ABSTRACT

Title of Thesis: Balancing Environmental and Economic Development of Chinese CAFOs—a recommendation to the 2016-2020 Guideline on Live Pig Production

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The Chinese government is increasingly fond of concentrated animal feeding operations (CAFOs) to meet skyrocketing demand for pork, but the sprouting farms also witnessed deleterious environmental effects. Infrastructure for proper environmental measures were not set up, and strike-hard campaigns to address environmental and public health concerns drove many smallholder pig farmers out of business. Extreme practices shut down too many pig farms, which created a pork shortage, worsened by a sweeping pig disease. To improve the situation, the government proposed the guideline for the period 2016-2020, to both strengthen dragonhead industry farms' production and improve smallholder liveliness in the market as alternate source of pork. In this thesis, I offer recommendations to meet these guidelines. For smallholder farmers, I recommend that if they have enough resource, to upscale their operations while devoting focus onto one pig raising process. If that is not possible, they can transition into organic, or green-labelled pig farming, to appeal to higher income customers. This can be carried out in impoverished areas in combination with international support, which also provides the locale with basic infrastructure. For CAFO farms, I suggest that they employ self-made feed to reduce environmental and economic burden. I also recommend that they establish partnerships with more pig businesses of different scales, referencing the cases in Vietnam. Such bridge would fight against the bias for bigger farms, help more operation sustain their businesses, and keep more local breeds. Since the situation is still developing in China, modifications in its path are essential in preventing a consolidated, unsustainable system.

Balancing Environmental and Economic Development of Chinese CAFOs—a recommendation to the 2016-2020 Guideline on Live Pig Production

By

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Dedication

To my father, who always encouraged me to pursue what I am interested in.

To my mother, who listened to me and offered unconditional support.

To my boyfriend, without whom it had been impossible to obtain connections to my interviewees. He also offered encouragement throughout my writing.

To my brother, whose company was always reassuring. I hope the best for his academic life at the University of Michigan, and his endeavor onwards.

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Chapter 1

1.1 Introduction

China's pig raising facilities are quickly growing to an industrial scale. Colossal pig farms are erected, and the13-stort-high pig hotel that sets a world record sits in Yaji Mountain, China (Patton, 2018). Industrial pig production is to satisfy the growing domestic demand, but it comes with deleterious environmental ramifications. Damages are irreversible, and rising concerns make the still developing environmental policies struggle to balance its intensity with practical needs. Unsustainable industrial farming should be forestalled from an environmental sense, but there are also economic and political rationales that prove shutdowns unviable. This thesis aims to study the stakeholders and concerns attached to large-scale pig farming in China, observe recent policies, and offer recommendations to move towards an equilibrium between sustainability and economic development.

I will be making suggestions to the guideline concerning pork supply in the period 2016-2020 (农业部, 2016). It contains a wide range of outlook as to where to build new sites, the relative scale of each site, recommended pig breeds, and collaboration modes to help larger and smaller pig farms converse. This document will be discussed in tandem with environmental laws. as a national document, it is ambiguous by nature, and the openness to interpretation can drift to an undesirable direction. Engaging first-hand interviews and existing trends, I predict the future market of Chinese pig farming. Based on the 2016-2020 recommendation, I will also explore an optimal middle point that invites as many stakeholders to the stage as possible.

I will recognize the moral, ethical, political, economic, and environmental considerations in my modification of this guideline. Other than environmental concern and economic incentive

that compete, citizens' inclination to consume more meat links with political stability. Environmental impact is felt not only by domestic citizens, also attracting international criticism. Although it is impossible to make all parties satisfy, I aim for an eclectic suggestion that helps the guideline move towards a more flexible and tolerant one.

Chapter 1 explains the background, the research question and argument, and define some crucial terms used throughout the paper. In chapter 2, I discuss the methodology and research design, as well as the dilemma experienced by the government. In chapter 3, I explore the development of environmental laws and their interplay with economic development policies. In the last chapter, I conclude with prediction towards the future and some recommendation to different-scaled pig farmers, referencing international cases. Lastly, an appendix on my interview question is attached together with the references.

1.2 Literature Review

Demand for livestock production has been steadily rising among the developing East Asian region, with China taking a salient lead (Thornton, 2010). The OECD-FAO predict that, in the long term, China's total meat production will reach 93 million tons within ten years, with a steady 2.3% annual increase from 2013 through 2022 (*OECD-FAO Agricultural Outlook 2013*, 2013)However, the population's demand for pork had not traditionally been this way. Pigs were kept in backyards, consuming household waste and turning it into valuable fertilizers. Because of the close contact with people and the reciprocal value they offer, pigs have been of great importance to people, practically and culturally. Pig is a member of China's zodiac, appearing in the pictographic character "home," and are part of various sayings and idioms. The word "meat" refers to "pork," while other meat requires specific prefixes (lamb-meat, chicken-meat, and cow-meat, if translated literally). Pigs are slaughtered for feasts and annual festivals, which associates

pork with festivity, wealth, and jubilance. A whole pig is consumed without waste—pig ears, pig feet, and even intestines are prepared in various ways, some preparation styles attached with symbolic meanings. Both live pigs and pork have had significant practical and cultural implications for the Chinese population, but it is gradually changing in the current landscape.

In 1978, China's market expanded under Deng Xiaoping's new policy. The new economic model implied a resource transfer from the rural to the urban area, which is enabled by the central government: it subsidizes farmers to produce more, while also manipulating market prices for the urban consumers to make food affordable. The excess would be stored as reserve, and the government was spending money for both the farmers to produce more and for the consumers to make cheaper purchases. That amount of expenditure was so burdensome to the government that it soon declared unviable, and made way for a free market production. However, it did largely expand the food production business, enabling Chinese agribusiness leap into the international market. Other than the high investment in staple grain crops, the government emphasized hog as the primary animal protein, pursuing a diet "high on hog." (Schneider, 2014)

Although the rapid increase in production enabled more frequent, and even daily consumption of pork, its traditional status has not changed, especially among older people. Pork on dinner tables is still associated with festivity and wealth, now also attached with modernity and national pride. This sentiment explains the disproportionally large demand for pork (J. Wang et al., 2014) and its predicted continual increase (Schneider & Sharma, 2014).

To satisfy the population's craving for meat, to reify state legitimacy (Prändl-Zika, 2008), and to promote economic development, China started launching concentrated animal feeding operations, which is an intensive feeding lot that uses the least land mass to produce the most

livestock possible. Pig pens are densely packed into a factory room, and pigs are fed industrial feed. To stop horizontal expansion, the sites are becoming denser and taller to produce more pork, given the same area. This rearing model is a prevalent but unsustainable practice ingrained in the United States. The deleterious consequences have made the developed world suffer (Cole et al., 2000; Donham Kelley J. et al., 2007; Hodne, n.d.; Hu et al., 2017), and is increasingly making Chinese farmers experience the same difficulties. The system imposes threats on the environment, human health, and animal welfare. Because the livestock agribusiness involves a myriad of stakeholders along its production chain, it has an expansive scope both in time and reach. The national guideline in the period 2016-2020 (农业部, 2016) focuses more on environmental and economic concerns to make decisions about future development. Therefore, I follow the government's lens of proving the problem, devoting attention mostly to environmental and economic solutions.

The previous literature largely criticizes the established CAFO system in the developed countries, or discusses the destructive influence the large-scale farms exert on smallholder businesses. Not much has been analyzed in terms of existing governmental policies, and personal narrative is presented over company interviews. The literature has also focused more attention on developed countries with mature livestock rearing systems, but not Chinese ones.

The conflict between conservation and development has always been present (Day & Schneider, 2018; Eriksen, 2016), but neglected when discussing CAFO development in China. Additionally, because the Chinese government is rapidly changing its livestock industry, it is hard for the academia to establish up-to-date observation and analysis on this topic. The heavier focus of Chinese government on grain production also encourages domestic scholars on

agricultural issues, rather than animal husbandry. Scholars foreign to China has conducted several sets of interviews with individual smallholder farmers, but not much connection with industry farms were established. Large firms have traditionally been targets of criticism, and the foreign scholars might find it psychologically closer to smallholder farmers, or there might be political reasons that inhibit access. In either scenario, without Chinese scholars conducting similar studies, the company side of narrative is left blank.

To fill the gap, this thesis will be dedicated to the pig industry in China, providing perspective from the company's side as well. I study its present and future prospect, and will contribute to the existing 2016-2020 guideline for changes.

1.3 Research Question and Argument

Given the controversy of conservation and development, I put forth the research question: how can the Chinese government balance environmental protection against the raising demand for pork, pursuing sustainable development that satisfies both parties?

I argue that the government should build its operation on the existing guideline on pork production (2016-2020), which promotes pig factory farm building. However, it should also subsidize smallholder farmers to transform in a different direction, which creates a different market than the factory farms. A reserved development for the megafarms should be considered, and other infrastructure, such as local governing body, veterinary services, and economic subsidies should be strengthened to create a better environment for the pork production industry.

The current guideline effective from 2016-2020 (农业部, 2016) envisions a coexistence of smallholder farms and large-scale industry farms. Although the policy predicts a gradual replacement of smallholders with industrial farms, it also foresees a slowdown of industrial farm

expansion, which is attained at a balancing point among different sized farms. At that point, no more megafarm expansion is required to produce enough pork for the entire population. With ambitious environmental goals in the policy, the not-yet-complete infrastructure and subsidies naturally selects for wealthier, bigger sized farms. Therefore, the smallest backyard farmers are increasingly excluded and persecuted in this tide of reformation. It is beneficial to the waterways, but the current solution is too simple to account for economic and emotional subtleties surrounding the industry--an equilibrium should also mean a stable working condition for the industry workers.

To reach that equilibrium, I have different suggestions for differently scaled farms. For smallholders, the biased policies are likely to remove more small farms from the market. The remaining ones should specialize in one area of pig farming and partner up with Dragonhead companies. For economically disadvantaged areas with rich natural resources, especially autonomous regions occupied by ethnic minorities, it is also possible to develop small-scale organic pig farms, partnering up with international aids to simultaneously install necessary infrastructure such as more road and water access.

For mid- and larger scaled industrial operations, they should follow the current 2016-2020 guideline when investing for a new pig farm in designated regions, and incorporate self-made feed to reduce cost while keeping competitive pig finishing performance. This will decrease reliance to imported pig meal, reduce purchasing and transportation cost, and incorporate well into the future picture of agriculture-husbandry integration model, harnessing waste materials.

From the policy execution level, I suggest that subsidies should be expanded to include smaller-scaled farms. Existing environmental regulations should be translated with detail,

leaving no room for over-interpretation, and coordination among different levels of governance should be fluid in tailoring the law to the local condition. Referencing Vietnamese pig farms' transitions, a more flexible collaboration that accommodate smaller sized farms can also help preserve more businesses and unique local pig breeds.

1.4 Scope and Acknowledgements

I will be making recommendations to The National Pork Production Developmental Plan (2016-2020) (农业部, 2016). Instead of focusing on a single site, I inspect the national guideline, while gathering relevant news articles and blogs. News sites include Tencent, China news, South China Morning Post, and local news channels such as "sc. news. cn" (Sichuan News), to reflect how policies and decisions are presented, and to observe how the policies are exercised. Although these are government-regulated news sites and might involve pro-China biases, facts and figures are valid, and the sentiment attached is also my subject of study. In addition, these reports reflect timely snapshots of opinion shifts and local responses, which make them valuable sources. I also draw on foreign news sources, such as New York Times to see incidents with international impact.

For blog posts, I chose from a variety of sites from Zhihu to Huxiu, the former being a forum for bloggers to answer online questions and the latter being a personal blogging space visible to others. These platforms include comments on pig farming, which reflect personal experiences and opinions, and can be used to triangulate the presentation in the newspaper, or observe the policies' impacts on individuals. Specialized animal husbandry websites such as Nongjing is also referenced, where experienced personnel write from a management perspective, offering insights on the economy and policy analysis for the entire industry.

I also draw on environmental laws and food safety announcements that responded to past crises, company homepages, as well as WeChat official accounts offered by those companies. Food safety issues periodically plague the country, and many policy developed in reaction to scandals (Yasuda, 2015). Therefore, tracking the regulations together with reported scandals would allow a more thorough explanation as to why a series of laws were passed at a certain time. I retrieved pronouncements both from the State Council and from Ministry of Agriculture. The former is concerned about food, nutrition, safety, and economy in general, and the latter provides specialized decision on the farming sector.

