MEAT: The past, present, and future of meat in China's diet

A review of the "meatification" of China's diet

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1.0 Introduction

The consumption of meat has impacted social systems and the environment on a global scale and is becoming increasingly problematic as production and market systems change. Livestock production requires intense inputs of environmental and economic resources including water, land, and energy. The large requirements of input also carries over to animal agriculture's contribution to greenhouse gas emissions. Currently, animal agriculture makes up 18% of all global greenhouse gas emissions and consists mostly of methane - this is projected to increase by 80% by 2050 (Shindell et al., 2009). Intensive use of water is also seen throughout the linear livestock sector, starting from the feed used in animal rearing to the processing of meat for retail. When virtual water use is accounted for, water extraction for meat takes up an overwhelmingly large proportion of global water allocation and subjects extra stress on the already critical resource (Lucrezia et al., 2017). The negative toll animal agriculture has on water also applies to land and relates to deforestation, pollution, biodiversity loss; for example, in Brazil, one of the largest global producers of cattle has deforested 80% of the Amazon rainforest for animal agriculture (Stoll-Kleemann & O'Riordan, 2014). Along with these environmental impacts, social demands of living standards and modernization has increased the demand of meat consumption which further perpetuates the production and supply of meat.

The combination of livestock farming impacts and the increased appetite for meat is straining global resource supplies and social systems. The People's Republic of China (to be referred as China moving forward) in particular has been under international scrutiny due to its economic phenomenon and changing demographics and consumption trends. This report will provide a review on the presence of meat (poultry, pigmeat, cattle, sheep) in China's diet along with the ramifications and alternatives to its consumption and production in the Chinese context.

2.0 Backstory: Why China's consumption of meat has increased

Traditionally, the people residing in China consumed a predominantly plant-based diet. However, this has begun to shift during the past two to three decades. The growing demands, influences from Western-style diets, rising incomes and social status are the forces that are driving China to consume more meat.

1.1. Timeline: Growing demands

Prior to the 1980s, the majority of China's daily caloric intake was derived from a plant-based diet (Zhou, 2015). This mainly consisted of grains such as rice and wheat with minimal amounts of protein and oils (Zhou, 2015). In the next three decades, the presence of the Chinese meat industry has grown and expanded dramatically to also shape other sectors as well. For example, rising meat demands is resulting in an increasing demand for corn and other feed grains (Ghose, 2014). In the 1960s, 80% of the corn produced in China was allocated as food grains and has, since then, flipped to 30% for human consumption and 70% is used for livestock feed grains (Ghose, 2014). Soybean especially has seen an increase in demand since the late 1990s due to its increased use in livestock feed. Today, 98% of soy meal, a processed

form of soy, is designated for livestock feed worldwide (Oliveira & Schneider, 2016). Along with livestock cattle rearing, soy cultivation is also a key factor in the mass deforestation of the Latin American rainforests (Ghose, 2014). In 2009, China's meat consumption per capita rose from 14.6kg in 1980 to 58.2kg. With China's population of almost 1.4 billion, this rise in meat consumption brings China to surpass the US as the world's leader in meat consumption as a country (Ghose, 2014). The increase in pork, beef and chicken demand is illustrated in Figure 1.

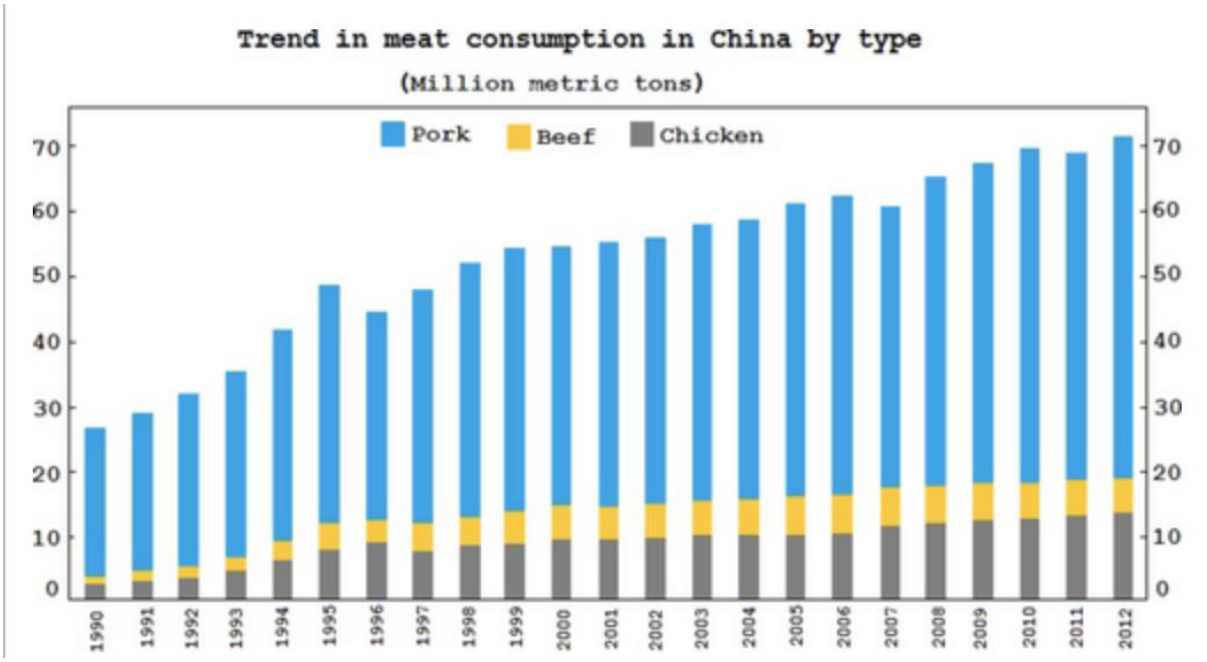

Figure 1 Meat consumption trends in China (Ghose, 2014).

