Quantitative evaluation of disease prevention and control measures in pig farms based on value chain

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Background

The biosafety system of pig farms mainly originates from the laboratory biosafety management system.Its management philosophy is derived from documents such as "General Requirements for Laboratory Biosafety" GB/T 19489-2023, and has been rewritten by the author based on various pig farm scenarios.

As work progresses, its unsuitability gradually becomes apparent. Traditional internal audits and management reviews cannot solve these challenges. Urgent need for a structured evaluation and improvement method for animal disease prevention and control measures suitable for pig farms.

CONTENTS

Part 1

Objective

◎Background ◎Assess ◎Upgrade

Objective

Background

Basic information

Investigate the establishment and operation of biosafety systems in domestic pig listed companies.

Assess

Value Chain Analysis

Establish a structured quantitative economic evaluation and optimization method for animal disease prevention and control measures under biosafety objectives.

Upgrade

Upgrade

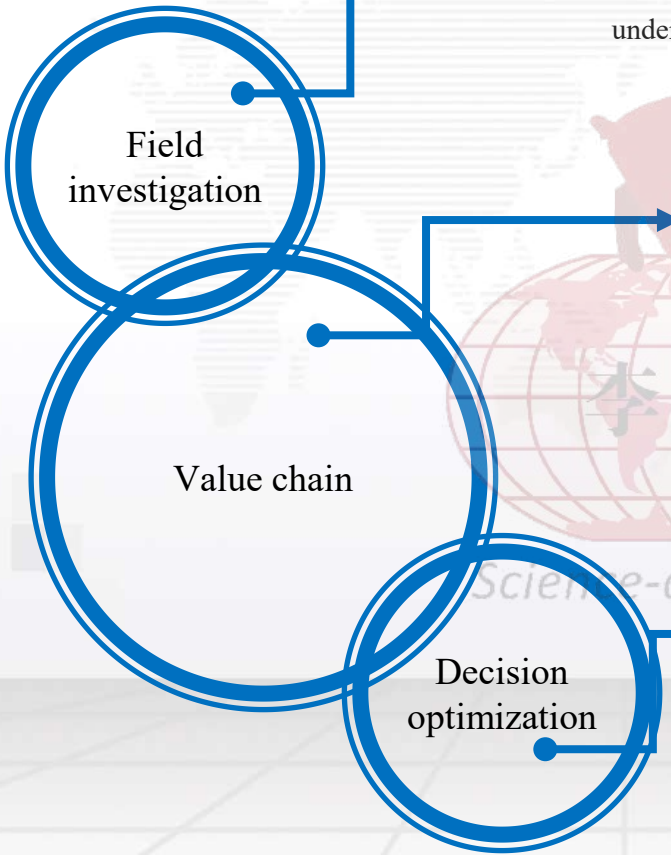
Identify common challenges in the current biosafety system of pig farms and propose methods for upgrading and transforming it.

Part 2

Methods

◎Field investigation ◎Value chain
◎Decision optimization

Methods



1. Collect biosafety system documents from domestic pig listed companies and understand their management and operation through interviews and on-site investigations

2. Establishing a value chain approach for animal disease risk management based on the scenario tree model.

Structuring the checklist based risk management.

Quantitatively evaluate the risk of a certain disease and the economic benefits generated by various measures.

Evaluate various disease prevention and control measures based on cost-benefit theory.

3.Establish an evaluation model for animal disease prevention and control measures in breeding farms based on cost-benefit analysis theory and Bayesian theory, taking into account the main prevention and control objectives.

Calculate the economic burden of different diseases.

Evaluate the costs and benefits of different prevention and control measures.

Identify which control point to increase or decrease will bring the maximum benefit.

Based on the networked relationship of disease transmission risk pathways and economic evaluation, collaborate to optimize on-site prevention and control measures.