I selected companies such as YangXiang (广西扬翔股份有限公司) and Yu Shi (余式猪场), which are Dragonhead enterprises aided by the government. They all have relatively large herd sizes, and actively integrate cutting-edge technology. Governmental subsidizes prospective Dragonhead companies, and the companies themselves engage in investments that attract more fund, creating a self-enhancing feedback cycle. I reference company statements, which inevitably involves bias, since their purpose are to promote their brand image. However, I consider self-reported narrative highly representative of the current government guideline, since it presents the ideal future direction most aligning with existing policies. Therefore, I will integrate company promotions into my analysis. Alternative narratives will be supplemented by news articles and blog posts.

This thesis offers a recommendation to the Pork Production Guideline in the time frame of 2016-2020. Past policies as early as 2005 are examined, but they are solely for understanding the pertinence of content and giving a more tailored recommendation for the four-year development guideline.

I would also like to acknowledge the difficulties obtaining direct interviews from large-scale hog farming companies. I reached out to 76 hog farming facilities, including mid- and large-sized hog farms, hog farming schools, academic institutions invested in agriculture or operated by a hog farm, and smallholder farms, ranging from Liaoning Province (a northeastern province with similar altitude to the state Michigan) to Hainan Province (the southernmost province in China). Methods of contact included e-mail, WeChat contact, direct online messaging, as well as phone calls. However, most of written requests remained unanswered, and the phone calls were rejected. Reasons of rejection ranged: some individuals simply hung up; some contacts notified me that the information I requested is not open to public, the hotline is for commercial purposes and not interviews, or that the representatives are too busy to answer.

Through a personal connection, I was able to contact two companies. One is a mid-scaled farm of about 1,000 pigs in Liaoning Province. The farm is a provincial level Dragonhead enterprise, and it specializes in raising sows, therefore professional in pig rearing and breed selection. It is individually operated without any contract from above or below, and it operates in the area that guideline designated as prospective heavy expansion areas. The other company is of larger scale, holding several thousand pigs (the representative did not provide a specific number). It has pig factories in both Liaoning, northeastern China, and Guangxi, a southern area close to the developed harbor, Guangzhou. It has a relatively integrated chain of operation, with feed production within their system. The channel of contact for both representatives was through Skype phone. Because the representative from the first company had more time when I called, most information was retrieved from the first pig farm. I also asked a different set of questions due to the same questions, but they are all based on the same list of base questions. Formatted

questions are listed in the appendix, and the different inquiries are gathered in casual conversations, expanding the topic at the representative's wish.

Again, my argument centers around environmental and economic concerns in the industry, and the following topics are excluded, because they are not directly related: animal welfare, domestic and international soy processors, government personnel executing environmental regulation, as well as departments involved in retail and international trade.

1.5 Term Definition

The Chinese market has created several words pertaining their market participants, and I would like to highlight them here.

1.5.1 Dragonhead Enterprises

Dragonhead enterprises are government-subsidized companies, often large-scale, with access to the most amount of consumer trust in the market. Due to their partnership with the government, they enjoy benefits such as tax exemptions, government labels, project subsidies, and export tax rebates (Schneider, 2017a). The government also primes Dragonhead farms with modernity, progress, and safety, and projects these qualities to the public sphere. Therefore, Chinese consumers have a generally positive attitude towards industrial farming, associating CAFOs with achievement, efficiency, better quality, and food safety (de Barcellos et al., 2013).

In return for the benefits they reap, Dragonhead enterprises are assigned the duty to spread technology and service to smaller operations, "radiating" the benefits from the center. Dragonhead enterprises now cooperate with smaller firms or individual smallholder farmers, which provides educational programs and aid packages, and the smallholder farmers work under

contract (Schneider, 2017a). Although many Dragonhead enterprises begin with private operations, the line between state-owned industry and private enterprise becomes blurred after several rounds of funding from the government.

1.5.2 Smallholder Farms

Before the age of CAFOs, small scale household farms were the dominant production model. Pigs were raised in backyards, consuming waste and producing fertilizers, kept mainly for households' own consumption. Since each household is likely to own some pigs that catered their needs within, raising pigs purely for commercial purposes was rare. Free from market pressure, farmers often incorporated crop farming and other animal raising practices, with pigs being a wedge of the farming cycle (贾, 544). Pigs ate various plants ranging from homemade pig meal to wild weed outside, without special attention devoted to manually expedite their maturation, which fit perfectly within the framework of modern-day sustainability standards.

Farms had an average of less than ten pigs (Lapar, 2011), which was possible because of little demand. As stated above, people only consumed pigs once or twice a year, and did not produce for commercial purposes. There are calls to scale down each farm and "return" to the previous style, but asking Chinese farmers to recede to the 20th Century omits the rising population and their climbing consumption. People consume pork much more often (Schneider & Sharma, 2014), and not all households are equipped with a backyard to raise pigs for themselves. Production solely for self-sufficiency is no longer compatible with the current national demand and lifestyles.

After 1978, when the economic advancement policy was enforced, the government started to encourage scaling up farmlands and animal raising lots. Under the policy, a significant

portion of rural labor drained to the urban area as migrant workers, and the traditional smallholder pig farms dwindled as more expansive enterprises replaced scattered individual farms (Day & Schneider, 2018; Jian, 2010; Schneider, 2017b). With scale expansion, machinery, and automation in sight, the government decided that rural labor is destined to shrink, and actively removed labor forces from rural China (Schneider, 2014a). This lack of manpower further discouraged pig farming, since it is physically demanding and time-consuming, making the task unworthy when the labor force is not enough.

Looking for a way out, some farmers who still work in rural areas chose to expand their hog raising yards, becoming middle-sized hog farms ranging from 30 to over a hundred pigs, while others became contract farmers under Dragonhead enterprises. Others abandoned pig farming altogether due to low cash return, high labor intensity, urban-biased policies, and further disadvantages. With the increased adoption of chemical fertilizers, nearby farmlands found manure provision from pig production sites excessive, and the land has no more capacity to process the sheer amount of feces. The collection, treatment, proper storage, and transportation of pig manure is another demanding task, especially when environmental regulations are becoming stricter. Facing difficulties including expensive disposal, fines from polluting waterways, and stagnant demand even if treating feces properly, farmers feel increasingly disincentivized to devote to pig farming (Jian, 2010).

Through policy measures, smallholder competitiveness in the market is weakened, further strengthening larger firms' growing power. Smallholder farmers do not benefit from market access subsidies, since a farm must be large enough to receive monetary incentives for upscaled productions. Additionally, government discourse often attributes food safety problems and environmental pollution to smallholder farmers. Framed as an opposite to Dragonhead industrial

farms, individual farms are termed backward and unregulated in the national discourse (Schneider, 2014), said to be causing poor food sanitation and waterway pollution due to improper farm regulation. When faced with the choice between government-certified labelled meat and individual production sites, consumers drift towards the former, leaving smallholder farmers little access to stable markets if not affiliated with a popular outlet. Therefore, smallholder farmers find it difficult to survive in both production and sales.

Despite the disadvantages, smallholder farmers still produce 40% of the national pork supply (Tisdell, 2009) as larger farms gradually attempt to take over. If overly harsh regulations are to completely deprive smallholders of livelihood, national pork supply will face a severe shortage. Recognizing the importance of sustaining smallholders' livelihood (新华社, 2019), the government published partnerships and alleviation programs to help their survival. Yet, at the same time, they cannot abandon the choice of promoting large feeding operations' expansion, given the economic benefits and efficient production it brings (四川在线, 2019, p. 13). To find a middle ground, the government has encouraged partnerships with larger farms, and the traditionally bipolar positions are now merging—at least on surface level.

1.5.3 Concentrated Animal Feeding Operation (CAFO)

CAFO is a mode of highly industrialized animal raising practice. Confining livestock into small spaces and reducing their growing cycle ("Why are CAFOs bad?," 2015), it is a machine tailored for intensive production. While the windowless, grain-fed, and highly efficient system produces an astounding number of livestock, it brings about significant environmental ramifications, including water and air pollution, diminished biodiversity, health threat to humans, and contributions to global warming (Xiaoyan, 2005).

Because of China's rising demand for pork (J. Wang et al., 2014) and the government's decision to scale up pork production, CAFOs are justified as the to-go solution by the government (Schneider, 2014b). Traditional smallholder pig feeding practices requires longer maturation span and produces more fatty pork, which is less controllable than regulated soy feed, less efficient, and goes against consumers' preference—people prefer leaner meat today, which is easily produced under the industrial farming operations (Schneider, 2014b). Therefore, Dragonhead enterprises all operate CAFOs, with the government subsidizing their purchases and transition to more vertically integrated, multinational corporations.

Past studies have shown an array of ramifications CAFO imposes. In places where residents come into direct contact with pig farms, complaints about unbearable odors are widely filed (Liberti & Parenti, 2018). Health impacts range from short-term eye irritation to long-term respiratory diseases, and lagoons that hold manure often result in waterway contaminations (Cole et al., 2000; Donham Kelley J. et al., 2007; Hodne, n.d.; Hu et al., 2017), threatening the residents who depend on the water for irrigation and family uses. Families either endure the resulting inconvenience or move away, but either impact is absorbed by the communities under their own expenses. People of lower socioeconomic status are disproportionally harmed, because industrial farms are often constructed in areas with smaller population and little economic activities, where little environmental restriction apply. Those are also the population that depends on the waterway for irrigation uses, and the deprivation of water resources makes them more vulnerable.

Nearby residents are not the only population harmed; mental health aid is not guaranteed for those who work in CAFOs. The meticulous biological security, a prerequisite for industrial farms, isolates farmers that work in CAFOs, restricting their access to the outside world and

prioritizing the companies' and the pigs' well-being over human's, such as the right to freely step out of the factory, or consume pork product from outside (Blanchette, 2015). There is a two-week quarantine for any worker that went outside, and the time spent unable to work are deducted from individual wages. Therefore, factory workers rarely take breaks from their daily husbandry practices. Multiple blog accounts pointed to the mental and physical isolation, from their family and from the outside world (付光栋—知乎, n.d.; 王忻—知乎, n.d.; 诚玉可鉴, 2017).

In addition, CAFO diminishes biodiversity by introducing standardized species and denying local pig strands. Various pigs of Chinese origins are on the edge of extinction, with elderlies and chefs lamenting on the loss of flavors (单, 2019). Other ramifications include the spread of antibiotic-resistant pathogens stemming from pig feed and medicinal approaches, disregard of the livestock's well-being, and contribution to global warming (Schneider & Sharma, 2014; Xiaoyan, 2005).

1.6 Conclusion

This chapter introduced the topic and scope, defined the terminologies, and stated the direction of possible future outcomes. Chapter 2 explores the research design and methodology, bringing the government's dilemma between the environment and economy into conversation. Chapter 3 outlines all environmental laws and economic acts. By putting them into conversation, I better understand the government's motivations, which help predict the future course of policies. Finally, in chapter 4, I offer recommendations on the 2016-2020 Guideline for Pork Production, and predict the future development of the pig market for pork producers of various scales.

Chapter 2

2.1 Introduction

Raising livestock is by nature a labor-and resource-intensive operation, causing disturbance in communities, transmitting diseases among people and pigs, forcing displacements, and causing environmental pollutions. Not only are the laborers directly involved in the industry chain feeling pressure, but the nearby communities are also experiencing impact, such as polluted water and air, which renders their daily farming activities inoperable. As an increasing number of stakeholders become involved, the ramification caused by intensive hog production becomes emergent in various fields. The government now juggles between keeping its environmental prospects and ensuring economic development.

In this chapter, I will discuss my methodology and research design, and display the economy-environment dyad experienced by the Chinese government, including environmental constraints, threat of pork shortage, and the government's long-standing desire to provide enough food for its population.

2.2 Methodology & Research Design

I carried out interviews via phone calls. Means of contact was provided by personal connections, and I used Skype for the calls. A set of questions was drafted before contact, with slight modification to differently scaled farms, also adjusted for different regions. Audio files were all recorded and stored in a password-protected computer[1]. It is a cross-sectional survey that happened in Chinese; the author translated the content into English.

[1] Study eResearch ID (IRB number): HUM00173126

Given the difficulty contacting a large sample that is enough to make a balanced observation solely from the interviews, I also draw from Dragonhead companies' articles from their social media channel (WeChat official account). WeChat is the most commonly used communication channel among the Chinse population (*China*, n.d.-a), providing a platform of information access. Companies create official channels that people subscribe to, and forward articles to their subscribers. Dragonhead enterprises often own WeChat accounts to publicize their latest updates and official work processes. Therefore, observing their reports informs readers about the current situation as well as the policies and practices that the government favors and prioritizes, which makes it an appropriate channel to evaluate company movements and future inclinations.

