODOLOGY

#### A. Data

As we all know, Chinese statistical Yearbook of meat consumption only includes indoor data, it's less than the actual meat consumption, and the per capita consumption from food balance sheet is often greater than the actual meat consumption, these data cannot reflect the real situation of resident's meat consumption. This paper adopts the meat consumption data of Chinese nutrition health survey (CHNS<sup>1</sup>), the data includes indoor and outdoor consumption data, nutrition and health data, etc. which is the authority of the food consumption and nutritional data.

#### B. Methods

According to nutrients transformation model from the food composition table, the paper calculate nutrients which meat contains.

According to the relationship of the meat in the diet from Chinese dietary guidelines, it can calculate reasonable meat intake standards

According to the feed rate of return, Cropping index and grain yield, livestock waste and greenhouse gas emissions model, analysis economic and social benefits from reasonable meat consumption.

#### III. NUTRITION DRIVEN MEAT CONSUMPTION ANALYSIS

#### A. Meat Consumption and Nutrition Intake

Livestock production in China has undergone a transformative development process due to the livestock

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value-chain reforms carried out from 1984 to 1985. Livestock production has seen remarkably consistent year on year growth, while long-term animal food shortages of urban and rural residents have significantly decreased. Especially since the 1990's, great changes have taken place in the food consumption structure.

According to data provided by the China Health and Nutrition Survey (CHNS<sup>1</sup>), grain consumption by China's urban and rural residents dropped 31.8 percent among thirty years, while meat consumption rose 67.6 percent. Urban and rural meat consumption almost doubled from 63.6g per day to 103.6g per day, with urban residents' meat consumption averaging 137.2g per day, compared to 88g per day for rural residents. Urban and rural meat consumption patterns have also changed significantly over time, with the strengthening of the meat production and supply capacity. Based on figures provided by CHNS, it is interesting to note that while pork and viscera consumption has dropped from 74.8% to 66.8% and from 7.5% to  $4.4\%^2$  respectively, the proportion of other meats has increased, particularly that of poultry from 10.7% to 21.0%, up by 10 percent, and beef and mutton from 6.9% to 7.8% from 1989 to 2009. Compared to world meat consumption, while pork consumption exceeds the world average level by 29%, while mutton consumption is almost equal to the world average level, the poultry and beef consumption ratio is still below the 2009 world average level. [1]

The nutritional status of the urban and rural residents continues to improve, with the average energy intake level of the adult residents estimated at 9376.3 kj (2241.0 kcal), with that of urban residents at 8758.4kj (2093.3 kcal), while for rural residents its 9740.8kj (2328.1 kcal) in 2009. Although the national energy intake level for adult residents meets the recommended standard stipulated in "Dietary Guidelines for Chinese Residents" (2016 revision) (of 2200 kilocalorie), the fat intake level exceeds these recommendations, while the protein intake level is found lacking. These nutrient imbalances are mainly caused by unregulated dietary patterns. Compared with plant sources, meats provide richer nutrients per volume, but excessive or insufficient consumption may lead to health problems. This research tries to compute the nutrient content from meat food based on the current residents' food consumption structure and the nutrient content from different kinds of meat based on the "China Food Composition (2010)". Meat consumption proportion is employed as a weight. It estimates the meat nutrients according to the known nutrients of meat sub-types, such as beef (fat, thin), lamb (fat, thin), pork

(fat, thin) and chicken based on "China Food Composition"

Calculation formula: 
$$C_i = \sum_{j=1}^n R_{ij} * f_{ij}$$

where Ci is certain nutrients of i types of meat; R is the proportion of the j kind of i types; fij estimates certain nutrients of the j kind of i types from the "China Food Composition" which lists the type of meat and nutrient content including energy, protein, fat and other nutrients.

Computed results in Table I below show that one hectogram of meat provides 307.3 g energy, 14.8 g protein and 26.9 g fat. Among the four kinds of meat, pork has the highest fat content (37.0 g) per hectogram and therefore provides the highest energy (395.0 kj); chicken has the highest protein content (19.3 g) per hectogram as well as the least amount of fat (9.4 g). The protein content per hectogram of beef and mutton is higher than that of pork, yet lower in fat content per hectogram than is chicken[2].

