

# Intensified Smallholder Pig Farming in Rural Yunnan: Implications for Livelihood, Culture, Gender, Health and Environment

Jing Fang\*

Institute for Health Sciences, Kunming Medical University, Kunming, China

Email: \*fangjing07@126.com

**How to cite this paper:** Fang, J. (2022). Intensified Smallholder Pig Farming in Rural Yunnan: Implications for Livelihood, Culture, Gender, Health and Environment. *Open Journal of Social Sciences*, 10, 55-67. <https://doi.org/10.4236/jss.2022.108004>

**Received:** June 7, 2022

**Accepted:** July 26, 2022

**Published:** July 29, 2022

Copyright © 2022 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

The aim of this paper is to draw the attention of policy makers and research communities to the critical but often ignored relationships between intensified smallholder pig farming, livelihood, poverty alleviation, culture, gender, health and environment in mountainous areas of Yunnan Province, China. It documents changes in how pigs are farmed in one county of Yunnan over the last four decades and analyzes the impact of pig rearing on local livelihood, culture and gender as well as its implications for health and environment. It concludes that modern pig rearing techniques that are intended to be used in large-scale industry pig farming operations have been partially adopted by poor farmers in smallholder pig farming settings, and this has generated a wide spectrum of different pig production systems and also changed disease risks associated with pig farming. It is hard to predict and manage the risks given the rapid, diverse, complex and dynamic changes in the intensified smallholder pig farming systems. The environmental pollution associated with these pig production systems is also different to that caused by major pig production companies, and also calls for new management approaches.

## Keywords

Intensified Pig Farming, Smallholders, Livelihood, Culture and Gender, Health Implications, Environment Implications

## 1. Introduction

China is the biggest producer and consumer of pork in the world (Maksym, Chemerys, Dushka et al., 2020). Farmers in China have a long history and tradition of pig rearing (Holdaway, 2022) and pig farming is an important livelihood strategy that provides cash income, animal protein, and manure for many far-

mer households. In the last four decades, driven by rapid socioeconomic development and advances in agricultural technology, pig farming in China has been moving from a natural and subsistent activity to a more intensified and commercialized system in which modern livestock production technology such as new pig breeds, artificial insemination (AI), industrially produced feed, and vaccination and veterinary drugs, particularly antibiotics, are widely applied to boost livestock productivity. These changes have and will have profound implications for the livelihood, health and environment of local farmers and the health and environment of the general public.

Using data collected from fieldwork conducted in one mountainous and former poverty-stricken county<sup>1</sup> (L County) in Yunnan Province, China, this paper firstly describes the changes that have occurred in the pig farming methods of smallholder farmers, and then analyzes the impact of pig farming on the livelihood, culture and gender of local farmers, and finally discusses the implications of intensified pig farming for health and environment at local level and beyond.

The aim of this paper is to draw the attention of policy makers and research communities to the critical but often ignored relationships between intensified smallholder pig farming, livelihood, culture, gender, health and environment in mountainous areas, through an in-depth case study of L County.

The first part of the paper provides a narrative of how pig farming has changed over the last four decades in this county. The second part is an analysis of the impact of pig farming on the livelihood, culture and gender of local farmers as well as the roles played by rural to urban migration, market price fluctuations, epidemic diseases, land use changes, and urbanization in the changes to pig farming. The third part discusses the impact of intensified pig farming on health and environment, including pig-related zoonotic diseases, antimicrobial resistance, water, air and soil pollution by pig manure, and food safety issues caused by the residues of veterinary drugs and other additives.