I also examine governmental statements from international forums (FAO, 2017) and statements made to China's domestic citizens (国办发, 2019; 国务院办公厅, 2014). Because of inadequate monitoring bodies and technology to assess the national-scale statistics associated with pig production, FAO (Food and Agriculture Organization of the United Nations) reports are the most cited alternative source (Day & Schneider, 2018; Rae, 2008; Schneider, 2011, 2017b). All domestic policy updates are published through the State Council, which will be the focus of my policy assessment. Existing census data cited within the literature will be combined with FAO's figures for triangulation.

2.2.1 Discussion of Translations

Government statements, multiple news reports, phone interviews, and references to company websites are all in Chinese, and are translated by the author. With 18 years of

experience living in China and completing high school education in Chinese, the quality of translation content is assured.

2.3 The Dilemma Explained

This section traces how the government juggles between environmental concerns and economic-political forces.

Despite voices against the system, industrial farming remains popular for reasons: it produces disproportionately more livestock compared to the little land it takes up, it makes regulation easier than many scattered individual farms, and it produces high profit margin. Recognizing the short-term benefits of industrial animal husbandry, Chinese government is expanding large feeding lots both in quantity and in operating scale (四川在线, 2019).

Smallholder farmers, in contrast, are shrinking at a high rate under policies that favor large scale feeding lots. Subsidies are granted for farms that are above certain size, and environmental as well as health regulations target smallholder farmers, nudging them towards a decline. But they are still the dominant pork producer (Tisdell, 2019), and the CAFOs are still not capable enough to cater the growing demand. Seeing a decline in supply, and recognizing CAFOs' lack of power, the government reacted by policies to reinvigorate the smallholder farmers (国办发, 2019; 新华社, 2019).

However, the government is also cognizant that heavily subsidizing smallholder and keeping their activity is not a long-term goal. Solely relying on smallholder farmers will not satisfy the continually spiking demand curve, and an overhaul towards systematic industrial

production is not environmentally sustainable. Deleterious environmental effects of industrial hog farms have been inflicting both the environment and public health. As a part of the national food safety concerns (P. Liu, 2010; Yasuda, 2015), pork has been detected with excessive antibiotics use, illegal drugs that kept pork lean (新京报, 2011), and other improper sanitary practices such as recycling carcasses for processed food.

The issue of meat intertwines with land use and grain production as well, as one traces back the production phase a pig goes through. Rapidly rising pork demand inevitably drives up the demand for more soy feed—the most commonly used grain that efficiently turn pigs into commercial pork. Pigs that are fed traditionally had relatively omnivorous diets, consuming any human waste product, grass, and farm waste. Such feeding style requires a longer maturation span and produces more fatty pork, whereas industrial soy feed is now the exclusive source of pig meal, expediting the growth cycle and making the meat leaner (Barboza, 2013).

However, the adoption of soy feed triggers the problem of supply: China officially announced the "21-9 Challenge" it faces—holding world's 21% of population, it only has 9% of arable land, with constant water shortages (Schneider, 2014b). Soy is a relatively water-intensive crop, and it is more imminent for China to prioritize grain production for humans than planting soy to feed the animals. Given that the domestic soy sector declared themselves unable to keep up with the hungry hog industry, China has chosen to outsource soybean production to grant the limited land for human's staple grain production. This move made China the biggest importer of soybeans worldwide (Schneider, 2011).

Brazil now bears the water and soil problem that China outsourced, exporting almost 80% of its soy production to China ("Brazil exports 80 percent of soy to China in January-

August," 2018). Smithfield Foods, a United States company producing the most pork worldwide, was taken over by Shuanghui International Group. The $4.7 billion purchase (Barboza, 2013) was granted within 48 hours (Liberti & Parenti, 2018) which is a clear sign of state intervention. Both purchases can be regarded as strategic moves to shift the environmental impact outside of China (Schneider, 2014). Potential deforestation (*Soy | Industries | WWF*, n.d.), restructuring of farmland, water pollution, and land occupation are all partially mitigated through such environmental measures, although fraught with economics and political dynamics.

However, the reliance on foreign feed source and frozen pork disproves the efficiency of industrial farms (Schneider, 2014). The land and resource investments are all required to sustain the CAFO's daily operation, and both government subsidies and outsourcing the consequences merely makes the problem invisible, rather than eradicates it. In addition, the genetically modified soy imports saturating the market outcompetes local production (Fuller, 1997), denying Chinese producers' livelihood. Despite the concealed and emerging problems, the government's overseas purchases still prove that they are committed to expanding, or at least sustaining the current industrial hog raising facilities.

Apart from public health, disease among animals is also a rising concern, the most recent outbreak being the African Swine Fever. Because of improper vaccination, inadequate access to veterinary services, and the convoluted inspection and transportation process across provinces, African Swine Fever killed over half of Chinse pig population, spiking the pork price and causing public discontent. There is an estimated three-to five-year recovery time for China, and even the frozen pork reserve (Yiwei Wang & Zhong, 2019) is doing little to alleviate the diminished supply.

To tackle the environmental consequences, including nature's health, human's health, and livestock health, the government has experimented with various steps. Offshoring environmental cost is one measure, and executing strong environmental policies is also a strong domestic movement. Relating back to the African Swine Fever, one of the reasons that pork became so scarce is that the government took a precautionary approach. All pigs that are potentially infected were killed along with the confirmed cases, since the trucks and slaughterhouses are not equipped with proper resources to curb disease progress, despite being important threads and nodes of the network (Tisdell, 2009). Experts have concluded that human meal leftovers were the main source of transmission, and that unregulated smallholders are known for feeding leftovers to cut cost. Therefore, regulation and inspection acted harshly on smallholder individual businesses.

Stringent environmental policies looking to protect waterways designate pig intolerant areas, banishing both smallholders and CAFO pig companies from those area. The closing down of sites is another reason for the recent pork shortage—after all, larger, or mid-sized pig farms are still developing into maturation, while smallholders still produce 40% of the pork supply (Tisdell, 2009). Mass closure and slaughter inevitably leads to an increase in pork price, which ties into another aspect of concern.

Pork shortage is one of the most undesirable situations to eliminate, and this is where the other side of the dilemma joins the conversation. Despite the strong focus on the environment, as soon as the pork supply plummets and pork become unaffordable, the regulations are laxed, and multiple new guidelines are published to encourage new sites to be built in alternative locations. It is politically important for the Party to provide food continuously without hints of shortage.

The struggle to achieve a continuous food supply has been present since the beginning of the People's Republic of China. Since the 1970s, the government has worked hard to set the grain price, exerting subsidies to make grain cheaply available for the urban population, even sacrificing financial balance and creating a national deficit to secure affordability. The government also tried hard to incentivize farmers to produce more grain (Du & King, 2018), and the same mindset is being applied to the hog industry today. The crisis of the rocketing population and the efficient CAFO solution is juxtaposed, justifying industrial farms as the optimal way out.

Aside from satisfying dietary needs, the act of purchasing food is an important economic activity. After the African Swine Fever diminished the pig population, the overall economic picture had been dampened—"the main driving force of China's consumer spending comes from the country's middle class" (He, 2019). Although the pork sector is not as significant a factor that determines the populations' spending level, heightened food prices puts pressure on people's spending habits. People eat out less with economic strain, and the night-time economy also suffers (He, 2019). People change their homemade dish choice because of elevated pork price, and online posts complaining about the issue became increasingly popular. Economic hardships and dissatisfaction piles up, and people perceive pork shortage completely separate from environmental issues (Macdiarmid et al., 2016), making them less understanding of the shortage and the government's motive.

Seen from this perspective, the purchase of foreign production sites is more than an environmental act. It more strongly reflects the government's desire to secure, if not practically then psychologically, pork supply at any time. Again, all the governmental intervention

illustrates the desire of the government to secure adequate sources of meat in the market, fresh or frozen, domestic or international.

Despite the political significance of securing pork, CAFOs are sometimes still overpowered by environmental regulations, which relates to various public health crises happening at a given time. Neither political justification nor environmental action, or economic concern always take a salient lead, ebbing and flowing as the other forces fluctuate. Among the forces described above, environmental policies and economic development are more easily reflected in policies, whereas political justification are implied and interpreted. Therefore, this thesis will focus on the more explicitly stated interplay between environmental and developmental policies, and predict their future trajectories.

2.4 Conclusion

CAFO style of farming is a proven mode of an unsustainable farming operation. Although it offers short-term solution to food safety, it is not a viable model for a country in terms of the environment, livestock, or the workers involved. Recognizing its long-term inefficiency, the government is juggling between expanding CAFO and protecting the environment. Along their experiments and attempts, this thesis will aim at locating a possible middle point that is environmentally sustainable and economically viable in the long run. The next chapter will present the timeline of relevant policies, which will be discussed with scandals that pushed these policies into execution.

Chapter 3: Examining Policies in China

A double bind of growth and sustainability has been present since human started fueling economic development with resources (Eriksen, 2016). Either choice contains undesirable

compromises and ethical concerns, adding a layer of difficulty to policy making. This chapter explores the shifting policy dynamic as the government juggles between environmental deterioration and keeping sufficient pork supply. With disease outbreaks, negative environmental concerns, and economic forces in play, environmental regulations sometimes commensurate with CAFO development while sometimes setting it back. The dynamic shows the government's developing dilemma in exercise, but also the uncertainty and difficulties of being a hog farmer in China.

3.1 Environmental Laws[2]

China has been increasingly aware of its environment. Due to the strong focus on industrial development and urban expansion, environmental problem in general have become society's greater concern, with the government successively publishing laws combatting air, water, and land pollution (国家统计局, 2019). Environmental restrictions recognize and limit the exercise of aggressive economic activities, and appears to stifle development especially if previous industry practices have been operating beyond environmental capacity. Pig farming is no exception. Pig husbandry is one of the dominant industries concerning the majority's staple meat, and at the same time, it is one of the largest industry contributors to environmental pollution. This section of the thesis examines how environmental regulations encouraged and stifled the pig industry.

The year of 2015 witnessed a series of overlapping policies to ensure the water quality surrounding farming units. *Environmental Protection Law* published on January 1, 2015 limited eligible location and practice of animal husbandry, which was then followed by the *Livestock*

[2] All regulations, political statements, and news articles are translated by the author from Chinese to English.

Code (The National People's Congress of the People's Republic of China, 2005) that designated husbandry inhibition areas. In the same month, the *Animal Epidemic Prevention Law* (全国人大常委会, 2015) consolidated the regulation on wastewater and carcass treatment, and improved access to veterinary services. Following that, *The Action Plan for Prevention and Treatment of Water Pollution* (国务院, 2015) further strengthened the determination to combat potential and existing water pollution from animal farms, contending an expedited removal of farms in designated farm-ban areas. In November 2015, the government continued to publish guidance specifically targeting the raising of pigs (Ministry of Agriculture and Rural Affairs of the People's Republic of China, 2015), identifying manure treatment and land capacities as key problems. It suggested that policy intervention, technology transfer, regulations, and awareness campaigns should be implemented.

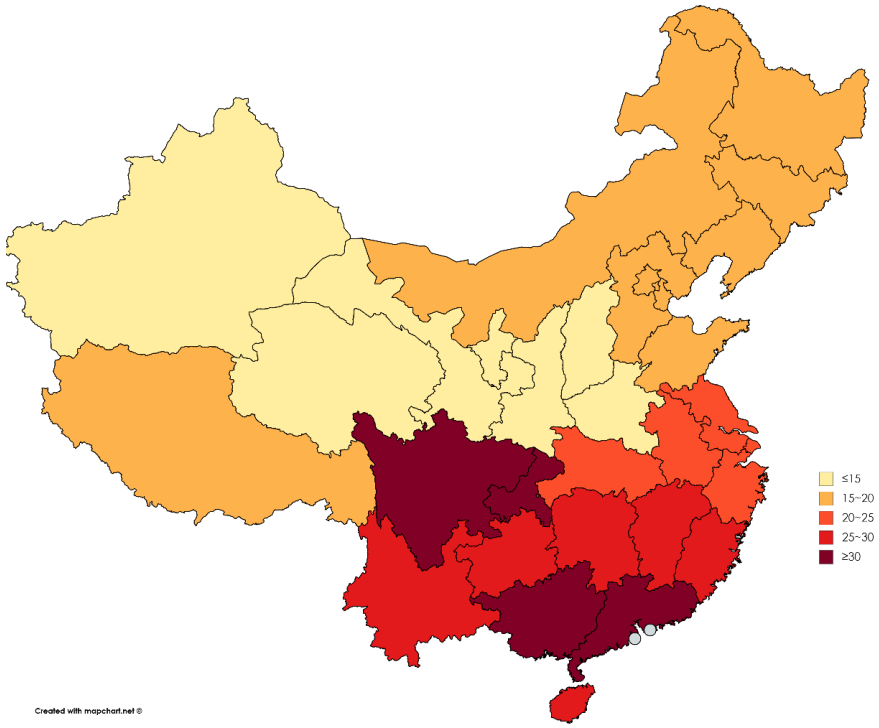
In addition to expressed concerns about land and water, Article 49 in *Environmental Protection Law* outlines the need for scientific disposal of animal carcasses, wastewater and manure, to prevent air pollution (第十二届全国人民代表大会常务委员会, 2014). In all the statements above, environmental protection laws aim to either cut back pig production in quantity as well as in the area it occupies, or slow down the production through implementation of careful planning, an improved application process, or put caps before proper treatment facilities are installed. Rather than planning for technological development to treat the polluted sites in the future, it is more efficient to slow down the expansion and create a different animal rearing system that is environmentally and commercially sustainable in the long term.