TABLE I.	THE RELATIONSHIP BETWEEN MEAT CONSUMPTION AND
	NUTRIENTS INTAKE

	consume (g)	Energy (kj)	Protein (g)	Fat (g)
Meat	50	153.6	7.4	13.4
	75	230.5	11.1	20.2
	100	307.3	14.8	26.9
Pork	50	197.5	6.6	18.5
	75	296.3	9.9	27.8
	100	395.0	13.2	37.0
Beef	50	95.0	9.1	6.7
	75	142.5	13.6	10.1
	100	190.0	18.1	13.4
Mutt on	50	99.0	9.5	7.1
	75	148.5	14.3	10.6
	100	198.0	19.0	14.1
Chic ken	50	83.5	9.7	4.7
	75	125.3	14.5	7.1
	100	167.0	19.3	9.4

Data source: Pork, beef, mutton and chicken's nutrients content from "China Food Composition (2010)", meat's nutrients content calculated above.

### B. Meat Consumption Forecast Based on Current Consumption

In recent years local and foreign research institutions and scholars have focused intensely on meat supply and demand in China. Along with the increase of meat consumption and imports, they have made short, medium and long-term forecasts of meat supply and demand. FAO and OECD use the Aglink-Cosimo model to predict global meat supply and demand, including in China, and estimate meat consumption will increase by 1.9% by 2020[3]. "Livestock to 2020: The next food revolution", a collaborative research study by IFPRI, FAO, ILRI, using the IMPACT model predicts meat consumption

<sup>&</sup>lt;sup>1</sup> CHNS is The China Health and Nutrition Survey, an ongoing open cohort, international collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention, was designed to examine the effects of the health, nutrition, and family planning policies and programs implemented by national and local governments and to see how the social and economic transformation of Chinese society is affecting the health and nutritional status of its population.

<sup>&</sup>lt;sup>2</sup> Meat consumption data from CHNS not only includes pork, poultry and other meat consumption, but also animal innards (swine liver, chicken heart, etc.).

will increase by 3.0% from 1997 to 2020, and per capita consumption of meat will hit 71kg in 2020<sup>8</sup>. The total amount of meat consumption is estimated at more than 100 million tons. The Chinese government has published annual plans and policy documents for the development of the meat sector. Both "The twelfth five-year plan for husbandry development" [4]and "The twelfth five-year plan for meat industry development" [5]predict meat production will need to average 85 million tons by 2015 to ensure an adequate supply of meat.

In light of the above documents, this article employs a traditional time-series model (trend extrapolation model) to forecast China's meat consumption for the next ten years based on current consumption<sup>3</sup>.National meat consumption of pork, poultry, beef and mutton is expected to reach 55.60 million tons, 23.66 million tons, 7.83 million tons, and 5.71 million tons, respectively, by 2020. By 2023 meat consumption is estimated at 97.52 million tons, with pork, poultry, beef and mutton consumption hitting 56.43 million tons, 25.67 million tons, 7.98 million tons, and 6.19 million tons, respectively. Meat consumption per capita is expected to reach 127.25g a day by 2020, in which per capita consumption of pork, poultry, beef and mutton is expected to reach 81.52g, 13.22g and 29.12g respectively.

#### C. Dietary Recommendations in China

"Dietary Guidelines for Chinese Residents" recommends a livestock and poultry meat intake of 50-75g a day for adults [6]. However, urban and rural residents' meat consumption at present has exceeded these recommended dietary guidelines. If this trend of meat consumption remains unchanged, meat consumption is expected to hit 127.25g by 2020, which far exceeds the recommended standard upper limit. Meat contains high levels of fat, and excessive fat intake has been linked to obesity, diabetes, cardiovascular disease and other chronic health problems. Unregulated meat intake not only affects people's health and nutrition, but also has a negative impact on social stability. Meat consumption needs to be regulated based on scientific nutritional recommendations and dietary best practices.

#### D. Recommended Best Practices for Meat Consumption

Although China's meat consumption patterns of the 1980's and 1990's are hotly debated by scholars, there is consensus that current and future meat consumption patterns need to be adjusted appropriately. The share of pork intake should decrease relative to total national meat consumption, while the share of poultry, beef and mutton should be raised. In recent years, the government has issued several guidelines on husbandry development planning targeting future meat production trends in China, such as "Opinion on accelerating the development of husbandry", and "national forage-saving husbandry development plan (2011-2020)". All of which are in

agreement that, pig production should be steadily developed, while beef, mutton, and high quality poultry production needs to be accelerated, in line with sustainable forage-saving herbivorous husbandry development. "China nutrition improvement action plan" by FAO and China aims to promote the adjustment of the animal food consumption structure and appropriate amounts of animal food intake. "The twelfth five-year development plan of meat industry (2011-2015)" points out that meat production patterns will become more predictable. By 2015, production of pork, poultry, beef, mutton, and other meat production in the sector will account for 63%, 21%, 8%, 5.9%, and 2.1% respectively.