## 2. Data Sources and Methods

Data used in this paper came from two main sources: qualitative research and quantitative research. Qualitative research is a number of interviews with farmers, vets and butchers conducted in three townships of L County in 2013 that mainly focused on the history of local pig farming and the changes that have occurred, including epidemics and the provision of veterinary services. 58 interviews and 16 in-depth interviews were conducted with various stakeholders. Quantitative research is two household questionnaire surveys conducted in 2014-2015 and 2016 respectively. In the 2014-2015 survey, 390 pig farmers in 8 villages of four townships in the county were interviewed by means of a questionnaire in August 2014 and April 2015; in the 2016 survey, 450 farmer households in the same villages and townships were surveyed again by means of a sim-

<sup>1</sup>L county was one of the 88 listed poor counties in Yunnan and in February 2021, the Chinese government announced that all of its poverty-stricken counties have been lifted out of poverty, thus we use the term “former poor county” in this paper.

ilar questionnaire. The two surveys focused on farmers' knowledge of, attitude to, and use of antibiotics, as well as pig rearing practices such as feeding and cleaning. Therefore, the research methodology of this paper can be described as an integrated approach using both quantitative and qualitative methods. However, not all data from the two studies were used in this paper. Author was the principal investigator (PI) and co-PIs for the two studies and heavily involved in the fieldwork and frequently travelled to the county during 2013-2016, therefore observational data was also obtained during those field visits.

### 3. Results

#### 3.1. The Changing Pig Farming in L County

L County is a mountainous county in Yunnan Province of China covering a total area of 4234 square kilometers. It is a former poverty-stricken county with a concentrated ethnic minority population. By November 1<sup>st</sup> 2020, it had a residential population of 378,881 (*Statistical Bureau of Kunming City, 2021*), whose livelihood mainly depends on agricultural production, including crop plantation and livestock rearing. In the latter case, pig rearing is one of the traditional production activities and has lasted for thousands of years. It remains a critical contributor to the local economy. In 2020, the county raised one million head of pigs, representing a per capita average of 2.6 pigs, per residential person and produced 80,035 tons of pork generating revenues of 1.246 billion RMB (*The People's Government Office of L County, 2021*). However, this traditional activity has experienced tremendous changes in the last four decades. In the 1970s almost every rural household in the county raised pigs, usually two: one for consumption and another for selling to raise the cash to buy family necessities such as salt and cloth and to support children attending school. The breed was an indigenous one with black hair and more fat, and usually took one year to raise for slaughtering during Chinese New Year. The feed for the pigs was wild vegetables and plants, which required the family members, usually women and children, to collect and prepare. This included cutting and sometimes cooking, bulked by rice bran or cornmeal or food residues if available. Cooking the pig feed often required the use of firewood or other fuel such as straw. Pig manure was important fertilizer for the fields and in order to produce more volume and also to keep pigs warm in the winter farmers used straw as bedding in the pigpen to collect pig urine and feces. The pigpen became a small compost unit. The rotted straw would be cleaned and moved to the fields after a few months, so the pigs stayed in a warm and damp but unhygienic environment. In terms of disease prevention and treatment, there was no vaccination and few drugs were available. In general, pig farming at that time was labour-intensive work with minimal inputs of cash and drugs, and the numbers raised by each farming household was limited to 1 or 2 beasts.

After economic reform began in 1978, tremendous changes occurred in agricultural production. Pig farming was actively promoted by the government, both

to meet the increasing market demanding for pork and to increase farmers' cash income as a means of poverty alleviation. Like many other counties in Yunnan, pig farming in L County has experienced many changes since then. New foreign pig breeds were introduced by the government's agricultural extension system. The hybrid foreign pigs can grow faster and produce more meat than the traditional local pigs, and thus can generate more and quicker revenues. In the past, farmers could only raise one batch of pigs but now, due to the shorter growing-period of the new pig breeds, they can raise 2 - 3 batches of pigs per year. Pig breeding methods have also changed from natural mating to the co-existence of AI and natural mating. Farmers can buy frozen pig semen from the Livestock and Veterinary Stations for AI, or request the services of a vet, while some farmers still keep boars for natural breeding. In addition, many farmers buy piglets directly from major pig production companies and do not reproduce pigs on their farms; these piglets are raised for 4 - 5 months and then sold. The new hybrid pig breed has gradually replaced the traditional local pig. Nowadays, it is hard to find the traditional breed even in very remote villages in this county. The number of pigs raised by each farming family has also increased from 1 - 2 to 5 - 6 beasts or even more than 10, and pig density in farming villages has also greatly increased. According to our questionnaire survey, the average pig number raised by the 390 surveyed households was 36 in 2014-2015. Farmers who keep more than 30 pigs were classified as "scale farmers" or "specialized pig farmers" according to government statistical criteria at that time. **Table 1** shows the numbers of the two types of pig farmers among the 390 surveyed households and we can see that 79% of farmers were small holders with less than 30 pigs.