Acknowledging the time-sensitive nature of environmental problems, the government designated several southern provinces as areas that should restrict CAFO expansion (农业部, 2016). Fresh water resources are more abundant in the Southern regions in China, and the potential water pollution problems associated with pig farming has alarmed the policymakers to turn these farm operations away from the rich waterways. At the same time, subsidies are offered for new operations to sprout in the north, which shifted the production upwards (Lu, 2019).

There are advantages attached to the movement: northern China raises most of its corn and soy, which makes industrial feed more geographically accessible, requiring shorter transportation. Population density is lower, and economic activities are less extensive compared to the south, which affords an expansive land for companies to build sites on. However, although Northern China has less waterways to guard against pollution from pig husbandry, water scarcity is a problem at the flip side of the coin (Lu, 2019). Pig farming is relatively water-intensive, with each pig requiring four to nine tons of water to raise. Expanding such farms will inevitably mean a competition with human water use.

A warmer environment strengthens pigs' survival rate (L. Wang & Fu, 2013a), which is difficult to attain in the harsh wintertime in northern China. The cost and amount of care often discourages smallholder farmers from providing optimal heat for the pigs, which makes death rate climb in the winter. Unfortunately, the lunar Chinese New Year, the peak pork consumption period, takes place in the coldest time, and the problem looms bigger if the major production site is in the north. Therefore, heating infrastructure should be paired with opening of new operations in the north, which is relatively costly and hard to penetrate for smaller farms.

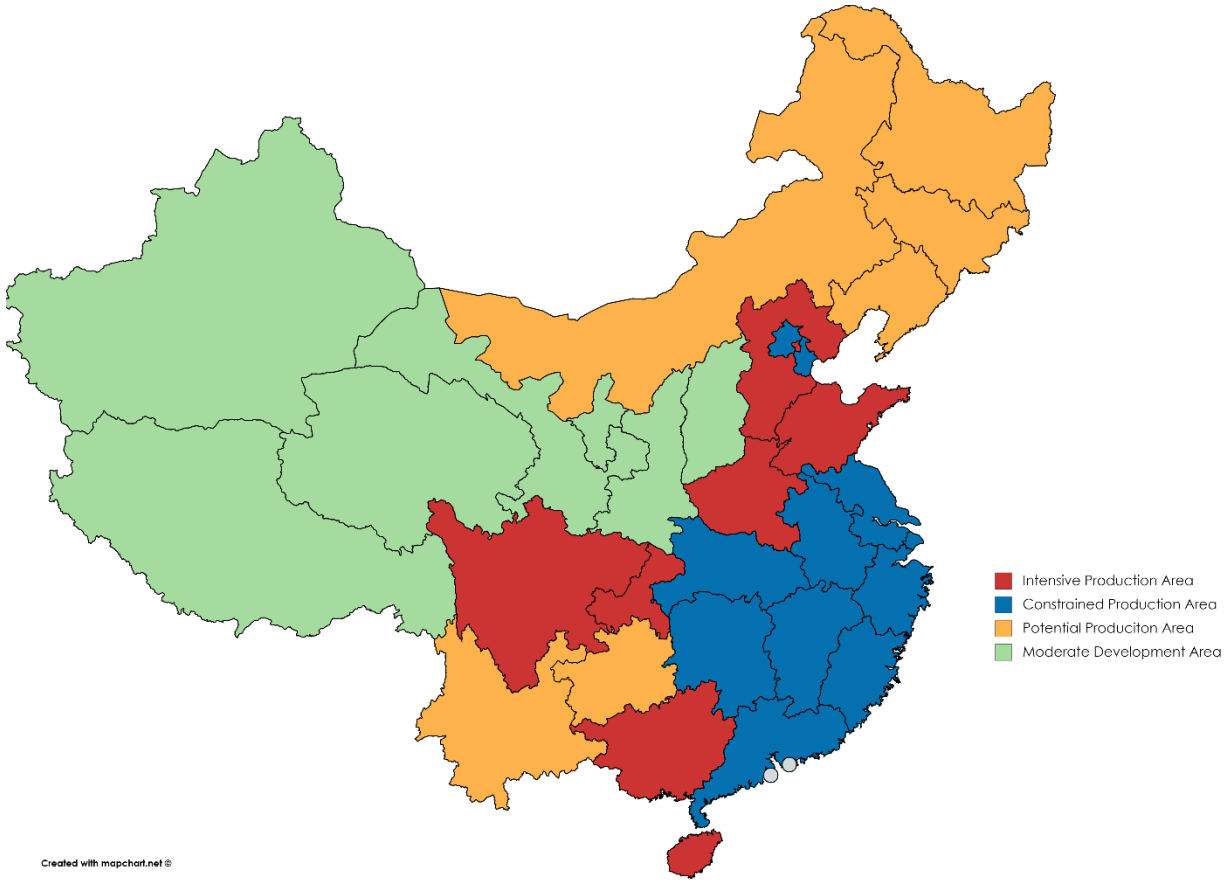
In addition, the cost-effectiveness of shifting site remains questionable. Pig production is only one part of the chain before it reaches the consumer's dinner table, and the overall cost-effectiveness is reflected within a larger network. Cutting back cost in one aspect might increase investments in another, and adding them up brings the total investment back to a zero-sum game. Production sites might shift north, but people's cravings remain high in south.



Map 1: Meat Consumption by Area (National Bureau of Statistics of China, 2018)[3]

As observed in the map, the southern regions consume more pork than the north. They are also the current major pork producers, but the 2016-2020 guideline designates the north as prospective pig farming area, as shown below:

[3] Created by the author using https://mapchart.net/china.html, with the data from the National Bureau of Statistics of China (2018)



Map 2: Pig Production Area Map[4]

To meet the southern population's demand—especially because Chinese consumers prefer fresh meat over chilled meat (Schneider, 2011), pigs that are raised in the north are transported as live pigs back into the south (Lu, 2019) and slaughtered near the local marketplaces. This added transportation cost cancels out the advantage of having pig feed available in the vicinity, and partially contributed to the spread of deadly pig diseases (Pan, 2019).

[4] Referencing the 2016-2020 Pork Production Guideline (农业部, 2016), created by the author on https://mapchart.net/china.html

3.1.2 Explaining the Pork Shortage with Environmental Laws

With the aid of improved transportation services and infrastructure, both human and livestock have become more mobile, which also means a heightened risk to various transmittable diseases (Jian, 2010). One of the most prominent differences between industrial farms and smallholder operations is the degree of attention devoted to biosecurity. Workers in industrial operations are denied access to the outside world, physically confined in the pig factory for months (Blanchette, 2015) to avoid possible virus transmission, coupled with meticulous care in everyday sanitary practices and regulated food stuff from outside the factory (诚玉可鉴, 2017). It is not an attainable degree of caution for smallholder farms and slaughterhouses to adopt, so when pigs carrying a virus arrive in trucks, disease outbreaks become nearly impossible to contain.

This explains the mass death of pigs caused by African Swine Fever, but the shortage is not solely a result of disease. Fearing disease spread, municipal executives slaughtered and buried over ten million pigs susceptible to infection. Pigs were cleared based on the entire outbreak area, and the precautionary killing made pork price skyrocket. Additionally, the environmental policies in effect from 2015 has also served to escalate the shortage. Under the guidance, many hog farming businesses, large- or small-scaled, were forcibly shut down (L. Wang & Fu, 2013a), without being provided an alternative. The ban swept over regions that originally kept pigs collectively, such as Guangdong and Shanghai (Rae, 2008), mostly stifling traditional hog farms (J. Liu, 2019), which supplies most of China's pork. In an opinion piece, the author pointed to the absence of smallholder farms that worsened the shortage—had they remained, there would be more flexible outlets producing pork, and the African Swine Fever would not have exerted such an impact to the economy (J. Liu, 2019).

However, the promoted national discourse goes otherwise. As observed in the African Swine Fever outbreak, pigs on smallholder farms are usually fed household waste, or homemade pig feed that requires some labor cooking pig meal. Whereas in factory farms, pigs are provided with industrialized feed, usually consisting of corn and soy. “We operate differently from smallholder farms—we use soy, corn, fish powder, and essential minerals to make our own feed.” (Anonymous interview with a Guangxi pig farm representative, 2020) A representative from Guangxi Province highlighted that standardized pig farms have controlled pig meal, which is free of pathogen and pollutant. Professionals in news articles also argue that a shift to regulated farms is necessary to prevent foodborne infections (Liu, 2020).

Other than disease outbreak that concluded with a need to penalize smallholders, public health issues also led to the same conclusions. Solutions to environmental problem, food safety issues, and public health crisis operate with hands clasped, but an attempted enhancement in one aspect might lead to a breach in another, which is likely the reason the respective crises in these fields arrived at the same conclusion.

3.1.2 Food Safety Law Enhancement and Backlash

In 2012, *Food Safety Law of the Republic of China* strengthened the existing food safety regulation (国办发, 2012), which included the treatment of diseased pig carcass disposal. Dead bodies were previously recycled to make processed meat products, but the new law closely monitors such misuse, executing strong punishment on the lawbreakers. However, despite the intensified law, designated treatment stations were still scarce and operated on limited capacities. Unable to keep the bodies at home or treat them, an intensive pig farming area dumped over ten thousand diseased pigs in Huangpu River, Shanghai (Deng, 2013). The policy was intended to

tackle food safety issues, but because of the underprepared infrastructure, it ended up as an even bigger environmental as well as public health issue.

The carcasses were attributed to small household farms. Since a CAFO is equipped with its own disposal infrastructure, it is more efficient to treat the bodies inside their farm than paying up to 30,000 yuan for being caught as a polluter. However, the policy works differently for smallholder farmers. Those who raise less than 50 herds are identified as smallholders, and do not enjoy carcass treatment subsidies (L. Wang & Fu, 2013a). Pigs often weigh more than a hundred kilograms, which makes transportation difficult without outside help. Although helpers are available for a fee, but the charge generally surpasses the financial capacity of smallholder farmers. Although the recent policies provided some monetary compensation, the granted amount is still unable to compensate that labor cost.

In addition to insufficient subsidies, the government actively help the consumer side, which further disadvantages the production side. Those who do not reach a certain scale of production bear too much opportunity cost (Rae, 2008), and are vulnerable to any form of sudden changes, from disease outbreaks to the recent whimsical exercise of environmental laws.

To alleviate the problem, the press suggests for an expansion of modern industrial farm. Regulation is more stringent for specialized units, while smaller scale and subsistence farming often evade the officials' radar. Smallholders also find technical reasons for not being able to set manure and carcass treatments in each unit, which makes CAFOs, or at least specialized pig operations more environmentally appealing (Deng, 2013; L. Wang & Fu, 2013a).

As a result, a campaign against smallholders began in a massive scale, forcibly removing husbandry sites and buildings. Coupled with the environmental regulations that prioritized saving

the water net over pig farming activities, many larger-scaled farms did not escape the massive shutdown (兽楼处, 2019). Soon, the practice escalated to an inessential extreme in some region:

an entire area of pig farm were shut down for just a handful of disqualified operations, and some cities even imposed “pig-free” status for themselves, even though they are not officially classified as “pig-ban” areas. This over-interpretation of policies devastated many former pig owners (月霜曼阿罗, 2019), and resulted in unnecessary closures. Although new farms were opening up as the southern farms shrunk, supply was far from enough, since closing a farm is much easier and faster than starting an operation de novo (Lu, 2019).