Part 3

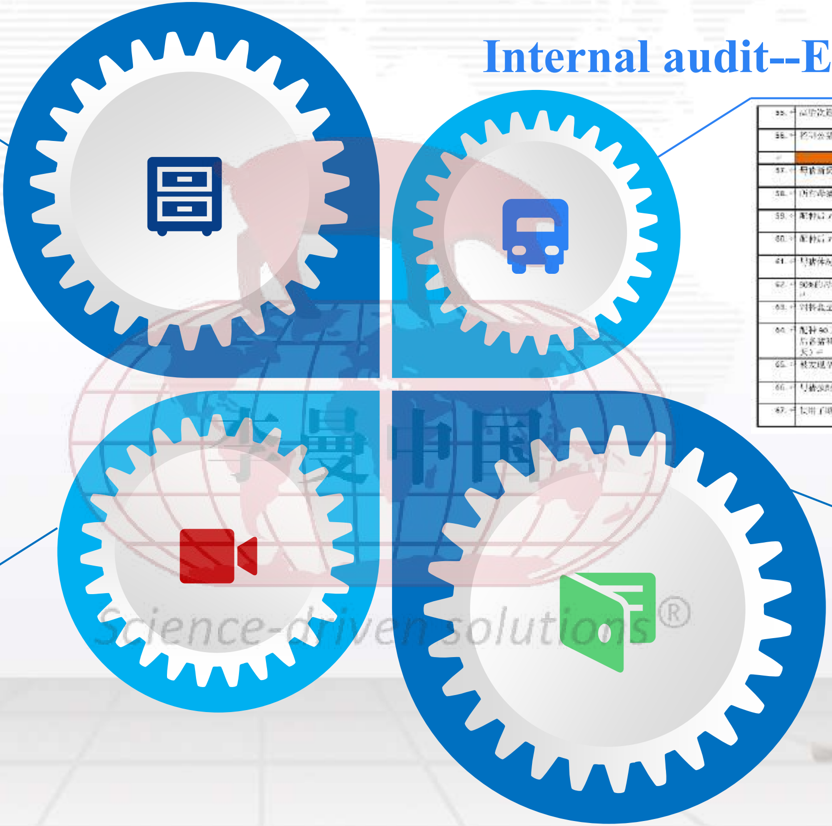
Results and Conclusions

◎Problems ◎Scenario tree ◎Value chain

Biosafety system of listed pig farms

Checklist --Structure?

Internal audit--Economic Perspective?



Lack of internal audit --Improve?

Writing style and length --Readability? Recall?

Problems in the Biosafety System

1. The biosafety system of domestic pig listed enterprises is mainly based on inventory management, and the measures lack structured design, which easily overlooks the mixed and interactive effects between prevention and control measures.

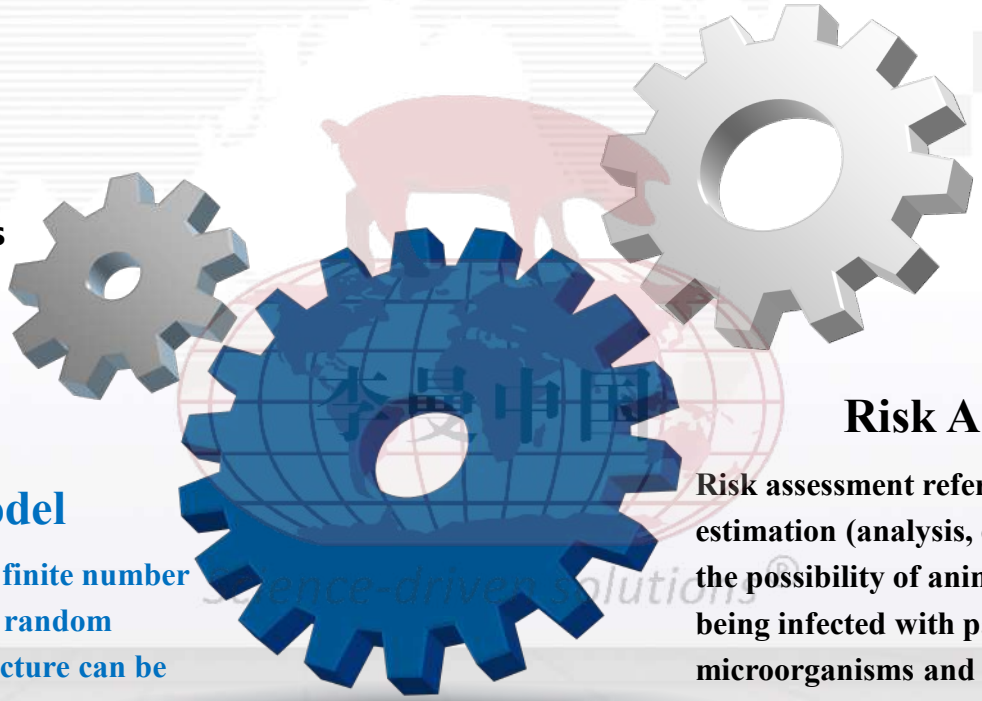
2. Internal audit and management review lack a fixed and effective procedure, and often do not include economic evaluation in the review, making it impossible to conduct both biosafety and economic evaluation simultaneously.