A larger number of pigs lead to a requirement for more space, and some farmers have even used their very limited areas of rice paddy to build pigpens. Some pig farms have been built on slopes and hillsides due to the limited availability of flat land in this mountainous county. Since the late 1980s, pig feed has shifted from homemade to factory-produced. Almost every surveyed farmer said that they feed their pigs with factory-produced pig feed, with some using the feed for the whole production cycle while others use the feed for 1 - 2 months or mix it with grain such as corn. Most farmers think the factory-produced pig feed is good for piglets to grow their skeleton and bone, so they will feed pigs with the factory-produced pig feed for 1 - 2 months. One positive change associated with the feed change is the reduced labour input from farmers, particularly from women who are usually the family members who collect and prepare pig food.

**Table 1.** The average pig numbers in the 390 surveyed households during 2014-2015.

Types of Pig farmers	n	%	Total pigs	Pigs per household
Smallholder	309	79	3118	10
Scale farmers	81	21	10,761	133
Total	390	100.0	13,879	36

However, the cash input of pig rearing has grown significantly compared with the past since many inputs now have to be bought from market rather than being self-produced; this includes piglets and feed. In high pig price years, some women cannot afford to buy piglets and they will stop pig rearing until the price drops to an affordable level.

Pig disease epidemics also have huge impact on pig farming. When a pig epidemic occurs many pigs will die or be sold or slaughtered and farmers will stop pig rearing for a period of time. This results in dramatic shifts in pig numbers from year to year; for instance, in the 2014-2015 survey the average pig number per farmer household was 36 heads, while in 2016 survey in those same villages the average pig number had fallen to 12, with smallholder farmer still the dominant group (**Table 2**). Nevertheless, current pig numbers per farmer household even in low years are still much greater than in the past, which results in high pig density in villages.

The traditional pigpen that used straw as bedding was considered unhygienic and was changed after the “Hygienic Pig Sty” was promoted by the agricultural extension system as part of the modern pig raising approach. Most of what are known as Hygienic Pig Sties in the county are small shelters built with bricks and cement with a cement floor that is easy to hose down. Most pig farmers, particularly scale farmers, use hygienic pigpens while 22.3% of the smallholder farmers still use straw as bedding in the winter in order to obtain more manure fertilizer (**Table 3**).

Increasing pig density and the mono-breed have led to an increase in pig diseases. Farmers reported that although the new foreign hybrid pigs grow faster and produce more meat, they are also more vulnerable than the traditional local variety to diseases and they are particularly sensitive to sunburn and heat. In addition, the number and frequency of pig diseases has increased since 2006. More than 20 common infectious pig diseases were cited by interviewees, some of which are re-emerging diseases such as swine erysipelas. At the time we conducted the survey, African Swine Fever (ASF) had not yet spread into China and thus was not mentioned by farmers. However, in August 2018, the first ASF case was confirmed in northeast China ([Wang et al., 2018](#)) and since then the disease has spread rapidly to other provinces, caused farmers economic losses, reduced pig farming, and led to a rise in pork price.