3.1.3 China’s Response to Repercussion from the Campaigns

Policies with derailed execution and immature direction resulted in a 50% rise in pork price (National Bureau of Statistics, 2019), despite unleashing the frozen pork reserve. This pressed the crisis to a national level (艾莎, 2019), which the central government responded with loosened regulation, and an acknowledgement that the guidance published in 2015 was interpreted too aggressively. Economic subsidies are granted to all households raising pigs, including more lenient insurance and loan policies (国办发, 2016). Problems remain in all level, including smallholders’ leftover feeds (艾莎, 2019) and the CAFOs’ monotonous genome that exposes the whole factory at risk once a single infection appears. Assessing the situation, the government concluded, similar to the experts, that a transition towards industrial farm is imminent in solving the problem. The most recent policy closed its paragraph with calls for an integrated production chain for Dragonhead companies and an expanded output (国办发, 2016).

3.1.4 Discussion

The conflicting prioritization of the environment and pig raising was evident, but the inappropriate executive moves and excessive bureaucratic interpretation should not be overlooked. Policy makers should also expect possibilities of skewed execution when translating articles into practice, and ensure proper on-the-ground activities. National regulations are inevitably vague, and a close partnership with local governmental units are required to reach a fair execution.

Smallholder farmers are devoted less attention, and the lack of resource renders the environmental and health regulation grueling to meet. Improper disease treatment, substandard feeding practices, and lack of labor are all direct result of insufficient capitals. Such condition has resulted in public health crisis among consumers, spread of African Swine Fever disease, and the subsequent pork unavailability. The government's response recognized the smallholders' plight and offered some degree of help, but more importantly, it focuses on scaling up the industrial farms to rid the country's dependence on smallholder farmers.

3.2 Promoting CAFOs

"粮猪安天下。"

--"Grain and pork bring peace over the land."

This old saying opens the *Pig Production Development Guideline* (农业部, 2016, p. 20), marking pork's political importance in China. Among all other kinds of meat product consumed by the Chinese population, pork is chosen as the most important staple protein. Chinese consumers traditionally tie meat consumption with wealth and luxury, even having a "meat

dream" in the 1970s— "my dream was to eat meat." (Schneider, 2011, Schneider, 2017) Pork was kept for special occasions, such as lunar New Year festivals and weddings, which brought families together for the feast (Niu, 2017). The number of personnel engaging in pig-related industries—from production to slaughtering and distribution—adds economic implication to the cultural and political importance.

In 2010, Chinese government published an evaluation system awarding region that produce ample pork. Funds were directed to such areas, which will in turn be used exclusively to fund more pig factories and improve management (财政部, 2010). This statement included a promise to help Dragonhead companies to expand their industry chain, and an integration of production and sales under a single branch. Ministry of Finance directly guides the integration, to promote food safety and combat market volatility (财政部, 2010). This means more market power for Dragonhead companies, with incentives to expand farms size.

Consistent with the guideline in 2010, environmental policies also left rooms for Dragonhead expansion: for example, the document promoting technological solution of manure and pig banishment from southern water webs (Ministry of Agriculture and Rural Affairs of the People's Republic of China, 2015) also promotes an appropriate degree of CAFO expansion; the *Livestock Code* (The National People's Congress of the People's Republic of China, 2005) explicitly noted the need for more industrial animal husbandry sites.

In 2019, the government proposed a guidance statement solely targeting pork production, stating that scaled-up production sites should reach 58% by the year 2020, and 65% by 2025 (国办发, 2019). As an example of promoted business expansion, Sichuan Province, one of the

major pork producing area, is building 13 industrial hog farms. Two point five billion Chinese Yuan are invested, and those CAFOs are projected to provide the market with 2 million more pigs (四川在线, 2019).

CAFOs enable a controlled environment that makes numeric measuring possible, and in such case both rearing and commercial transaction are easier to regulate. The pig market is known for its volatility, partially because of the disease that spread quickly. Other than the most recent African Swine Fever, the , PRRS (Porcine blue-ear disease) outbreak in 2006 also significantly impaired the pig sector in China (Schneider, 2011). In times of shortage, prices soar, which encourage farmers to either increase the sows or expand their operations. But the market would then respond with plummeting pork price because of oversupply, and the farmers that expanded their scale would then have to face a much lower return than they originally expected, some even going bankrupt for their investment (Wu, 2011). Given the relatively long raising-to-selling cycle, immediate responses and remedies are not possible, and it is also extremely hard to discern the optimal timing to invest. These are all concerns from a myriad of scattered smallholders, but all such coordination hardships are alleviated under government-controlled industrial farms. Experts and policy makers agree that that CAFOs both ease the producers' plight and stabilize the pork price for consumers, because they enable planned production, technology application, communication, and resource allocation (Wu, 2011).

Benefits brought by CAFOs explain the government's heavy investment—CAFOs offer structural and regulation convenience unparalleled by other systems. Due to the genetically modified breeds and controlled feeding, the pigs have better meat conversion rate, and produces leaner meat that the consumers appreciate more (de Barcellos et al., 2013). Workers also select

for breeds that convert themselves into industrial meat more efficiently (Interview with an anonymous worker in Shenyang), which repeats the cycle of efficiency. Although this operation monotonizes the genome and standardizes the feed, which make the pork taste uniform and bland, the population seems to weigh more emphasis on daily access than taste.

After all, no matter how much the government intensifies environmental regulation, the non-negotiable line is food security. As suggested in every statement in the environmental laws, the ultimate goal is to improve the competitiveness of the Chinese hog farming industry, and ensure access to pork for households in the long term. Although the middle class is rising, a sizeable number of households still find meat a luxury item, which requires a saturated market and a low-cost production line to achieve satisfactory consumption. Attentive to the short-term needs, the government understandably upholds larger-scale operations every now and then, which soon conflict with environmental standards, which requires another solution.

Keeping a stable and reliable supply of pork is expected both domestically and internationally (Schneider, 2014b). A prevalent international discourse points to the unsustainable, westernized, and meatified diet (Liberti & Parenti, 2018), with Lester Brown being the first to express such concern—"Who will feed China?" His work predicts a possible future that China is unable to produce enough food for its citizen, and relies on imports to sustain the population's need. Such situation would impose significant burden globally, which also associates with concerns of climate change. To justify its ability to feed itself, China has declared grain sufficiency through technological advances, and has been broadcasting such achievements to its citizens as well. Thanks to the expansion of industrial pig units, China was able to digest its soaring demand without turning to substantial pork imports as well (Schneider, 2014).

Recognizing this concern, many industrial farms display their advantage of producing a multitude of pigs in as little space as possible (广西扬翔股份有限公司—科技改变养猪业, n.d.; 拔势崛起，直冲霄汉——余式猪场 5.0 楼房式猪舍面世 集团新闻 四川天兆猪业股份有限公司, n.d.), intending to appeal to the domestic and international population concerned for their ability to feed the Chinese citizens.

Even if self-sufficiency is reached, however, there are still narratives from the environmentally aware community to reduce meat consumption. China is often targeted in the debate as the largest consumer entitled to alleviate environmental damages stemming from diet choices (Niu, 2017; Rossi, n.d.). Perhaps pressured by this discourse, China has modified its new dietary guideline, a new food pavilion that aims to reduce overall meat consumption. It showcases its commitment to reduce carbon emission (Milman & Leavenworth, 2016), but a guideline alone might be difficult to alter the rising middle class' choice for meat. Pledges on the international forum are nonbinding, and negative responses inevitably hit the point of obligation: it is "unfair" (新华网, 2015) that only Chinese people are required to cut back on consumptions, while the western countries still enjoy their animal protein intake. Meat consumption in North America and Europe far exceeds that in Asia (*Agricultural output—Meat consumption—OECD Data*, n.d.), and China is repeatedly requested dietary shifts because of its scale and timing of development. Had development began in the last century, or if China's population were not the third largest in the world, perhaps it would be receiving different amount of attention and opinions.

Watching a ship-full of coal being exported to China, an Australian coal miner said: "…who were we to refuse the Chinse their Industrial Revolution?" (Eriksen, 2016) From a macro-level perspective, it is reasonable to persuade the Chinese population to consume less meat. But it is not ethically convincing, and the final decision right belongs to Chinese consumers. Recognizing both domestic and international voices, the Chinese government needs to regard both sides. Achieving an equilibrium that both fills national demand and keeps its international appearance is another side of exploring the role of future pig farms.

Domestically, the state has used an abundant food supply to justify its role, with confidence and determination. Other than asserting its own right, There is a sentiment of allowing "eating meat in revenge against past scarcity" (Schneider & Sharma, 2014). Food availability is usually compared to the past times of shortages, and scientific advancement, such as Yuan Long Ping's hybrid rice often hailed as China's pride. For the same reason, the modernized and mechanized pig farms are perceived more favorably among consumers (de Barcellos et al., 2013). As stated by people surviving the times of shortage, "meat (pork) signifies wealth." (Schneider, 2014) However, among citizens born after the times of famine, access to pork has become a normal standard, a daily experience taken for granted. For these population, seeing pork vanishing from the stores is equivalent to threatening their accustomed way of life. To keep the promise for the generation of famine and to maintain the normalcy for the generation of satiation, the state strives to maintain pork provision.

3.2.1 Smallholders Integration

The Communist Party of China upholds the goals of a socialist market economy, which offers rewards according to an individual's contribution. Smallholder pig farmers are among the population that contribute substantially through manual labor, and should be provided with

proper incentives, compared to their counterparts in a Capitalist society. In China's model, public ownership is designated as the predominant business model, but private businesses are increasingly encouraged to galvanize the market as well. Upholding equity, rural economic development is also among the Party's agendas, with ambitious measures to fill the income gap, such as increasing direct subsidies for agriculture, and alleviating agricultural tax requirements (中国共产党第十六届中央委员会, 2003).

As the economy develops, it becomes less profitable for household farmers to raise pigs (Jian, 2010). The opportunity cost becomes higher for each pig, and the detriment of a disease outbreak strikes a smaller operation harder compared to either larger units or subsidiary ones (Lapar et al., 2012). Indeed, the recent trend of vanishing smallholder farmers means not only opting out of the industry; sometimes a transition into specialized pig farms changes is the only other way to ensure their survival.

Land ownership is modified for easier land transfer, which means that rentals, partnerships, and contract farming under bigger agribusinesses are easier. Upscaling agricultural businesses are also encouraged (中国共产党第十六届中央委员会, 2003), and population transfer into the urban area has already become a trend (Schneider, 2011). Despite the labor drain, smallholder production still serve as an integral part of overall pork production, and their power limits policy execution or extreme measures (Shimokawa, 2015), despite the hailed transition to CAFO system.

To advocate for smallholder farmers, aids are directed to them, but the package encourages them to expand into specialized farms. Household farms wishing to expand scale are encouraged, and management education are provided for mid- and small-scale pig farms.

Dragonhead industries are advised to lead the expansion and absorb smaller producers in the form of contract farms, which offers them a relatively secured service packet, and expects pig production in return. The guidance also criticized forcible removal of family farms. It offers renewal and assistance instead, and facility upgrade is promoted (国办发, 2019).

Dragonhead industries will increasingly absorb smallholder farmers, termed as "factory + farmer-partnership (公司+农户)." Through partnerships, the Party envisions a centralization of production and sales, technology sharing, as well as communal branding process to help integrate smallholder producers into the vertical CAFO chain (国办发, 2019). The government is essentially creating a new system. Although smallholders might not terminate their own farms, they will be absorbed by CAFOs under contracts, which, depending on the flexibility of policies, completely shifts their way of life.

Under a controlled market outlet, free markets and personal clients will cease to exist; vigorous inspection teams will visit households more frequently for environmental monitoring, and new legal issues surrounding pricing will emerge. Here, I note a difference between the government's projected structure change and the actual practice. In the interview, the representative from Liaoning Province said that although the policy names the partnership between "smallholders" or "farmers" and the Dragonhead companies, they are essentially mid-scale farms with a professional team—much different from what one would understand as individual farmers implied by the guidelines. Although it is only one testimony from the industry, there is likely a bias towards more resource-rich farms. Those who are able to remain in

pig husbandry and partner with industry farms will be bigger in size, or specialize in one raising cycle.

Smallholder farmers are increasingly denied value in multiple scenarios, whether in terms of environmental protection or in a public health frame, or when referring to modernization and development ("The planet needs China to curb its appetite for meat, The planet needs China to curb its appetite for meat," 2019). The government is not attempting to eradicate smallholder farms; instead, it is envisioning an expansion in scale, and an integration into the expanding CAFO system. Therefore, from an economic perspective, large industrial farms will be producing most of China's pork supply. However, it will be a conglomerate of upscaled smallholders contracted under national Dragonheads.