1.2 Western-diet Influences

Food trends in China are also increasingly influenced by Western diets and food cultures. In North America and Europe, foods are generally more calorically dense with larger proportions of meats and animal-based fats with less plant-based carbohydrates in contrast to the traditional Chinese diet (Yang, 2014). This difference could be attributed to the different climates and agricultural abilities to grow crops. However, since China joined the World Trade Organization (WTO) and simplified the process of exporting and importing (World Economic Forum, 2015), the increased exposure to foreign products have also blurred differences in lifestyles and lifestyle expectations. In conjunction with this, the increased income of China's growing middle class has also increased purchasing power and the availability of disposable income which has led to a higher demand of Western processed foods and many in China are incorporating more meat in their diets than before (Yang, 2014). The "meatification" is seen as a sign of progress (Giudice et al., 2016) and aligns with China's pursuit of reaching or surpassing the West since the Great Leap Forward where the mass steel campaigns were aimed to exceed the production of the Soviet Union and the United Kingdom (Chen, 2009). However, shifting from a mainly plant-based diet to a Western-influenced diet has also introduced health effects such as diabetes and obesity (Segelken, 2001). A study comparing the diets of Taiwan and mainland China today to the less meat-intensive past found that even a minor increase in animal foods could be associated with an increased risk of disease such as high cholesterol, liver cancer, and various cardiovascular diseases (Segelken, 2001).

1.3 Rising incomes

Since Chairman Deng introduced economic growth reforms and market liberalization in 1978, China has grown from an agrarian society to become the world's second largest economy and a global industrial exporter (World Economic Forum, 2015). This economic development has greatly influenced China's eating habits. With the growing middle and high-income classes, comes a change in their purchases with the increase of their purchasing power (Giudice et al., 2016). A study that was conducted in Guangzhou city in 2014 analyzed 617 completed questionnaires that were collected. The results showed that the average monthly purchase of pork and beef was 2.90kg and 0.77kg, respectively. This study also concluded that high-income households purchased more meat than the low-income households, which means that future meat consumption patterns will be affected by the changes in income (Figure 2.) (Zhang, Wang & Martin, 2018; USDA Foreign Agricultural Service, 2012). Food that is consumed outside of the household has also been on the rise due to the increase in income levels (Anderson, Bieroth, Tucker & Schroeder, 2011). Consuming meals that are higher in meat and lower in grains is a more prominent pattern when dining out (Anderson et al, 2011). For example, in Beijing the percentage of meat that was consumed outside of the household was 34% followed by 12% in Chengdu and 10% in Janjing (USDA Foreign Agricultural Service, 2012). What has also been interesting to discover is that family composition plays a role in the amount of meat that families consume. The USDA surveyed urban families and then grouped them into seven categories (2012). The data showed that families with middle aged members (31-55 years old) had the largest meat consumption per capita (7.5kg) while families with only elder members had the lowest (5.4kg) (USDA Foreign Agricultural Service, 2012). Although this study indicated a difference in meat consumption between the age groups, it could not conclude the reasoning behind each generation's meat preferences (USDA Foreign Agricultural Service, 2012).

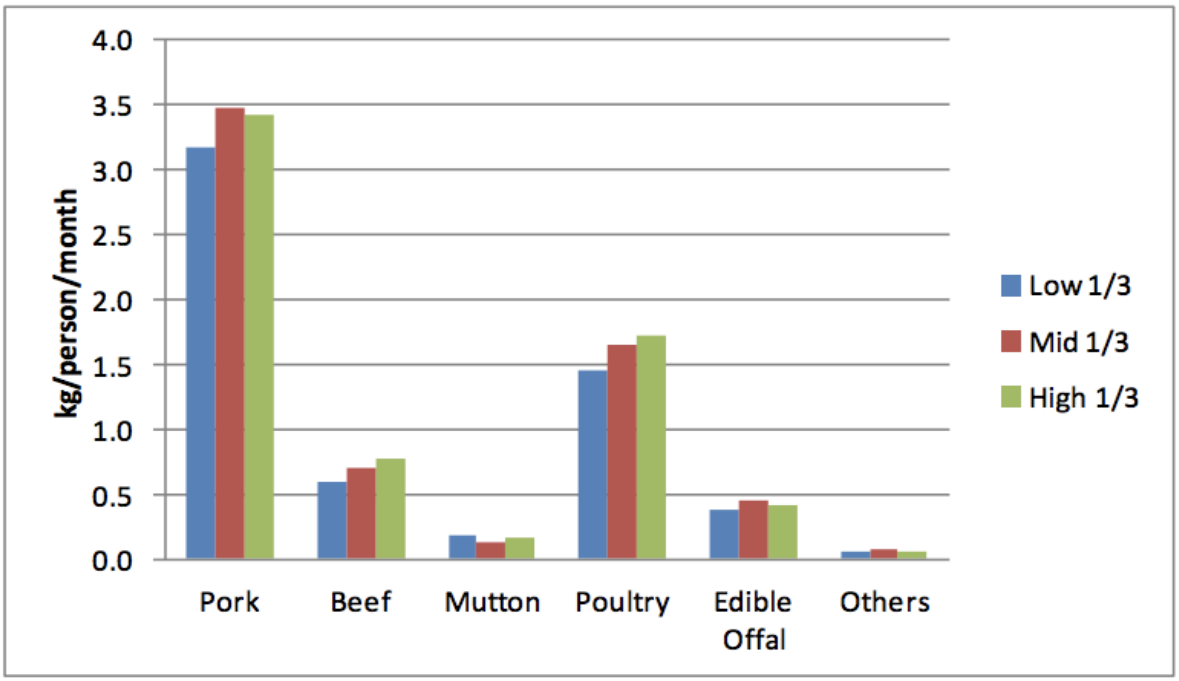

Figure 2 Per capita meat consumption rises with income (USDA Foreign Agricultural Service, 2012).