In order to prevent infectious diseases, pig vaccination has been actively promoted, especially after several major epidemics such as foot and mouth disease, porcine lung disease, and blue ear disease. Three pig vaccines are compulsory

**Table 2.** The average pig numbers in the 450 surveyed households in 2016.

	n	%	Total pigs	Pigs per household
Smallholders	416	92.5	2710	7
Scale farmers	34	7.5	2550	75
Total	450	100.0	5260	12

**Table 3.** The pigpen types of the 390 surveyed farmer households during 2014-2015.

Types of pigpen	smallholders	Scale farmers	Total	$\chi^2$	<i>P</i>
Traditional	68	0	68	22.267	<0.001
Hygienic	239	83	322		
Total	307	83	390		

and provided free of charge by the government—those against foot and mouth disease, highly pathogenic porcine blue-ear disease and swine fever. Farmers only pay vets a small fee for the syringe and injection. There are also other pig disease vaccines, which are not free, therefore only those who can afford them use these vaccines; these are usually large-scale pig production companies. The research and development of pig disease vaccines has become a rising industry in China.

At the same time, the use of veterinary drugs has also greatly increased, of which antibiotics represent a large share. A recent study estimated that 52% of all antibiotics produced in China were used in animals, both to prevent/treat diseases and to promote growth (Zhang et al., 2015). Our household survey conducted in 2014-2015 revealed that 77.2% farmers reported that they had bought and used antibiotics in pigs for disease prevention and treatment without a vet prescription (Table 4).

### 3.2. The Impact of Pig Farming on the Livelihood, Culture and Gender of Local Farmers

Pig farming has a long history in L County and it is a crucial part of the lifestyle of many farmers. Many farmers cannot tell when they began pig farming because raising pigs was part of their life from birth. Despite the tremendous changes in pig farming, pig rearing continues to play an important and multiple roles in local farmers' lives. It is an important income source for many farmer households, and particularly for women. One paper reported that in this county, 70% of rural household incomes come from animal husbandry, of which pig farming accounts for 50% (Feng, 2015). Pig farming also provides important animal protein and fat for farmer households. The majority of the local farmers still raise pigs for their own consumption in addition to the pigs raised for income, and many farmers feed the former in a different way to the latter. They give those for their own consumption more grain and fodder while the pigs for sale are given more factory-produced feed.

The reasons for this are mainly the different flavour of the two types of pork, and also a concern for food safety. Almost all farmers reported that the pork from pigs fed with more traditional pig food is much tastier than those fed with industry-produced feed. Some farmers, most of them women, also think the pork from pigs fed with factory-produced feed can cause overweight and obesity in people, and they think it is not healthy to eat such pork. Some farmer families do not rely on pig farming for income, but they still raise 1 - 2 pigs each year for

**Table 4.** Self-reported antibiotic use in pigs of the 390 farmer households surveyed in 2014-2015.

Types of pig farmers	Use antibiotics in pigs without vet prescription		Never use antibiotics in pigs without vet prescription		Total		$\chi^2$	<i>P</i>
	N	%	N	%	n	%		
	Smallholders	232	75.6	75	24.4	307		
Scale farmers	69	83.1	14	16.9	83	100		
Total	301	77.2	89	22.8	390	100		

their own consumption. This is particularly popular among older farmers who can supply “home-grown” pork to their children who are often working in cities or urban areas and no longer involved in farming. For these older people, pig rearing is a symbol to show that they are still useful and making a contribution to their families. Pork is also an essential dish for key festivals such as Chinese New Year and important family events such as wedding and funeral feasts. As in many other counties in Yunnan, each family will slaughter at least one pig during the Chinese New Year festivities, and hold a banquet in their village to which relatives and friends will be invited. This is called “Shazhufan”, meaning “slaughtered pig meals”. “Shazhufan” provides an important opportunity for relatives and friends to gather together, to communicate with each other and to build relationships and social networks, which is very important in Chinese society. Some families do not raise pigs and thus have no “home-grown” pork for their “Shazhufan”. They will therefore buy a pig for the event. So pig rearing is not only an economic activity but also an activity that is very meaningful on a socio-cultural level.

Some farmers said they might only earn 100 - 200 Yuan from each raised pig, which is the equivalent to the wages for only 2 - 3 days’ work in the local labour market. The economic benefit from pig rearing is too small to earn a living; however, the local people still want to raise pigs. This demonstrates that pig rearing in L county is not only an economic activity but also a cultural practice. The study conducted by Wang Yulin and colleagues in 25 counties in Sichuan Province revealed that economic efficiency had no significant impact on the importance of pig rearing to smallholder farmers (Wang et al., 2015), which is similar to our findings in L county. Our research provides an explanation of the underlying reasons behind this phenomenon.