3.3 Conclusion

This chapter examined the shifting policies that responded to environmental problems, diseases, market prices, and pig farmers' livelihood. The difficult balance between environmental protection and large-scale pig farming is hard to achieve, but the government is reacting to problems and envisioning a new system, where CAFOs play a dominant role in the Chinese pig industry under strong environmental regulation. Based on the current picture, the next chapter predicts the possible future market outcome for different sized farms, and offers recommendation to the 2016-2020 pork production guideline.

Chapter 4: Looking Forward

4.1 Introduction

This chapter will predict the future of Chinese hog farming industry. For individual backyard farmers, they will either remain as subsistence farmers without commercial activities, or

opt out of the industry altogether. A small portion of them could either shift towards being small, organic farms, or scale up to establish partnerships with Dragonhead megafarms. Mid-scaled farmers will largely retain their operation, but will be subject to more stringent environmental policies. For existing large-scale Dragonhead firms, they will not become organic, but will continually increase in size, number, and scale in the designated areas. With the government's technological subsidies and facilities to promote more thorough water treatment as well as integration with farmland, it will likely become more environmentally responsible. This chapter will continue to give a suggestion to the 2016-2020 pork production guideline, referencing the current economy, government statements, and precedents in Vietnam.

4.2 Prediction

Following the projection pattern and observing domestic policies, smallholder farmers will continue to decline, but will not cease to exist. As discussed above, the Chinese government has been actively encouraging a transition into industrial hog farms. Among the increasing disadvantage competing against the larger operations, labor shortage is one of the most important reason for former smallholders to abandon the practice. Decades of guidelines preferred urban area to develop at the cost of rural areas (Schneider, 2017b), and migration towards city centers has been easier and encouraged (Qi, 2019). In contrast to long working hours, amount of practical knowledge, and the struggle to combat various market risks, factory jobs in city centers offer much better return compared to investment. Raising pigs is a labor- and resource-intensive practice, but those who are being left in the countryside tend to be the elderly and women. Traditional farming practices, although environmentally friendly, are physically demanding, and households with no labor nor money to employ helpers increasingly struggle to make ends meet while simultaneously fulfill policy requirements.

Pork production and consumption will continue to rise. As the government expedites the expansion of pig megafarms, the lowered cost of production makes pork more easily accessible. That prevalence would then in turn encourage consumption, and turn into a self-enhancing wheel, as observed in precedents from Finland (Vinnari et al., 2010).

In addition to economic reasons that pressures smallholders out of the market, personal choices also reduce pig raising activities. Once the farm scale reaches the brink of personal and specialized farm, the individual bears all environmental degradations from intensive pig farming, and receive little incentive from the government. Families from impoverished areas sometimes have no other choice but to expand to increase earnings, but once the economy develops and household income is allowed from more sources, families will choose to stop pig husbandry for their own well-being. Richer coast side areas are observed to be increasingly abandoning their hog farms, while the economically disadvantaged inland regions still expand their productions for income (Rae, 2008). Therefore, as more areas develop economically, the total number of pigs raising operations will likely diminish (FAO, 1999).

Inadequate infrastructures, empty promises for subsidies, and the insufficient regulations altogether discourage smallholders from competing in the market. Veterinary services, for example, are only loosely exercised in remote areas where it is the most needed. Low-quality vaccination makes people suspicious of the appointed veterinarian, and pigs suffer from preventable diseases. Unreasonable taxes in the slaughtering process (Jian, 2010) and absent help when it comes to treating dead bodies (L. Wang & Fu, 2013b) has in part facilitated public health problems, which has fermented the public's distrust towards smallholders. With damage to public image and economic practices, the current decline is likely to continue in the following years.

Purely subsistence household pig keeping will be free from economic threat, since they do not participate in the market. Since subsistence households usually keep less than five pigs for their own use, I often omit them when discussing the smallholder farmers, but they are still present. Since they produce for themselves, and satisfy their neighbor's occasional consumption needs, their existence is significant in alleviating market pork demand in times of scarcity. Since they are free from market preference and industry control, they are more likely to keep local breeds, and retain cultural practices with greater ease. There is no pressure to purchase industrial feeds to expedite the growth cycle, and no intentional environmental attention is given, since the little amount of waste generated can be naturally handled. They establish personal relationships with their clients, and consumption is associated with high levels of trust and relatedness (de Barcellos et al., 2013). However, backyard pigs are largely kept in households where only children and the elderly are left. In the coming decade, children are more prone to move out of the household for urban opportunities as well as the social shaming of pig raising as a career choice, and backyard pig keeping would become rarer after the elderly pass away.

Households practicing backyard farming are likely to be struggling with poverty. Such households tend to consume less animal protein from the market, with purchasing decisions heavily impacted by seasonal market prices (Jian, 2010). Lower class population mirror the sentiment of people in the last century, but the inaccessibility is because of poverty instead of unavailability. This population would be willing to consume more, if given economic privilege. Since meat is regarded as a luxury gourmet, once their income allows more frequent purchases, people will be more inclined to increase consumption (Schneider, 2014). Western media has expressed concerns on how China adopts western dietary style and "meatify." The amount of resource required to sustain that demand, especially under the unsustainable rearing practices

today, can cause deleterious consequences. Their concern is not ungrounded, given the already upward meat demand curve and the growing economy. It is happening more in the urban area where economic development is encouraged earlier, but largely spreading to rural China, although with fluctuations and recedes (Y. Wang et al., 2007). If rural households consume pork more frequently than several times a year, their own pigs in the backyards will not be enough for their consumption. The statistics for the increase is still debatable, but regardless of the degree, there will be an overall upward consumption curve, with 40% of population residing in the rural area (*China—Rural Population,* n.d.).Therefore, commercial pork purchases will increase in the countryside in the following decades.

The cooperation mode between industrial farms and the smaller scaled farms also inevitably drives up the scale of each individual farm, and outcompetes the remaining smaller operations. In the interview, a pig farm representative from Liaoning disclosed that the contract farms are in the scale of thousands, which are the same sizes as individual mid-sized operations—"those who contract with the large farms are also large—about the same size as our entire farm. Those industrial firms would produce about ten to twenty thousand piglets, and that is only achievable by contracting with ten or twenty farmers. It makes no sense for us to contract with 'smallholder farms,' since we have about the same size, and it'd be more expensive to hire them." (Anonymous interviewee)

"Nonghu,"(农户) or "farmer units," who are the contract farmers that cooperate with the large farms, are essentially mid-sized, specialized pig farms. They are equipped with an expert group in charge of feed provision and vaccination, and are under stringent environmental requirements to be in line with the larger firms' standard (Anonymous interviewee). The significant investment and precondition that select for larger farms still come to disadvantage the

truly small-scaled farms, which again explains why the backyard producers are more likely to quit pig farming altogether (Qiao et al., 2016). Agribusiness firms prefer efficiency, which inevitably choose against truly small-scaled farms, even though the name still appears so in written policies.

It is likely that the smallholder farmers specialize in one field, such as farrow to weaning, or grow to finishing, and become contract farmers under the large agribusinesses. Since most factory farms engage in full-cycle production with an integrated industry chain, it will be difficult for smallholders to compete against them when they need a more laborious investment reaching the same result. When they specialize in a certain area, it will be easier for them to be integrated into the factory farms' operation, which helps them keep their own business but also ward off some market competition under the umbrella. Since the government is also seeking to integrate as many parts of Dragonhead companies' industry chain as possible, reaching for their requirements might be more viable than managing one's own business.

Development and expansion should not, and will not always be the government's narrative. Resource is limited, and there is a general tendency for populations to stabilize at some point (*China*, n.d.-b). Pork consumption will gradually slow down, as seen in other countries (Capps & Park, 2002; Dagevos & Voordouw, 2013; Reisch & Thøgersen, 2015). Dutch consumers associate meat consumption with festivity and luxury as well, but despite this culturally important implication, their consumer base is becoming increasingly flexitarian (Dagevos & Voordouw, 2013). As people's socioeconomic status rise, attention to health problems (Capps & Park, 2002), environmental awareness, and concern about animal welfare will follow (Reisch & Thøgersen, 2015, Dagevos & Voordouw, 2013).

The Chinese middle class is becoming increasingly aware of the health implications associated with different dining styles. There are three phases of meat consumption: the first is consumption based on availability, observed in mid- to late 20th century, when meat is scare in the market. The second phase is consumption allowed by affluence, referring to free purchase if one is willing to pay. This led to "eating in revenge" (Schneider & Sharma, 2014), and now the majority of population is experiencing a third phase, which is eating based on need, taking nutrition and health into consideration. Most people are becoming familiar with how a more meat-heavy diet would lead to diseases such as obesity and increased susceptibility to heart diseases (许 & 杨, 2018).

It is possible that the Chinese citizens will shift their diet like the Dutch's path towards flexitarian, but there are still obstructions. Many still do not associate eating meat with environmental problems (Macdiarmid et al., 2016), and online community still regard the vegan population as hypocritic. Account on the time required for a national dietary transition has been scant, with most researches offering a cross-sectional study (Reisch & Thøgersen, 2015; Vinnari et al., 2010). In a study on Finnish households' meat consuming trends over 40 years, a significant increase of vegetarian population emerged in the 1970s, but the growth stagnated in the following years, reaching about 6% in the total population in 2006 (Vinnari et al., 2010). It is possible that the Chinese urban young would embrace a flexitarian, or plant-based diet as ideologies are imported, but it is also likely that the total vegetarian population remain low even in that situation.

Relating it back to the projected consumption rise among rural households, and considering the sheer population size that still rely on pork to make up 60% of their animal

protein intake (农业部, 2016), import will continue to subsidize the still developing large-scale pig operations (Zarate, 2002). With Chinese pig population devastated by the African Swine Fever, foreign purchase is inevitable. However, as more domestic pig farms are built and the existing CAFOs expand on their efficiency, reliance on the international community will soon be alleviated.

The rare cultural practices of pig slaughter are now seen only uniquely in the countryside, primarily for annual feasts. With farms either scaled up under contracts with companies or moving into the cities, pigs for personal use will increasingly become a luxury. There will be wealthier households directly contacting specialized farms for festive occasions, but for the majority of population, slaughtering pigs for festivals will be a tradition seen more in stories and documentary videos. However, the family gatherings and festivals themselves will remain, and there is an abundant array of alternate food as substitutes. A whole pig might no longer be their main dish, but people will still enjoy the annual family gathering, and the sentiment to serve them with the best food.

4.3 Recommendations

4.3.1 Smallholders

The government recognizes the dwindling smallholder pig farms, and are actively building CAFOs to fill the demand gap. (四川在线, 2019). Since smallholder farmers are the major supplier of pork in the market, their decline has made pork provision increasingly difficult since there are still only a handful of industrial megafarms. However, this move to expand industrial farms would further debilitate smallholder competitiveness, and become a cycle that

repeats itself. To some extent, China envisions and hails this transition into modernity, but it surely does not intend to draw smallholders completely out of the market.

Reshaping the system, namely, attempting to replace traditional farming with the CAFO system, is neither sustainable nor attainable, both economically and environmentally. At the same time, halting the construction of industrial pig farms altogether is not feasible either, especially faced with the growing economy and demand. People's dietary structure is shifting, and there are international trade issues, social longing for meat, and psychological security attached to adequate food supply. Following the government's proposal, I believe that expanding CAFOs while subsidizing lesser scaled farms—keeping them alive and operational in any form—should be upheld, which is already inside the government's published guideline. However, they should also recognize the disconnect between languages in the policy and biased actual practices.

First, in case of partnerships, imported pig breeds should be used carefully. Although consumers today prefer leaner meat, there are Vietnam precedents claiming local or mixed breeds perform better than western Yorkshire (Lemke et al., 2007). The guideline effective from 2016-2020 (农业部, 2016) also discusses the need to breed local Chinese pig strands, instead of being solely reliant on imports. Especially for more remote smallholder sites (Zarate, 2002), social functions might be more important than market performances. Specific taste of local pigs arouses nostalgia and the memory of merry interpersonal relation. Following the standardization of pig feeds, generations familiar with various local strands come to lament the loss of flavor (Liberti & Parenti, 2018), and academics are becoming alarmed about the diminishing biodiversity (Zhang, 2018). From an economic standpoint as well, smallholders are more likely to survive with certain characteristics that distinguish themselves from industrial farms. Focusing

on quality rather than quantity offers them relative advantage in the market, and local breed is one of the prominent privileges seen in the pork outlets. It would solely appeal to consumers in the wealthy, first-tier cities like Beijing and Shanghai, with limited market in developing areas. However, it is still a choice for certain capable smallholder farmers that cannot scale up. Additionally, those areas can be important players in keeping local Chinese pig genomes, establishing more communication with academic institutions. Therefore, the government should divert some more attention to smaller farmers that help maintain genetic diversity, which also keeps the economy vigorous.