1.4 Social Status

Additionally, in China, people do use food as a way to show their social status (Ma, 2015). Foods that are typically more expensive, such as meat, are presented in order to express their wealth (Ma, 2015). This could also be a driving factor for the increases of meat purchases in the country since meat has been viewed as a symbol of material prosperity (Hale & Marsh, 2012). Certain types of meat also have symbolic meaning to the people in China. For example, pork is presented during multiple celebrations such as Chinese ancestral rites, wedding banquets and funeral rituals (Discover Society, 2017). However, with this comes the issue of food waste. In 2015, Chinese consumers living in Beijing, Shanghai, Chengdu and Lhasa wasted approximately 17 to 18 million tons of food that was served (Hui, 2018). Out of that amount, 29% was from vegetables, 24% was from rice and noodles and 18% was from meat (Hui, 2018). Moreover, within those four cities, it was discovered that 93 grams of food was thrown away on average per meal (Hui, 2018). As a response, the "Empty Your Plate" campaign arose in Beijing in 2013 in hopes to change the way people viewed leftovers (Piesse, 2017). Despite the social movement, it has been proven difficult to shift the views of a nation that considers ordering more food than needed a form of status symbol.

2.0 How China is currently supplying the increased demand of meat

China is one of the most water-stressed countries in the world. The rapid declines in the groundwater table as well as water quality has become a core environmental challenge China is currently facing (Wang et al., 2017). Despite the water scarcity, only 2% of water consumption is used towards ecological protection (Figure 3; Sun et al., 2017). The Chinese Ministry of Water Resources predicts that approximately 90% of total usable water resources in the country will be consumed annually by 2030, accounting for 750 billion m^3 of water (Wang et al., 2017). Considering that livestock production has immense water requirements of roughly 100 times to grain, it is a global concern that average meat consumption has quadrupled over the last 30 years with China consuming 28% of the world's meat (Sun et al., 2017). With the need to meet demands in livestock production, agricultural land has also become increasingly stressed with the added pressures of China's rapid development of urbanization and land appropriation; for example, 90% of grasslands now considered endangered (Feeley, Machovina, & Ripple, 2015). With water scarcity and limited arable land, China's food systems need to be examined to support China's ability to be self-sustaining or food

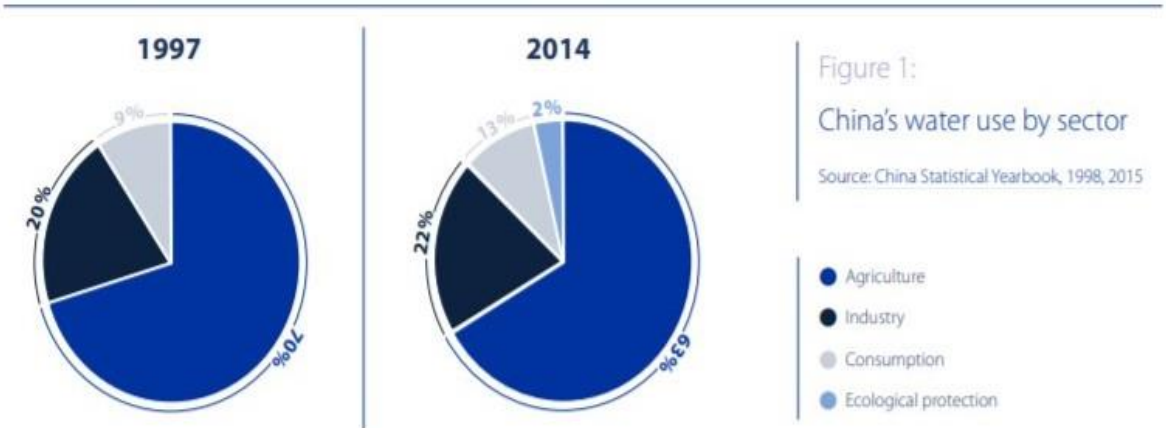

Figure 3 China's water consumption by industry (Sun et al., 2017).

secure. This section explores these issues and what China is doing to balance these obstacles to attain a sustainable food system.

2.1 Modernization of Agriculture

Over the last 50 years, China's industry has rapidly grown. The growth of the livestock sector has been accompanied by a large shift towards more commercialized, large-scale production (FCRN, 2015). Various movements in the past such as the Great Leap Forward, have pushed the nation towards industrialization in efforts to further develop their economy and compete with global north. In the mid-1990s, government changes allowed farmers to rent their land on a broad scale, permitting larger commercial companies to expand their properties (Schuman, 2018). Changing from household farming to industrial agriculture is controversial, as there are concerns of the impacts it may have on community dynamics (Schuman, 2018). However, by scaling up their farm or renting out their property to larger organizations, farmers could stand to make significantly more than they would have if they continued farming on a household level (Schuman, 2018). This change in policy has given some farmers the opportunity to expand their company and invest in new farming technologies, fueling the belief that more land is equal to more money (Schuman, 2018). Additionally, land restrictions have become a concern, as China has nearly one quarter of the world's population to feed, but only 7% of the world's arable land (Stanway, 2017). Additionally, China is currently working to create ecological red lines that will put sections of the country off limits to development (Stanway, 2017). Various provinces have agreed to restrict development in specific areas or ecosystems, such as Sichuan province who has agreed to dedicate 40.6% of its total territory to the red line system (Stanway, 2017). Impacts of this on agricultural systems are unknown.