Pig farming is also a gendered activity since more women than men raise pigs, but the owners of big pig farms are usually men. Most women are smallholder or backyard pig farmers who are more vulnerable to outbreaks of disease and pig price fluctuations. For example, in summer of 2016 many women gave up pig rearing. They could not afford to buy piglets because of the high price. However, they will start pig rearing again once the price drops to an affordable level. Therefore, their withdrawal is not permanent but temporary, and their pig rearing is very dynamic.

Pig farming is also an age-biased activity: most of the smallholder pig farmers in this county are middle-aged or older farmers. The average age of the pig farmers in our household survey during 2014-2015 was 47.6, and in the survey of 2016 it was 50. Most young people have migrated into cities and the few who remain are generally not interested in pig rearing. Some villages are close to the county town where farmland has been requisitioned by the government for urbanization; farmers in these villages have less land to build pigpens and grow crops. As a result some farmers have given up pig farming, which has a more negative impact on the livelihood of older farmers, because they rely more on pig rearing for their livelihood than younger farmers.

### 3.3. The Impact of Pig Farming on Health and the Environment

Both international and domestic research demonstrates that pig farming is associated with bacterial, virus and parasitic zoonotic diseases such as Japanese encephalitis, Nipa virus infection, flu, cysticercosis, hydatid disease and leptospirosis (Lindahl, 2012), and the transmission of antimicrobial-resistant bacteria between pigs and human (Randad, Larsen, Kaya et al., 2021). Pig farming is also associated with emerging infectious diseases (Witte et al., 2007; Nunez-Avellaneda, Cetina-Trejo, Zamudio-Moreno et al., 2021). The outbreak of Nipa virus infection among swine farm workers in Malaysia and Singapore in 1998 is a typical example of this phenomenon. A study conducted in two regions of Nepal found out that both pigs and farmers had extremely high infection rates of parasitic diseases including protozoa, blastocystis hominis, eimeria spp, hookworm and Ascaris suum, and that more than 50% of pigs were infected with multiple parasites (Shrestha et al., 2014).

In China, studies have also revealed high rates of infectious disease among pig populations, some of which have caused human infection and even death. For example, a study collected sero and liver samples from pig herds in suburbs of Beijing and found an alarming prevalence of hepatitis E (47.5% - 100%), in which the seropositive rate was 76.6% for pig herds from large-scale husbandry and 90% for family farms. More importantly, the gene sequence of the hepatitis E strain isolated from the liver samples exhibited a close relationship with the strain isolated from sporadic acute hepatitis E patients in Beijing (Li et al., 2009). One study analyzed data on infectious pig diseases in Yunnan Province during 2000-2009 and the result showed positive rates of CSFV 22.46% (31/138), PRRSV 26.23% (32/122), PCV91.30% (84/92), PRV 46.99% (39/83), pathogen bacterium 41.07% (23/56), lung mycoplasma 0.00% (0/39), toxoplasma gondii 50.00% (8/16), and eperythrozoon 14.29% (6/42) (Liao et al., 2012). In 2005, there was an outbreak of 215 cases of human *Streptococcus suis* infections with high mortality in Sichuan Province, China (Yu et al., 2006), a neighbor province of Yunnan.

However, during our surveys, farmers in L County refused to acknowledge any of those zoonotic diseases, and some even said: "Pig diseases never transmit to humans". The infectious disease reporting system of the Centre for Disease



Control of this county also did not report a higher incidence or prevalence of such diseases. It is still not clear whether the increased pig density will increase the risk of zoonotic diseases in the county.