Second, the government should ensure that its promised subsidy packages are effective and delivered in the locale. Guidelines include subsidies for promoted pig breeds, economic assistance for high-risk pig raisers, promotion of waste treatment plants, and improved access to medical services—more are directed to large-scale pig farming sites, but some improvements are offered to smaller-scale farmers as well. As of now, veterinary services are either not sound in the remote areas, or the quality of vaccines are compromised, for vaccines are now held for commercial competition. Unlike the modern factory farms that have medical service readily available, the smallholders must discern the quality of medication, and trust is eroding among appointed veterinarian and the farmers (Jian, 2010). Ensuring the pigs' health and establishing a better relationship between the farmers and the veterinarian directly links to food safety, and prevents the mounting costs and waste from locating and slaughtering diseased pigs in cases of disease outbreak. Similarly, costs for dead pig treatments, building infrastructures such as biogas generator and silage sites for getting organic pig feed are strategies that promote sustainable and long-term development (李曼大会, 2019).

Third, the government should encourage smallholders' transition into organic pig farms. Just like how local pig strands (such as "black pigs") are welcomed only by the wealthy upper-class population, organic pigs have limited market appeal in most regions in China, which inevitably sets organic development to the bottom of the list--food safety is the top priority, and luxury consumption can always follow later. However, creating organic operations are also relatively time-sensitive, because it is more likely that smallholder businesses declare bankruptcy than turn themselves into organic farms. Therefore, the government should actively subsidize the smaller farms to help them achieve the designated organic standard, or lax the standard of "organic," catering to the regional differences. Sometimes the

Indeed, one of the disadvantages of smallholder can be modified into their strength. Their choice of feed can prepare them with both economic competitiveness (Lapar et al., 2012) and in organic pork's scenario, qualification for a requirement. Organic farming methods require that pig feeds are not industrially processed and does not contain artificial chemicals, which is achievable by reusing farm waste in regions with excess. Since 70% of smallholder farmers' farming expenditure is spent on purchasing industrial feeds (Huang, 2015), processing their own feed would provide them with significant advantage. Cassava plants and sweet potato silage has long been used among Chinese households, and inexpensive feed processor can be installed in each village for common use. Installing one silage site in a village would be sufficient to generate enough feed for all, and there is already technology that allows silage generation that requires little attention and labor, which also commensurate with the rural reality of reduced labor force.(Dom, 2010; Lapar, 2011). Government subsidies and infrastructure building would empower smallholders in the long run.

The “green” and “organic” pigs are not pursued by the CAFOs, since the sheer quantity of pigs can secure their income. Most organic farms are smaller scaled, raising as little as ten pigs per farm, as the representative from Liaoning Province estimates (Anonymous interviewee). This feature, again, tells them apart from the industrial pig farms. It can also be used in combination with poverty alleviation, which will be discussed in detail later in this chapter.

Lastly, for the emerging specialized household farms, environmental regulation should be enforced rigorously but with proper planning and policy interpretation. According to a report by OECD, manure management costs were the greatest for medium-sized (3,000-5,000 pigs) and the very-large scale farms (over 10,000 pigs), while large-scale farms that produce around 500 pigs annually was the most cost-efficient (Agriculture Trade and the Environment: The Pig Sector, 2003). Although most farms that would develop from smallholders would stagnate at around 500 pigs, medium-sized farms would still be sprouting with increased fund and opportunities in northern China. Since newly expanded farms will not be equipped with infrastructure digesting its own waste, receive proper subsidies, and bear the most waste treatment cost, more attention should be devoted to these newly expanded farms and ensure that enough supervising is offered to keep them environmentally responsible. Either a direct oversight from the government or a more binding partnership with designated CAFOs could serve this purpose, and the executive process should be carried out with care.

4.3.2 Changing CAFOs

Large scale CAFOs should also consider using non-industrial feed. Indeed, the government guideline has already promoted the idea of “agriculture-animal husbandry integration,” and many new modern farms are actively applying the policy into their farm designs. With agricultural lands inside their system, I suggest that they adopt certain level of feed

from farm waste, just as some smallholder farmers' practices. Pigs are omnivorous, so whether the farmland is directed to animal feed material or human crop produce, there will always be useful material available for the pig's diet. It creates more employment opportunities, and is more cost-efficient.

The Chinese government envisions a reduced farming population, substituting the pig farmers with machines instead. It holds American agriculture style as an ideal—mass automation coupled with small farmer size. In this regard, CAFO serves as a great system to adopt, which is compact in nature and requires fewer human laborers. However, the small amount of labor comes to limit any use of nonindustrial feeds, which requires certain degree of manpower. Processed feeds are chosen, because they are simpler, and the labor to make such feed is exported outside of the farms (Lapar, 2011). It contains soy or corn meal and essential minerals, and the pigs would grow even without chemicals that stimulate their growth, according to the spokesperson from Liaoning Province (Anonymous interviewee). However, I still contend that CAFOs should integrate traditional feeds, for the following reasons.

First, using agricultural by-products and waste materials corresponds with the policy to reduce food waste. Although the present policy focuses predominantly on the consumers' end, there are spotlights cast on the production phase, such as allowing more "ugly" products to circulate in the market and bettering storages. But the potential of harnessing agricultural waste should not be overlooked. Making use of material that would otherwise go to waste adds value to the integrated farmland-animal feedlot system, and discharges less pollution and waste outwards, since much of the reusable "excess" would be digested within the system.

Second, enriching the feed source attracts economic opportunities. There is an emerging community of Chinese upper-middle class consumers who demand luxury food items. It can be

observed from the CSA (Community Supported Agriculture) movement, which supports direct interaction between consumers and producers. Among the sprouting organizations, the most salient is *Shared Harvest* (农场简介, 2017), which also produced local, organic pig breeds in its developmental phase. Although the spokesperson stated that industrial feed contains just the same essential nutrition as traditionally processed feed (Anonymous interviewee), feed processed at a minimal degree always appeal to the consumers differently. A population of upper-class consumers today are increasingly attracted to labels cueing at "green," "organic," and "certified," and having a heightened awareness for public health. Therefore, labelling it in terms of bettered pig health, or relating it with nationalistic sentiment would possibly resonate with consumers.

Third, homemade feeds promote employment and improve economic resilience. Increasing staffing in CAFO is not necessarily negating its advantage. The "excess" labor that previously practiced smallholder pig farming is usually forced into the cities as migrant workers, since there is little labor demand inside CAFOs. With the new feeding scheme in operation, more people would find an alternative livelihood closer to home. They will be able to perform familiar skills, and offer better technical observation and feedbacks to the operation, making full use of the local knowledge. Collaboration can take many forms, and it is not always the enterprises that offer help to smallholder farmers.

Self-made feed also fits with the narrative of food-sufficiency. Although food-sufficiency largely refers to grain sufficiency today (Schneider, 2014a), is likely to expand to the pork industry in the near future, especially given its extensive reliance on foreign imports. At present, any fluctuation from the supply side would exert an influence on the market, and increasing the proportion of natural feed would decrease the volatility. Stabilized price would benefit both the

producers and the consumers, and even reducing the burden of soy farmers, who are largely impacted by the government-subsidized imported soy that floods the market.

Fourth, homemade feed is a more environmentally friendly solution. Brazil is replacing its forests with soy plantations—environmental sacrifice must be made somewhere to sustain the system, and if not in China, less economically advantaged population from other countries would trade their environment for income. Observing the changes on a global level, there is essentially no change in the amount of environmental degradation, and the only remedy is to change the production mode. Given the efficiency and ease of regulation, industrial operations will not halt the use of industrial feed. But since they are operating in large numbers, if more farms replace industrial feed with farm waste feed, it will alleviate the global environmental pressure.

Fifth, replacing up to 50% of industrial feed with potato silages have been proven commercially viable (Dom, 2009). In the study carried out in Papua New Guinea, there were no significant difference in total weight gain, average daily gain, or feed conversion ratio of the diets. Digestibility and growth performance were not affected in growing pigs, either, which is also effective in long-term situations. In addition, the study is carried out in metabolic cages that restrict the pigs' mobility, which makes the conclusion more applicable to CAFOs, since pigs in CAFOs hardly have a chance to roam. Silage technology can be undertaken indoor by manpower or by machine, enabling all sites to meet the requirement. Again, it is not realistic to eliminate industrial feeds, but replacing it by up to 50% is still a considerable difference if scaled up.

The Chinese public would be able to afford the raised cost. Decades ago, imported goods signified good quality and reliability (Hanser & Li, 2015), but the magical appeal is reduced today. Consumers increasingly acknowledge the higher quality that specialized domestic producers provide, and many are more trusting of local farmers, which is a sizeable market to

explore. Although there is a general preference for leaner meat, there will always be a population responding to luxurious, quality food option. Regional difference should also be considered, as the representative stated: “Southerner like fatty pork more, because they use it to make dried bacon sausages. With fatty pork you get 3 kilograms but from leaner pork you’d only get 2. But yes, it’s true that the northern population prefer the leaner imported strand.” (Anonymous interviewee, also see map 1). Therefore, even though a diverse feed would increase the labor cost and thus elevate the price, there will be demand, and the multimodal CAFOs can be replicated in various regions with their own suitable crop. In addition, it is also unrealistic that all operations become luxurious pork producers, so people of different socioeconomic status can prioritize different priorities when choosing their daily meat.

Containing hog farming in water-rich areas is an advisable path to continue. However, new farms should not be created too far north, such as Heilongjiang. Although the problem of water and population is less of a concern, it is ultimately more resource-intensive when taking the winter heating and pork transportation into account. Therefore, exploring new sites in Inner Mongolia, Liaoning, and some western regions such as Ningxia can be executed more expansively.

Veterinary packages and environmental checks should be undertaken vigorously. Since the indiscriminate shutting down of farms, the government has published a precaution against such blind execution, and demanded that any closing down of a farm should be supplied with a new site to continue business operation. The recommended sites also enjoy better subsidies, so large farms in the north will continue to grow both in size and scale. A careful environmental assessment and medical package should parallel the economic advantage—the best way to cope with pollution is effective prevention. Rather than planning for technological development to

treat the polluted sites in the future, it is more efficient to slow down the expansion and wait for each branch's maturation.

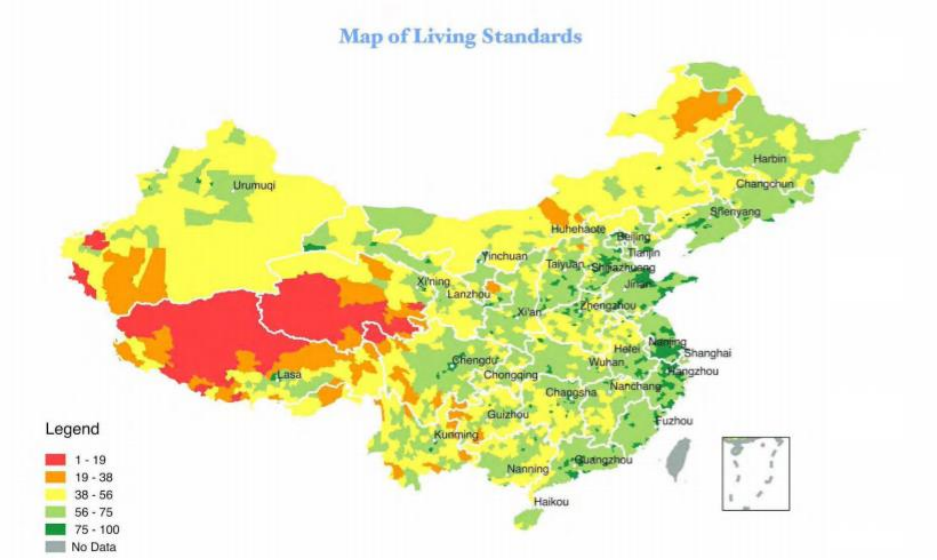
There are many viable policies already proposed on the national level. The problem of scale comes into the discussion, and the extent to which guidelines can be exercised on a local level determines the immediacy and efficacy of the proposed solutions. Coordination among different levels of government, as well as inadequate feedback systems (Yasuda, 2015) increase the difficulty of execution. Instant remedies are impossible, neither are the policies designed perfectly, with the government expressing uncertainties and fluctuations as different concerns appear on the agenda. Local adaptations should be flexibly installed, and communication among different levels and regulation bodies should occur in a timely fashion to amend the guidelines and better meet people's needs.