The increase in meat-based diets from a production side is part of a "livestock revolution" and is seen as the result of capitalist agricultural processes (Hansen, 2017). The perspective that larger-scale farms are more productive has become dominant, which motivates some of the policies surrounding agriculture in China (FCRN, 2015). Policy support is not solely given to industrial productions and still exists as subsidies for backyard producers (FCRN, 2015). Through geographical concentration and increasing vertical integration along the supply chain, farmers have been scaling up livestock production (FCRN, 2015). However, modernizing practices is not necessarily an overnight process. In 2010, only 20% of pig slaughter was completely mechanized (FCRN, 2015). International firms have been a significant enabler of intensification for example through importing genetics, which has led China to become a major buyer in the genetics global trade market (FCRN, 2015). The Chinese livestock sector makes up nearly a third of the world's agricultural economy by value (FCRN, 2015). In China, there has been explicit government support for the scaling up and modernization of farms (FCRN, 2015). An example of government funding towards livestock producers include in 2012 when a policy was introduced to give 3,500 million RMB or $663, 250, 000 CAD, to large-scale pig production infrastructure, importing breeds, and waste treatment facilities (FCRN, 2015). Subsidies such as this exist on different scales for various types of farming, a number of which are aimed at increasing infrastructure and creating waste treatment facilities.

2.2 Outsourcing Resources and Global Trade

China is combating these food system pressures through importing resources from

other countries to limit the strain on their own. This includes water and crops such as soybeans, which can be used as livestock feed. By doing this, some of the resource pressures and environmental consequences may fall on the exporting countries, however this is not always the case.

2.2.1 Feed

China is the world's largest importer of soybeans (Sun et al., 2018). Most of this is being imported from Brazil and the U.S.A (Sharma, 2014). To ensure food security, China uses a diversifying method to ensure they are not solely depending on one country for a food, in this case feed and meat. This involves importing palm oil and sunflower seeds from different areas of the world, as well as importing soy (Sharma, 2014). Despite this, Brazil and China have built a unique dependency on each other for importing and exporting "cheap grains". Pressures from countries such as China have been a significant driver behind the rapid conversion to large scale soy farming from the natural ecosystems and pastures in South America (Sharma, 2014). This has had detrimental environmental impacts capturing global concern and has led to unparalleled deforestation in the Brazilian Amazon and Cerrado caused by soybean and grazing land expansions (Sun et al., 2018). Huge companies providing the soy, for example Monsanto, are using genetically modified soy that have resulted in an epidemic of cancers, birth defects, and other health problems due to chemical contamination of water supplies in villages and schools (Sharma, 2014). Solutions are desperately needed for reducing environmental pollution to offset the negative impacts of international trade globally.

State and private owned Chinese companies have been directly investing in the Brazil's soy supply chain wanting more control, for instance through land acquisitions (Sharma, 2014). However, this does not align with Brazil's wants, who is regulating foreign ownership of land given its own substantial interests in livestock production (Sharma, 2014). By importing this cheap feed, it is a common belief that the negative environmental impacts will be the responsibility of the exporting country which in this case would be Brazil. Sun et al. (2018) suggest this is not the case, and in some studies, there have been larger impacts on the importing country in the form of nitrogen pollution. A large shift to importing soy can result in dramatic decreases in domestic production. A common practice is to switch from in this case growing soy, to producing wheat, corn, rice, and vegetables (Sun et al., 2018). This crop conversion process is extensively seen in China and results in increased nitrogen pollution. Soybeans are able to fix nitrogen requiring less fertilizer to grow compared to other major crops, and this excess of nitrogen ends up as runoff, leaching, and losses to the atmosphere (Sun et al., 2018). Approximately 49% of increase in nitrogen balances come from cropland conversion, in addition to the increased per hectare nitrogen application which contributes to 51% (Sun et al., 2018).

The shift to the mass production and imports of soy has not been good for domestic soy farmers in either Brazil or China (Sharma, 2014). In China, crop conversion has been encouraged through government efforts. One method used is to support urbanization as a means to get more people out of rural communities so that shifts to larger, industrialized, farming can occur (Sharma, 2014). Secondly, through raising farmers' incomes to try and attract younger generations to participate in farming (Sharma, 2014). The increasing environmental, health, and food safety concerns with the livestock

sector are sparking questions around the current approaches used in meat production and consumption by some Chinese experts, government authorities and consumers (Sharma, 2014).

2.2.2 Water

As previously mentioned, China is facing water shortages across the nation. A variety of methods are being used to lessen pressure on their water resources. An interesting way to manage national water usage is through the strategic management of a country's imports and exports. Since joining the World Trade Organization in 2001, China has faced a boom in foreign trade, becoming the number one trade country in the world (Chen et al., 2018). Commodities have "hidden water" associated with them from manufacturing processes which is referred to as virtual water (Chen et al., 2018). Looking at the virtual water footprint is an indicator of the water efficiency and gives a quantitative measurement to the amount of water correlated with it (Lucrezia et al., 2017). Analyzing and regulating virtual water in global trade through sustainable policies can be used as an effective method to alleviate water shortages (Lucrezia et al., 2017). 65% of water withdrawal in China is used for the agricultural sector (Lucrezia et al., 2017). A study looking at virtual water in China from 2000-2012 showed that 80% of China's virtual water was from the agriculture industry as well as the electric and water industry as per Figure 4 (Chen et al., 2018). However, these industries are not main exports from China, as the main water intensive industries are textile, garment and leather products and general machinery and equipment management (Chen et al., 2018).