One important health impact of pig farming is the antibiotics used for both preventing/treating pig disease and promoting growth, and the consequence: antimicrobial resistance (AMR). Research revealed that pig farmers carry greater methicillin-resistant *Staphylococcus aureus*, including spa-type t108 and other spa-types (Voss et al., 2005; Cleef et al., 2014). An experimental study conducted in Vietnam on integrated pig/fish production revealed that both *E. coli* and *Enterococcus* spp isolated from pig manure and water-sediment overall exhibited significant higher frequencies of resistance toward NAL and ENR during the 2 months when pigs were administered feed with antimicrobials, with frequencies reaching 60% to 80% in both water-sediment and manure samples (Dang et al., 2011).

There have also been studies conducted in China that have reported AMR related to pig farming: one study analyzed soil samples collected from the surroundings of large pig farms showed that the fields contained high and rich AMR genes (Zhu et al., 2013). Another study revealed that vegetables grown using organic fertilizer made from pig manure contain antibiotics used for animals (Hu et al., 2010). This implies a new health risk of using pig manure in addition to the traditional health risks associated with pig manure such as parasites, bacteria and virus. Our research in L County found out that farmers frequently use antibiotics in pig disease prevention and treatment, and they have very limited knowledge of antibiotics and a poor awareness of AMR.

Our research in L county did not measure the impact of pig farming on the environment by using laboratory testing; however, the negative impact of pig rearing on local water, soil and air can be observed. While pig manure is still valued and used by local farmers as fertilizer for crops and trees, it does cause air, soil and water pollution in villages, not only because of the residues of veterinary drugs including antibiotics and antimicrobial resistant genes contained in pig manure, but also because of the offensive odours coming from the high-density pigpens and pig manure accumulated in the small village roads and lanes. The accumulated manure can also serve as breeding sites for disease vectors such as fly and mosquito. Waste water generated from the cleaning of hygienic pigpens in many farmer households is totally untreated and directly discharged into small local rivers or even onto village roads. Unlike solid pig manure, waste water is not easy to collect and treat and thus cannot be used as fertilizer and therefore becomes a new pollution source associated with the modern pig rearing model. While pig density is greater, the volume of pollution associated with pig production cannot be ignored, and it becomes even more important given that this county is located in the scope of the water supply source for Kunming City, the capital of Yunnan Province. In addition, the pollution coming from hundreds of smallholder pig farmers is different from that of big pig production companies.

The prevention and treatment of this pollution calls for new solutions.

#### **4. Discussion**

Pig farming is a traditional agricultural activity that has lasted for hundreds or even thousands of years in L county, but this age-old activity has witnessed a series of tremendous changes over the last four decades. However, the impact of these changes has not been even and some traditional production and consumption models remain. As modern pig farming techniques were introduced into this mountainous county, they interacted with the traditional production system and were gradually integrated into the system. However, due to the land, financial and other resource constraints in this poor county, modern techniques that are supposed to be used in large-scale industry pig farming operations have been partially applied by poor and less educated farmers in smallholder pig farming settings. This has generated a wide spectrum of different pig production systems that are the results of modern pig farming techniques married with traditional production models to various degrees. This also changes the risk of diseases associated with pig farming. It is hard to predict and manage the risks given the rapid, diverse, complex and dynamic changes in intense small holder pig farming systems. The environmental pollution associated with these pig production systems is also different from the pollution caused by large pig companies, which calls for new management approaches.

The national pig production development plan for 2016-2020 issued by the Ministry of Agriculture in April 2016 identified Yunnan Province as a potential pig production development area, which means that pig farming will further increase in this province. Large-scale pig farms are the main developmental direction promoted by the government; however, diverse forms of intense small holder pig rearing will definitely continue to exist in this county and similar settings for decades due to the economic, cultural and social value attached to pig farming. In order to better manage health and environment risks when we promote pig raising as a means of poverty alleviation and development, special attention needs to be paid to the hybrid pig production that is situated between large-scale pig production that applies modern pig raising techniques, and the traditional subsistence pig production that uses indigenous knowledge and practices.