4.3.3 Partnership with FAO

The FAO (Food and Agriculture Organization of the United Nation) has published a partnership with China, tackling five project areas covering human rights, conservation, and food security. In the collaboration program, the ECTAD (Emergency Center for Transboundary Diseases) China program has helped alleviate the African Swine Fever. Its poverty alleviation program can be linked to creating hog farms in mountainous, less developed areas, as directed by the government's guideline (农业部, 2016). Although it is possible to build larger factory farms in mountainous regions—in fact, one of the most intensive pig mansions is built in the mountains (Patton, 2018)—it is also more sensible to develop free-range, or organic pig raising operations in the mountains. Since population is scarce and natural vegetation is relatively abundant in such areas, pigs can roam around and feed on wild crops as they did in the past (Xiang, 2018; 贾,

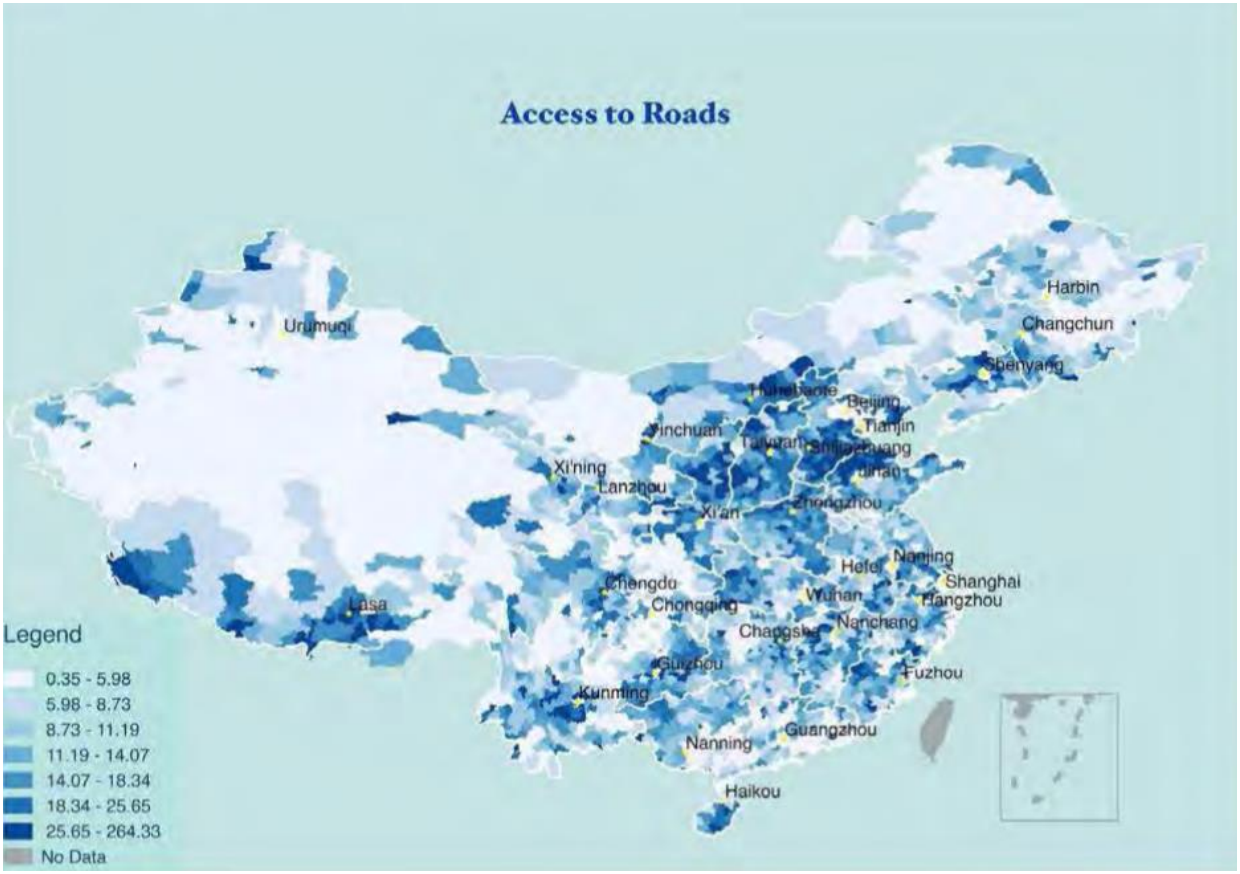
544). As stated earlier, locales lacking access to industrial feed can turn this disadvantage into an asset.

Pig raising can alleviate poverty. Among the areas designated to expand pig production like Qinghai, Xizang, and Ningxia (农业部, 2016), some are rather impoverished areas, with inadequate infrastructure including road and water pipe access (*The Living Standards Dimension of the Human Development Index: Measuring Poverty with Big Data | UNDP in China*, 2016). Expanding their farming operation would necessarily be coupled with transportation outwards, or more commercial exchange with the surrounding regions. To operate pig raising sites inevitably invites traffic access towards the county, with pig sow provision and market access, as well as regular environmental supervision. Coupling pig production with road building, increased electricity and water coverage, as well as other sanitary installment will benefit the impoverished region holistically.



Map 3: Living Standards in China[5]

[5] Retrieved from (*The Living Standards Dimension of the Human Development Index: Measuring Poverty with Big Data | UNDP in China*, 2016)



Map 4: Access to Roads in China

As shown above, the potential production area and moderate development areas coincide with the still underdeveloped area needing infrastructure. As areas like Yunnan, Guangxi, Guizhou, and Gansu adopt moderate pig farming, poverty reduction campaign can be carried out simultaneously.

Additionally, organic pig farming will not endanger the local landscape. First, environmental requirement for achieving organic is more stringent than standard farming, including proper water discharging and manure treatment. The government is also actively promoting technological solution, which farms in the scenic areas would benefit from. Second, the farms can maintain a smaller size, allowing their integration into the surrounding nature. The

consumer base demands quality than quantity, and taste over price. It is also uncommon that such consumers establish personal connection with pig growers, and perform direct exchanges (农场简介, 2017, DuBois, 2019), protecting them against business threats.

Expanding on the possibilities of economic development, there is potential for agricultural tourism as well. Given the ethnic novelty that commensurate with developmental sites, it can be combined with the infrastructure projects to bring traffic and attention, which would subsequently contribute to bettered overall economy. As the rural experience become rarer, people begin to actively seek for authentic countryside experiences in their leisure time. Those sites tend to be accessible from city centers by car, and be within a reasonable travel time. Some CSA (Community Supported Agriculture) partners would hold weekly programs to encourage people to "feel the nature" and "go back to the farmlands." However, this possibility is only applicable to sites with proper infrastructure setup, as well as villages that are relatively easy to access. Additionally, since some labor should be diverted to catering the incoming urban tourists, such places should have some extent of excess labor to sustain the business. Some population will benefit more: a minority experience and uniqueness adds incentives for people to visit. The majority group of ethnic Han people tend to relate minority ethnic groups as "outsiders," or those who are "exotic" and somehow connect better with the nature (Sautman, 1997), and seek their unique experiences when travelling. Coincidentally, the mountainous regions where the government promotes CAFOs are where such ethnic groups reside. Although agricultural tourism suffers from geographical constraint, the novel nature inherent in the practitioners themselves would make the business distinct and viable.

Relating back to the FAO partnership, there will be technical assistance, funds, and advice from the FAO cohort to conserve biodiversity, reduce poverty, and harness resources

more efficiently. Such programs would attract more funds by integrating many aspects of their service areas, and more importantly create a working environment that would sustain itself and continue to benefit the practitioners after FAO program ends.

4.3.4 Referencing Observations from Vietnam

Just like China, Vietnam lists pork as their major source of animal protein intake, which now comprises 77% of the total meat produced nationally (GSO Vietnam, 2007). Also transitioning towards modernization and mechanization, their government has published an overt promotion for large-scale hog farms, pushing traditional farms into disadvantage (Tisdell, 2009). Despite its aggressive policy support, an estimated 80% of national pig population were still raised under smallholder farmers (FAO, 2005), which still keeps its local breeds (Roessler et al., 2009).

However, the literature does not agree with the government on its scheme to eventually replace smallholder farms with factory farms (Lapar et al., 2012; Lemke et al., 2007; Roessler et al., 2009). Although business is becoming difficult for small-scale farms, it still costs less to raise a pig in mid-sized hog farms compared to CAFOs (Tisdell, 2009). In addition, profit margin increases when local pig breeds are used, which keeps smallholders' competitiveness, and preserves biodiversity in the long run (Lemke et al., 2007). Drawing from this research, China should reconsider its farm size expansion, scaling up the farming practices but not to the extent that regulation and costs become unmanageable.

Keeping the efficient domestic strand, receiving education on feeding practices, and improving access to veterinary services can all improve the biological and economic efficiency of smallholder farmers (Lemke et al., 2007). A report shows flexible formal and informal partnerships among small, mid-sized and industrial hog producers, each specializing in different

pig raising phases, as well as relationships with market outlets (Costales et al., 2006). Participants of different production models each prefer a different cooperation style (Costales et al., 2006), but the general partnership among farms of different sizes is depicted optimistically. Overly detailed regulation is impossible to execute in China, given its scale and immature bureaucratic processes. Informal economic transaction will also be an indispensable economic force as it has always been, and it serves to eventually better the mainstream economy. Therefore, relative informal relationships and laxed monitoring should be tolerated. Although regulation and food safety problems would still be a lurking problem, if the hard measures such as disease control and environmental criteria are strictly enforced, perhaps some degree of regulatory freedom in transaction and collaboration is better than being overly concerned. Since the government is ultimately pursuing a minimized number of small-scaled backyard farms even if the name of cooperation promotes them, therefore the remaining scales is debatable. As discussed above, the current cooperation mode has a tacit bias that selects for larger smallholders, which might be the government's hidden statement or a potential unintended consequence that would be reconsidered in the executive level. If the latter is true, the cooperation or competition among the differently sized farms should be planned to make a more equitable competition ground, which allows more smallholders to survive.

As observed from the Vietnamese cases, the Chinse government should focus on four main areas: first, they should ensure that partnerships with companies do not serve to overpower local pig breeds. Foreign genotype has become much more prevalent than the local strand, which might offer better feed efficiency, but the biological and cultural importance of local pigs should not be abandoned. Second, a better connection among different sizes of farms should be established. Vietnamese smallholder farms are smaller in size compared to Chinese counterparts,

and are predicted to retain a decelerated growth curve (Lapar et al., 2012). Therefore, there are more opportunities for different-sized farms to cooperate. The Chinese government, especially on the provincial and county level, should learn from the collaboration projects in Vietnamese villages to gain an insight on flexible management. The surface level "smallholder-Dragonhead cooperation" selects for only privileged operations, leaving no room for the truly small backyard farms. Opportunities should be created for those farms to participate and benefit from the production. Third, an increased academic communication—whether internationally or domestically, should be listed on the agenda. Although there are academic consultants in the larger hog farms, little attention is devoted to researches of the smallholder operations. Much of Vietnamese village models come from partnership with German researchers, recording the current state of smallholder sites, and offering improvements to the development.

4.4 Conclusion

This chapter offered the prediction of China's hog industry, as well as changes to the 2016-2020 Pig Raising Guideline. I referenced Vietnamese cases, and proposed modifications for both smallholder and CAFO farming systems.

Quoting a comment from a mid-scaled pig farm representative in Liaoning, "the environment is getting better—we can already see cranes and wild chicken around our pig lots. There has not been cranes for years, and I think it is the improving water treatment that restored the nearby ecosystem. Environmental laws will impose inconvenience for us individual operators for sure, but it would benefit the environment in the long run." (Anonymous interviewee)

I am hopeful that the Chinese CAFO system will find a balance between the environment and its population's daily well-being. That the system is developing also means that it is open to a multitude of modification, and such uncertainty is welcome and exciting. There is no perfect

solution that invites every party onto the forum equally, but under coordination and careful planning, there should be an alternative that encircles the existing center and periphery, the powerful and the marginalized.

Appendix

Questions asked in the phone call

1. What is the scale of your feeding operation?
    a. (As Dragonhead industries,) do you cooperate with smallholder farmers?
2. What kind of feed do you use in your raising lot?
    a. Do you have a vegetable farm integrated inside your farming lot?
    b. Is it viable to self-produce feed?
3. Which is more constraining, environmental policies or food safety regulations?
4. How do you dispose pig carcasses and manure?
    a. How are manure used, do you sell it to farmers or treat it in-house?
5. How do you think about the prospect of “green” and “organic” labels?
    a. Do you intend to develop into such modes?

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