Through managing imports and exports with other countries, China is able to save water through the trade of goods. For example, virtual water flows between China and Italy show that 95% of China's imports are related to animal products (Lucrezia et al., 2017). The two countries have a bilateral relationship, where the virtual flow from Italy to China is larger than the water flow in the opposite direction, and a significant amount of the virtual water Italy imports from China is grey or green water (Lucrezia et al., 2017). Looking at China's international relationships raises questions of who should be held responsible for environmental impacts and management, and if these are global issues than perhaps both importing and exporting countries need to be aware and held responsible.

3.0 Efforts to Reduce Meat Consumption in China

Efforts to reduce meat consumption in China have been increasing within the last decades

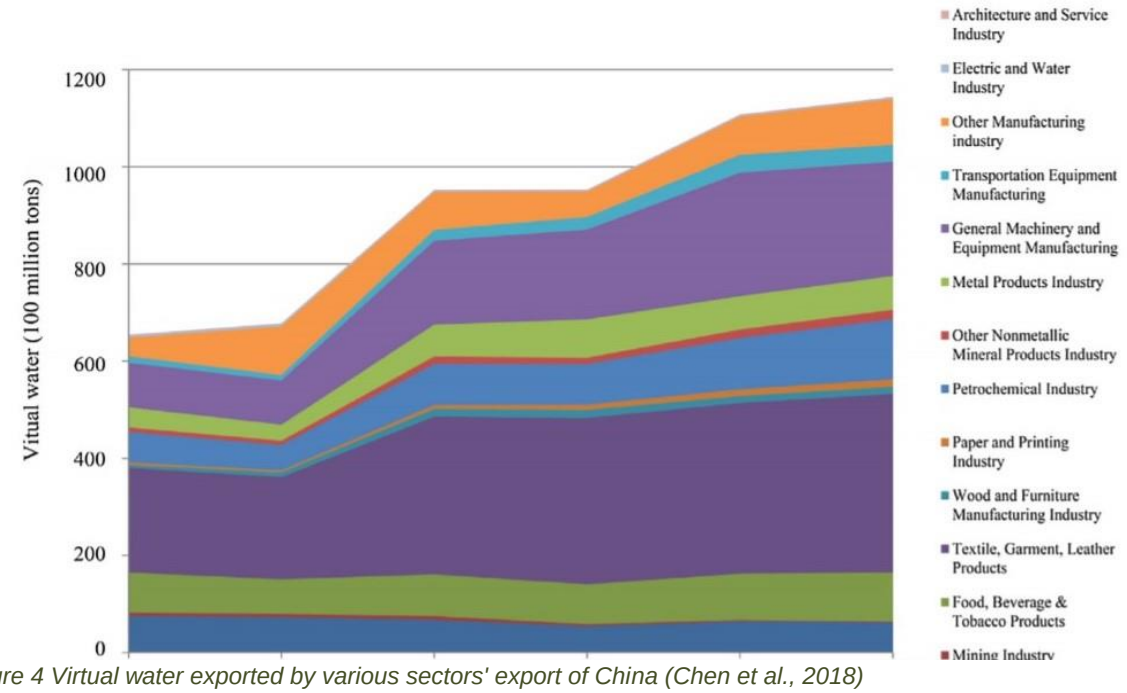

Figure 4 Virtual water exported by various sectors' export of China (Chen et al., 2018)

due to rising concerns surrounding food security, national health, and environmental degradation. These concerns have been raised by both consumers and governments which has resulted in changes in consumer behaviours, government policies, and as a result, the food industry. More consumers in China are adopting plant-based lifestyles not only for environmental and health reasons but because of updated dietary guidelines, new meat-alternative trends, and flashy advertisement campaigns.

3.1 Consumer Efforts

Veganism in China has become a recent phenomenon where many Chinese consumers are now adopting plant-based diets. According to a recent study, the vegan market in China is expected to rise by 20% by the year 2020 (Moon, 2017). In 2014, it was estimated that the vegan population in China exceeded 50 million people (Moon, 2017). The rise in veganism in China, specifically in city centers like Hong Kong can be largely attributed to millennial consumers who use social media to promote the plant-based diet. Veganism among Chinese consumers is not only considered a diet but also a lifestyle which values health and environmental sustainability and traditionally, China has a cultural background associated with Buddhism and therefore vegetarianism- making the transition much less drastic. The rise of veganism can also be attributed to meat food safety scandals in China such as, pork contaminated with clenbuterol in 2011, a drug used to make pigs faster and leaner but results in negative health effects in humans. Or in 2013 where Chinese officials arrested people for processing rodent meat with additives in order to sell in farmers markets as mutton (Luo, 2015). Because of distrust in animal agriculture products many consumers began to avoid these products entirely.

There have also been many consumer-led initiatives that promote the reduction of meat consumption such as the concept of "Meatless Mondays" where people avoid meat one day of the week in order to reduce their overall consumption. These small initiatives led by consumers make large impacts in terms of reducing meat consumption in China, these initiatives are promoted by restaurants, workplaces and on social media.

Consumers changing attitudes towards animal products has also been an important factor in the reduction of meat consumption. According to environmental psychology, there are typically one of two motives that people possess for consuming less meat; health and moral (Taufik, 2018). As people in China become more educated and aware of the health issues associated with meat consumption and as chronic health problems continue to rise in the country, consumers are more inclined to change their diets for health reasons. China currently has the largest number of people with diabetes in the world (National Health and Family Planning Commission report of diabetes, 2010). The increased consumption of red and processed meats has taken a serious toll on the country's overall health. Historically, animal welfare in China has not been a well-known topic, but as industrial agriculture increases in China, animal activists have started growing public awareness of cruelties (Pohlner, 2015). As awareness surrounding animal welfare in China also continues to grow, there are more people adopting plant-based lifestyles for moral reasons.