#### **5. Conclusion**

Pig rearing has a long history in L County, a mountainous and former poverty-stricken county located in Yunnan Province of China, and remains and will continually play important roles in the livelihood, economy and socio cultural aspect of local farmers. However, tremendous changes have occurred in local pig farming over the last four decades that are mainly caused by introduction of modern pig farming techniques such as new pig variety, AI, factory-produced feed and drug including vaccination and antibiotics into local traditional pig

rearing practices that lead to a number of intensified smallholder pig farming systems. These intensified smallholder pig farming systems have profound implications for health and environment including infectious disease risk, food safety, AMR and environment pollution, which might be different with the impact caused by large-scale pig production operations and thus need new management approaches. Policy makers and research communities need to pay attention to the critical but often ignored links between intensified smallholder pig farming, livelihood, poverty alleviation, culture, gender, health and environment, and research is needed to further understand health and environment implications caused by those intensified smallholder pig farming and explore new solutions.

### Acknowledgements

Master program students from Kunming Medical University participated in the two surveys mentioned in the paper. They include Guodong Gong, Xiao Sun, Yan Jingsong, Dou Yingchun and Guan Qiuyan, and I hereby acknowledge their contribution to the field work.

### Funding

This work was supported by a grant from the International Development Research Centre (IDRC), Canada to Asia Partnership on Emerging Infectious Disease Research (APEIR) Coordinating Office (Grant numbers: 57-005] and a research grant from the Institute of Development Studies (IDS), Sussex University, UK [contract No: 12/615 Project No: KN/11015].

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

### References

- Cleef, B. A. V., Bentham, B. H. V., Verkade, E. J., Rijen, M. V., & Schouls, L. M. (2014). Dynamics of MRSA and MSSA Carriage in Pig Farmers: A Prospective Cohort Study. *Clinical Microbiology & Infection*, *20*, 764-771. <https://doi.org/10.1111/1469-0691.12582>
- Dang, S. T. T., Petersen, A., Truong, D. V., Chu, H. T. T., & Dalsgaard, A. (2011). Impact of Medicated Feed on the Development of Antimicrobial Resistance in Bacteria at Integrated Pig-Fish Farms in Vietnam. *Applied & Environmental Microbiology*, *77*, 4494-4498. <https://doi.org/10.1128/AEM.02975-10>
- Feng, Z. Q. (2015). Current Status and Thinking of Pig Production in Luquan County. *Contemporary Livestock*, *67*, 4-5.
- Holdaway, J. (2022). Pig in the Middle: Environment, Health and Development Dimensions of the Pork Sector in China. *Open Journal of Social Sciences*.
- Hu, X. G., Zhou, Q. X., & Luo, Y. (2010). Occurrence and Source Analysis of Typical Veterinary Antibiotics in Manure, Soil, Vegetables and Groundwater from Organic Vegetable Bases, Northern China. *Environmental Pollution*, *158*, 2992-2998.