In summary, the share of pork consumption will decline in the future, but will remain dominant due to Chinese consumption habits. Due to China's feed and forage resource constraints, it will be impossible to dramatically increase the proportion of beef and mutton. Future meat consumption patterns should take into account the balanced production, resources and ecological environment requirements.

#### E. Meat Consumption Based on the Recommended Dietary Allowance (RDA)

The recommended dietary allowance (RDA)<sup>4</sup> from the Chinese nutrition society (CNS) is divided into 7 energy levels from 1600 kj to 2800 kj based on the dietary guidelines, different energy levels have different nutrients recommendation, according to the differences in age, gender, height, weight, intensity of labor, and circumstance [7]. It is recommended that residents' daily protein intake should be 58.5-103.5 grams, fat intake, 50-79.1 grams, and carbohydrate intake, 210.9-419.7 grams. According to the average energy level 9200 kj (2200 kcal), per capita protein intake should be 83 g/day, fat intake, 69 g/day, carbohydrate intake, 284.9 g/day.

It can be calculated backwards using both the RDA and "Chinese food and nutrition development program", which outlines animal food energy proportion and animal food protein proportion. Plant food sources account for nearly 80% of daily energy intake, the rest comes from animal sources, yet while the plant sources account for only 30% of protein intake per day, meat sources account for 50% according to Chinese residents' dietary guidelines.

Calculation

formula:  $C_{\text{imeat}} = (Q_{\text{e}} * A_{1} * A_{2}) * 100 / Q_{\text{f}}$ 

Cemeat= (2200\*20%\*50%) \*100/307.3=72 g

Cpmeat= (83\*30%\*50%) \*100/14.8 = 84 g

Cemeat represents energy intake from meat and Cpmeat protein intake from meat. Qe means energy or protein level per capita, A1 represents animal food energy or protein proportion, A2 represents meat sources

 $<sup>^{3}</sup>$  Using the CHNS historical data, through a scatter diagram and model choice, the research forecast meat and main kinds of meat consumption.

<sup>&</sup>lt;sup>4</sup> Recommended dietary allowance (RDA) means the average level of daily dietary intake which is sufficient enough to meet nutrient requirements of 97– 98 percent of healthy persons in particular life stages and gender groups.

proportion of animal food. Qf represents meat contains energy or protein each hectogram (calculated above).

The calculation results are largely consistent with the recommended meat intake. A daily meat intake of 75 g/d is the upper limit of the recommended dietary guidelines<sup>5</sup>. The dietary guidelines adopt such low dietary thresholds of meat intake to prevent Chines e residents from excessive intake of fat which is linked with the increased prevalence of chronic diseases. This article will continue its analysis based on the meat intake level of 75 g/day.

#### F. Nutrition Driven Meat Consumption

The recommended threshold for meat consumption of 75 g/d can be further decomposed based on the rational meat consumption structure discussed above: pork meat accounts for 47 grams, beef consumption for 7 grams, mutton for 5 grams, and poultry for 16 grams. Annual meat consumption on the other hand is 27.4 kg, with pork accounting for the majority at 17.2 kg, beef at 2.5 kg, mutton at 1.6 kg, and poultry at 5.7 kg. It is predicted that meat consumption in China will grow steadily in the next ten years, in line with dietary recommendations. According to the United Nations (UN) population growth forecasts (2010) for China from 2010 to 2020, the average annual growth rate will decline to 0.60%, and from 2020 to 2030 this growth rate will fall to 0.50%. Given these projected growth rates, China's population is expected to reach 1.425 billion by 2023. As indicated in Table II, meat consumption in the same period will stand at 39.36 million tons.