3.2 Government Efforts

The Chinese government has implemented multiple policies, campaigns and investments in order to reduce meat consumption in China. One of the most impactful was the release of updated dietary guidelines for consumers by

the Chinese Nutrition Society. In the updated dietary guidelines, Chinese consumers are encouraged to reduce meat consumption by 50% in order to reduce greenhouse gas emissions and to improve overall health in order to reduce chronic health problems like obesity and heart conditions. Some of the most important changes to the Chinese consumer dietary guidelines include; the selection of fish, poultry, and eggs as sources of protein over red meats, and daily meat intake recommendations of 40-75g per day (Luo, 2016). While it can be debated whether or not dietary guidelines have an effect on changing people's diets, in China the updated guidelines have sparked conversations about the issue of meat consumption and health among consumers.

Many Chinese consumers are concerned about their health and the health of their families as diabetes among children in China continues to become more prevalent. Because of Western influences, the perception among Chinese consumers has been that a healthy diet must include meat and animal products. The influences from government agencies like the Chinese Nutrition Society, and official guidelines are valuable in terms of shifting views regarding diets and health. The Chinese government can be considered a leader in the promotion of plant-based diets for environmental sustainability as seen in Figure 5 where plant-based foods make up the majority of the food guide.

Figure 5 2016 Chinese Food Guide Plate (Luo, 2016)

In conjunction with the updated dietary guidelines, the Chinese government has launched an advertisement campaign called "Less Meat, Less Heat, More Life" this campaign promotes the reduction of meat consumption in order to reduce greenhouse gas emissions and slow climate change in China while also outlining the health benefits of reducing meat consumption. These adverts are starring Western celebrities including former California governor Arnold Schwarzenegger and director James Cameron in order to promote the message.

3.3 Food Industry's Efforts

As urbanization in China increases factors such as convenience, taste, and price are important to consumers when it comes to food. Because cooking at home is less common in China, consumers rely on restaurants for the majority of their meals. As diets shift to become more plant-based, restaurants and the food industry has followed suit. A recent article from 'China Daily' reported on the introduction of a plant-based burger to popular chain restaurants, called the 'impossible burger' because of its accurate resemblance of meat. As burgers and other Western food become increasingly popular in China due to the introduction of North American fast food chains to the Chinese market, it is imperative that plant-based alternatives are available in order for meat consumption to decrease due to the popularity of fast food chains in China.

Another initiative started by a Hong Kong climate campaigning group called 'Green Monday' has been working to provide meat-less alternatives to consumers. Chinese dumplings typically filled with meat are one of

the most popular dishes in Chinese cuisine. Green Monday has partnered with food scientists to create a meat-less dumpling for Chinese consumers. The founder, David Yeung stated "Just to tell people what not to do is not going to solve the problem. You've got to give them alternatives" (Mannion, 2018). Green Monday is a leader in China in developing and providing plant-based alternatives to consumers.

Because of the demand for plant-based food in China within the last decade, there has been a substantial increase of vegetarian restaurants offering meat-free foods. Specifically, in Shanghai the number of vegan restaurants has more than doubled within the past five years (Flink, 2018). Many entrepreneurs in the food industry are capitalising on the plant-based trends. In a recent news article, it stated, "The niche market of vegetarian and vegan eateries has never been more competitive." (Flink, 2018). Consumers are being offered more choice in terms of vegetarian options because of increased consumer demand.

3.4 Meat-Alternative Trends

While reducing the consumption of meat via meat-free alternatives is a popular trend in China, there have also been developments for more 'creative' ways to consume protein. One of the most recent developments are eating insects such as silkworms for protein, since they require much less resources to produce than typical animal agriculture. Silk worms are also a by-product of silk production, since the silkworm cannot be removed from its cocoon without perishing during silk production. If there was not a market for eating silkworms, they would be disposed of, creating a waste product. In China, silk worms are mainly fried and sold by street vendors for low prices. As consumers continue to become more aware of sustainable eating, silkworms will continue to grow in popularity in China (Moxley, 2018).

Another protein rich meat alternative in China that has a long history within the nation is seaweed. China is the largest producer of edible seaweeds, harvesting approximately 5 million tonnes per year (FAO, 2018). Seaweed is consumed in many traditional Japanese and Chinese dishes and has also been used as an additive to animal feed and natural fertilizers. As these industries grow and advance, China will have more environmentally sustainable alternatives to protein rich foods.

4.0 The future of meat in China: Current trajectory and alternatives

The FAO defines availability, stability, accessibility, and utilization as the four pillars which have to occur concurrently to meet food security objectives (FAO, 2008). In China, the pursuit to meet these pillars has been defined by self-sufficiency. To reach these goals, modernizing the food systems through industrialization from the production to processing to distribution stages has been a policy priority to the state. China's economic shift from an agrarian society to a world leader in industrial and manufacturing sectors has provided the economic means for China has been able to improve food productivity and living standards drastically (World Economic Forum, 2015; Kuteleva, 2016). However, China's pursuit of food security is becoming increasingly complex as global markets, consumption patterns, and the discounting of planetary boundaries (Raworth, 2012) collectively change the dimensions of today's food systems and adds uncertainty to future projections.