- <https://doi.org/10.1016/j.envpol.2010.05.023>
- Li, W. G., She, R. P., Wei, H. T., Zhao, J. Y., & Wang, Y. H. (2009). Prevalence of Hepatitis E Virus in Swine under Different Breeding Environment and Abattoir in Beijing, China. *Veterinary Microbiology*, *133*, 75-83.  
<https://doi.org/10.1016/j.vetmic.2008.06.026>
- Liao, Q. S., Li, Z. X., Ding, L. C., Chai, J., & Xu, J. (2012). Epidemiological Research of Major Infectious Disease from Partial Pig Farm from 2009 to 2010. *China Animal Husbandry & Veterinary Medicine*, *39*, 194-199.
- Lindahl, J. (2012). *Japanese Encephalitis Virus in Pigs and Vectors in the Mekong Delta*. Thesis, Acta Universitatis Agriculturae Sueciae.
- Maksym, V., Chemerys, V., Dushka, V., & Berezivskyi, Y. (2020). The Main Trends and Perspectives of Pork Production Development in the World. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies*, *22*, 21-27.  
<https://doi.org/10.32718/nvlvet-e9604>
- Nunez-Avellaneda, D., Cetina-Trejo, R., Zamudio-Moreno, E., Baak-Baak, C., Cigarroa-Toledo, N., Reyes-Solis, G. et al. (2021). Evidence of Zika Virus Infection in Pigs and Mosquitoes, Mexico. *Emerging Infectious Diseases*, *27*, 574-577.  
<https://doi.org/10.3201/eid2702.201452>
- Randad, P. R., Larsen, J., Kaya, H., Pisanic, N., Ordak, C., Price, L. B., Aziz, M., Nadimpalli, M. L., Rhodes, S., Stewart, J. R., Love, D. C., Mohr, D., Davis, M. F., Miller, L. S., Hall, D., Carroll, K. C., Perl, T. M., & Heaney, C. D. (2021). Transmission of Antimicrobial-Resistant *Staphylococcus aureus* Clonal Complex 9 between Pigs and Humans, United States. *Emerging Infectious Diseases*, *27*, 740-748.  
<https://doi.org/10.3201/eid2703.191775>
- Shrestha, U. T., Kafle, S., Adhikari, N., & Bowen, R. (2014). Comparative Study of Parasitic Infection in Pig Population from Different Climatic Eco-Zones of Nepal and Its Impact on Productivity and Human Health. *National Conference on Microbiology*, Kathmandu, November 2014.
- Statistical Bureau of Kunming City (2021). *The Main Data Bulletin of the Seventh National Census in Kunming*. <http://tjj.km.gov.cn/c/2021-06-07/3969607.shtml>
- The People's Government Office of L County (2021). *2020 Annual Quality Analysis Report of Luquan Yi and Miao Autonomous County*.  
<http://www.kmlq.gov.cn/c/2021-09-26/5424416.shtml>
- Voss, A., Loeffen, F., Bakker, J., Klaassen, C., & Wulf, M. (2005). Methicillin-Resistant *Staphylococcus aureus* in Pig Farming. *Emerging Infectious Diseases*, *11*, 1965-1966.  
<https://doi.org/10.3201/eid1112.050428>
- Wang, Q. H., Ren, W. J., & Bao, J. Y. (2018). The First Outbreak of African Swine Fever was Confirmed in China. *China Animal Quarantine*, *No. 9*, 1-4.
- Wang, Y. L., Liu, J. Q., Li, H. J., Chen, R., & Liu, S. L. (2015). Analysis of Influencing Factors of Pig Free-Range Breeding by Farmers—Based on a Survey of 25 Counties (Cities and Districts) in Sichuan Province. *China Rural Observation*, *No. 5*, 85-96.
- Witte, W., Strommenger, B., Stanek, C., & Cuny, C. (2007). Methicillin-Resistant *Staphylococcus aureus* ST398 in Humans and Animals, Central Europe. *Emerging Infectious Diseases*, *13*, 255-258. <https://doi.org/10.3201/eid1302.060924>
- Yu, H., Jing, H., Chen, Z., Zheng, H., & Zhu, X. (2006). Human *Streptococcus suis* Outbreak, Sichuan, China. *Emerging Infectious Diseases*, *12*, 914-920.
- Zhang, Q. Q., Ying, G. G., Pan, C. G., Liu, Y. S., & Zhao, J. L. (2015). A Comprehensive Evaluation of Antibiotics Emission and Fate in the River Basins of China: Sources Analysis, Multimedia Modeling, and Linkage to Bacterial Resistance. *Environmental*

*Science & Technology*, 49, 6772-6782. <https://doi.org/10.1021/acs.est.5b00729>

Zhu, Y. G., Johnson, T. A., Su, J. Q., Qiao, M., Guo, G. X., Stedtfeld, R. D., Hashsham, S. A., & Tiedie, J. M. (2013). Diverse and Abundant Antibiotics Resistance Genes in Chinese Swine Farms. *Proceedings of the National Academy of Sciences of the United States of America*, 110, 3435-3440. <https://doi.org/10.1073/pnas.1222743110>