According to the estimate, annual meat consumption as recommended by dietary guidelines is much lower than the current actual consumption. Except for waste, eating out and other factors, the consumption of meat related to the traditional diet is also more than the nutrition-oriented consumption target, and therefore the excess amount of consumption is minimal from the point of view of a recommended diet focused on improved nutrition. Too much consumption of meat is not only harmful to the health of the urban and rural populations, but also wastes natural resources, destroys the ecological environment, threatens food security and affects husbandry and sustainable development.

 
 TABLE II.
 MEAT CONSUMPTION FORECAST BASED ON THE NUTRITION GOALS (10000T)

year	meat	pork	beef	mutton	poultry			
2016	3804.89	2359.03	342.44	228.29	760.98			
2017	3827.72	2373.18	344.49	229.66	765.54			
2018	3850.68	2387.42	346.56	231.04	770.14			
2019	3873.79	2401.75	348.64	232.43	774.76			
2020	3897.03	2416.16	350.73	233.82	779.41			
2021	3897.03	2416.16	350.73	233.82	783.30			
2022	3916.51	2428.24	352.49	234.99	787.22			
2023	3936.10	2440.38	354.25	236.17	791.16			
Data source: Based on meat intake level of 75 g/day calculated								
meat consumption per year.								

#### G. Benefits Analysis under Nutrition-Oriented Demands

Supposing meat consumption is at a medium-energy level, meat production that meets nutrition-oriented demands requires much less resources than that without the guidance of nutrition objectives, promising to annually save up to 81 million tons of grains, 147.8 billion tons of water, not including slaughter, processing and other use. It will save 8.5 million hectares arable land by 2020, just the land for feed grains, not including livestock farming land. In addition, nutrition-oriented meat demands are also conducive to ecological and environmental protection, by annually cutting 807 million tons of animal excrements, 2.2618 million tons of methane emission and 242,900 tons of nitrous oxide emission by 2020. (More details in the attached list)

#### IV. CONCLUSIONS AND RECOMMENDATIONS

#### A. Steady Growth in Meat Demand and Reduced Pressure on Supply

Based on the nutritional standards, annual meat demand is less than current meat consumption .If residents' meat consumption in China follows the nutritional guidelines, meat consumption given prevailing constraints will meet nutritional demands, and meat production levels will settle at a new equilibrium quantity following the spontaneous adjustment in market supply and demand. Meat supply pressure will be effectively relieved and the negative impact on resources and the environment will be mitigated. It is beneficial in the long run therefore to promote fundamental changes in husbandry production technologies, to maximize the attendant ecological, social and economic benefits[8].

## B. Adjust Food Consumption Patterns, Ensure a Balanced Diet

There is a need to guide residents towards moderate meat consumption based on the dietary nutrition guidelines, control total meat food intake, and reduce certain kinds of meat which contains high amounts of fat. In recent years, animal innards and fat consumption has gradually declined in China, whereas lean meat, processed meat and other good quality meat consumption has increased, and more and more people are now focusing on nutrition and health. Whereas the under-consumption of aquatic, milk and dairy products should be addressed through increased consumption, a sustainable and stable consumption of eggs is necessary for balanced nutrition and meal quality. Market mechanisms should play a basic role in determining animal food consumption patterns. On the other hand for dietary pattern adjustment, economic measures are a more effective tool. Price, tax, credit, and salary controls and other economic tools may be used to regulate animal food consumption in China. For underdeveloped areas with high numbers of rural poor characterized by inadequate animal food product consumption, the government should develop the local economy, increase the income of residents, provide meat subsidy to the malnourished residents, and guarantee basic levels of meat intake [9].

#### C. Rational Meat Consumption Contributing to Reasonable Meat Production

Meat production should meet the needs of residents' requirements given reasonable growth rates. Meat production based on planned dietary guidelines not only ensures residents' nutritional requirements, it also avoids unnecessary waste resulting from unplanned production. Policies should aim to accelerate the development of the dairy industry, aquaculture, and other breeding industries. Dairy animals have the highest feed conversion rate among livestock, while pork production consumes twice as much grain as does that of dairy[10]. Through the development of the dairy and sheep industries which have higher feed conversion efficiencies, the animal protein supply of residents will be effectively increased. Besides, China has vast inland and ocean waters, and has great potential for the development of freshwater and marine aquaculture. Aquatic products neither compete for cultivated land with grain, nor for feed with livestock. Aquaculture development not only provides a large number of high quality animal proteins, but also reduces fat intake, and saves a lot in feed grains consumption.

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