4.1 The future: Status quo

The current positioning of China's animal agriculture policies show the state's support in

pursuing agricultural intensification through land consolidation, farm expansions, implementation of modern agricultural technologies for increased production, and for the growth of dragonhead enterprises. These policies are important to recognize because state support in China is an essential component to business opportunities as the state provides initiatives such as annual subsidies , interest-free loans, and funding (Schneider, 2017). Thus, policy decision-makers in China have the onus to ensuring policies drive growth in the animal agriculture industry towards food security objectives without obstructing other sectors. The following subsections explore the production, consumption and import trajectories of today's policies continue as is in supporting the vertical integration of animal agriculture in China.

4.1.1 Production

If China was to maintain status quo, current projections show that China will continue to be a key global producer and consumer of meat and livestock feed. Over the next decade, the price of meat is projected to decline as efficiency increases through the intensification which will lower the costs of production and livestock feed(OECD/FAO, 2014). This is especially the case for poultry and pork production which are more feed grain intensive in the production process in comparison to beef. The future growth in production from feed grains; however, will not be shared universally across the market as developing countries such as China will have greater access to producing and purchasing feed grains over least developing countries (OECD/FAO, 2014). Developed countries, on the other hand, will be constrained by limiting factors such as environmental and animal welfare regulations. Moving forward, China will be challenged with the same issues as developed countries due to China's focus on intensification. This especially applies to food safety which is increasingly linked to political stability after the 2008 baby formula scandal by a model business, Sanlu Dairy Corporation (Fraser, 2008; Li, 2009). However, in today's scenarios, projections of meat production in China are expected to increase in poultry, beef, pig meat and sheep meat by 2024 with China being a large proportion of the world's additional production (OECD/FAO, 2014). China's ability to increase meat production stems from intensification in production and processing technologies and growing economies of scale which is shifting smallholder production into commercialized production models and can also be related back to low livestock feed prices and better feed conversion ratios (Li, 2009; McMichael et al., 2007). For example, as of 2010, only 20% of pig slaughtering was fully mechanized but with the government's support, 70% of slaughtering is expected by 2020 with 25% being partly mechanized (FCRN, 2015). This trajectory of livestock intensification will also continue to drive the environmental and social impacts of China's food systems (Brighter Green, 2011) and surpass the "roof" of the donut economics in the nine planetary boundaries (Raworth, 2012).

4.1.2 Imports

Moving forward, China will increase the amount of meat and feed grains imported. The growing dependence of feed grain imports is estimated to increase because of China's food security objectives and desire to be self-sufficient in food grains; thus, allocating domestic grain production towards human consumption or as grain reserves will be the priority. By 2024, China is expected to be the second largest importer of coarse grains with barley and sorghum overtaking maize imports (OECD/FAO, 2014). Much of the imported grain will continue to be from Brazil and China is expected to remain as Brazil's key market

for agricultural exports for soybeans (Oliveira & Schneider, 2016). China's imports of soy will likely to be processed into or already come in the form of soybean meal as 98% of this processed form of soy is designated for livestock feed worldwide (Oliveira & Schneider, 2016). However, as per China's concerns with national food security, China may also begin increasing the use of wheat in their livestock feed to reduce reliance on Brazilian soy (OECD/FAO, 2014; Zhong & Zhu, 2017). China's Feed Industry Association has recently released a new type of feed for pork and poultry to improve efficiency and environmental stress. It also reduces the use of soybean meal by 11 million metric tons per year (Ministry of Agriculture and Rural Affairs of the People's Republic of China, 2018) which can possibly be tied to reducing the dependency of feed grain imports. As of now, domestic demand is still supported by domestic supply which limits meat trade but China's meat trade is also expected to shift due to new or changing bilateral trade agreements made possible by China's membership to the WTO in 2001 (World Economic Forum, 2015). For example, a free trade agreement with Australia will allow the Chinese livestock sector to be more accessible to Australia (OECD/FAO, 2014). China also imports a significant amount of livestock offal from countries such as the United Kingdom, Germany, Spain, France, and Denmark which is expected to remain a key market (FCRN, 2015). The importation of livestock offal contributes to food waste reduction as these livestock components are generally not part of Western diets which notes the importance of dietary preferences in trade. Along with importing meat, China is also expected to increase their reliance on genetic material imports. The Ministry of Agriculture's Long Term Pig Genetic Improvement Plan 2009-2020 is aiming to restructure China's pig herd to mainly consist of three European and North American breeds which will grow to market-weight faster and are more feed efficient than the current breeds grown in China (FCRN, 2015). It is interesting to note that a study on Chinese consumer attitudes towards pig systems demonstrated that consumers did not prefer imported pig breeds (de Barcellos et al., 2013). The use of these breeds are also inclusive to backyard producers as there are policies to provide subsidies for raising breeding animals; however, the policy structure in China still favours the development of larger farms by providing programs such as individual grants and income tax waivers to promote the intensification of the livestock industry in China. On this note, China will continue to grow and concentrate their livestock sector domestically while global linkages continue to strengthen as international companies such as Tyson and Novas International increase their presence in China and China increases oversea investments in developmental states in Africa especially (FCRN, 2015).

4.1.3 Consumption and consumer preferences

The consumption of meat is expected to plateau as economic growth in China slows which introduces uncertainty as a transitioning economy (OECD/FAO, 2018). However, the overall projections of the meat market is still positive with China remaining as one of the leading meat producers in the future – along with Brazil. China's production of pork is especially key as China is the only country in the world with a strategic pork reserve of both frozen and live pigs (Brighter Green, 2001). However, this contradicts consumption expectations in China as domestic demand is slowing – potentially due to previous food safety concerns – while production is increasing (The Western Producer, 2018). The projected decrease in demand could also be credited to a combination of an aging

population and market saturation levels being reached (OECD/FAO, 2018). It should also be noted that different ethnic populations in China have different levels of meat consumption, for example, in the Northwest areas of China such as Ningxia, Xinjiang and Shaanxi, the consumption of pork is low as the majority of the population is Muslim and abstain from pork; thus, resulting in less pig farms than other areas in China (Cheng et al., 2011). It is also in these areas where the pillars of food security are low and lack agricultural infrastructure (Fengying, Jieying & Xuebiao, 2010) which can also contribute to why meat production is lower in these areas. Furthermore, consumers in China are indicating a preference towards meat from large-scale industrial systems over family farms – whether they be large or small scale (de Barcellos et al., 2013). Consumers, similar to government policies, as they perceive industrial production to be of higher quality, safer, and demonstrate the consumer values of food safety in China. Parallel to this is also the lack of voice farmers have in China as there are mainly negative perceptions to farmers such as being uneducated and risks to food safety. This further pushes away the value in smallholder farms (Swinnen & Maertens, 2007). These perceptions are important to identify in China because China is considered a quasi-developmental risk society which is willing to compromise sustainability for growth (Zhao & Ho, 2005) consumer perceptions can shape the market to be either environmentally sound or ecologically detrimental.

4.2 The future: Alternatives

To alter the current trajectory of increased and intensified industrial production of meat in China, policies need to be shifted and alternative models must to be explored in the livestock industry. This is essential to ensure the complexity of food systems in China take environmental and social factors into consideration and not only economical factors are highlighted. As of now, China's livestock industry will hinder China's ability to reach the 2030 targets of the UN Sustainable Development Goals (SDGs), especially in achieving food security and improved nutrition, and the promotion of sustainable agriculture. There are many opportunities to explore in the Chinese context as ecological security is rising in priority in conjunction with the national food security concerns since 1949.

4.2.1 Evidence-based decision making

Based on projected models, the China Agricultural Monitoring and Early-warning System (CAMES) was created and integrates market supply and demand, food security, and scenario analysis and various levels and spaces to assess the different mechanisms of agriculture (Xu, Li & Li, 2015). This tool applies mainly to agriculture and thus, an alternative to consider would be to create a tool or apply a similar model to assessing the supply chain of meat which can provide data to inform policy and decision-making stakeholders such as the different levels of state in China. This is important as currently, Chinese livestock industry policies are based on assumptions that intensification will be easier to manage and monitor than a large base of smallholder farms to maintain standards under the environment-social-economic nexus. However, this is not supported by comparative evidence and by increasing the reliability of projections can help facilitate the creation of sustainable food procurement for the livestock industry to best reach an environmental, social, and economic compromise. Also, more solid studies can increase the food literacy of consumers and rebuild trust in China's food systems which is an opportunity demonstrated by the study of Chinese consumers preferring

industrial production over family farms (de Barcellos et al., 2013).

4.2.2 Alternative food networks, low-emission farming, sustainable intensification, meat replacements, collective global action

Other alternatives to consider for China's livestock sector is to focus on growing alternative food networks and community supported agriculture schemes such as the Green Cow Farm in Beijing to move away from expanding industrial-scale livestock practices for both domestic and foreign farms in China (Brighter Green, 2011). This needs to be supported by the political will to slow conventional growth models and reduce the political sensitivity of food security to increase the circulation of ideas and public discussion with groups such as civil societies (Zhong & Zhu, 2017). Also, on an industrial pork farm, the cost of the livestock feed is estimated to be 60-70% of the production cost in China (Cheng et al, 2011). To reduce these costs while simultaneously addressing food loss and food waste, China should consider sustainable intensification by feeding livestock food loss and waste to close the gap on both issues. Although funding programs already exist, China could provide more funding to small farms to increase their capacity in converting to ecological farming and reduce price premiums of sustainably grown meat which implements practices such as biogas digesters and other closed-loop bio-cultural systems. Another pathway to a more sustainable food future in China is to shift consumption from a meat-centred diet to a safe and accessible plant-focused one which is more sustainable than its meat counterpart (Pimentel & Pimentel, 2003). China could also explore and fund research and development on meat substitutes such as lab-grown meat; however, current life cycle assessments show that lab-grown meat have the highest impact and better performing products are insect and soy meal based substitutes (Smetana, Mathys, Knoch & Heinz, 2015). China can also continue to contribute to international food-related goals such as the Milan Urban Food Policy Pact which municipalities across the world, including Beijing, Shanghai and Chongqing have signed to.

5.0 Conclusion

The consumption of meat has impacted social systems and the environment on a global scale and is becoming increasingly problematic as production and market systems change. Livestock production requires intense inputs of environmental and economic resources including water, land, and energy. Along with these environmental impacts, social demands of living standards and modernization has increased the demand of meat consumption which further perpetuates the production and supply of meat. Efforts to reduce meat consumption in China have been increasing within the last decades due to rising concerns surrounding food security, national health, and environmental degradation. These efforts are being followed by consumers, the government, and the industry. The current positioning of China's animal agriculture policies show the state's support in pursuing agricultural intensification through land consolidation, farm expansions, implementation of modern agricultural technologies for increased production, and for the growth of dragonhead enterprises. However, moving forward, this trajectory of livestock intensification will be a driver of detrimental environmental and social impacts to China's food systems. It will be essential for China to explore different alternatives to alter this projection by filling in knowledge gaps and exploring alternative food networks, low-emission farming, sustainable intensification, meat replacements, and collective global action. This report's review of meat in China's diet along with the ramifications and

alternatives to its consumption and production recommends that policies be reconsidered to support a stronger ecological and secure food system in China.

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