3. In order to achieve higher disease prevention and control goals, blindly increasing the content of the prevention and control list can ultimately lead to difficulties in implementation and prevention and control failures.

Improvement methods

Value chain

The value chain is a series of activities that link stakeholders and provide a unique product.



Scenario Tree Model

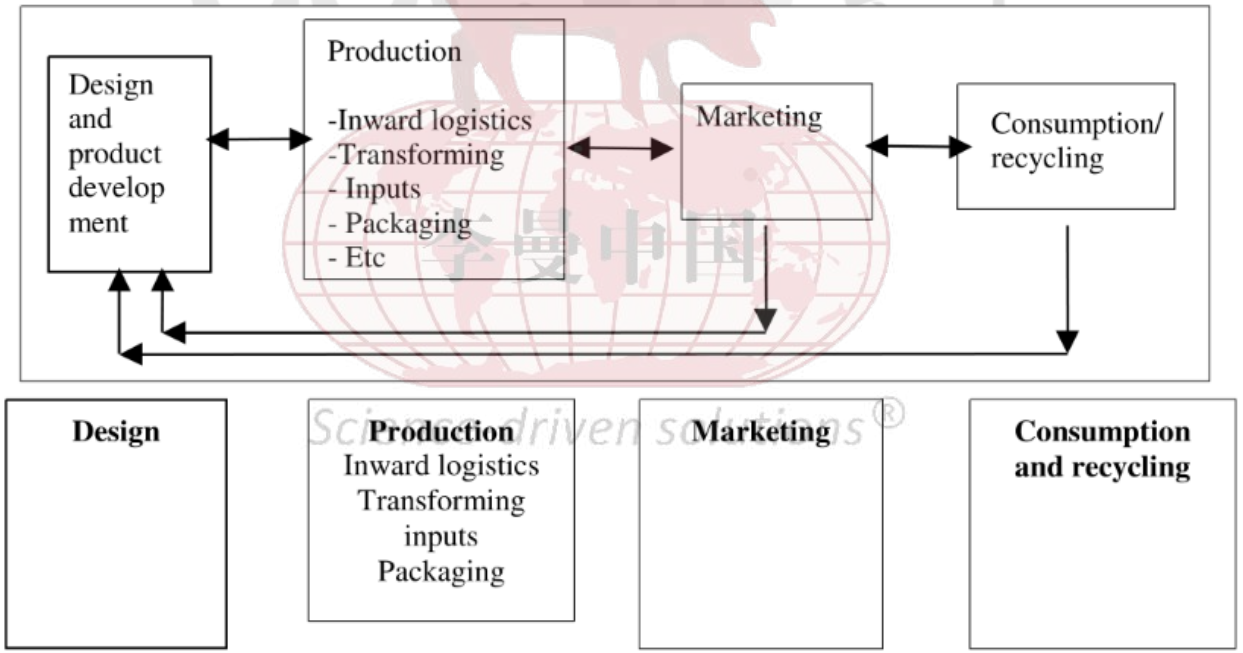
If it is assumed that there are only a finite number of possible values (scenarios) for the random parameters in each stage, a tree structure can be obtained based on the evolution relationship of the random parameters over time, which is called a scenario tree.

Risk Assessment

Risk assessment refers to the evaluation and estimation (analysis, estimation, definition) of the possibility of animals or animal products being infected with pathogenic microorganisms and their increased spread during the production and other related business activities of animals and animal products.

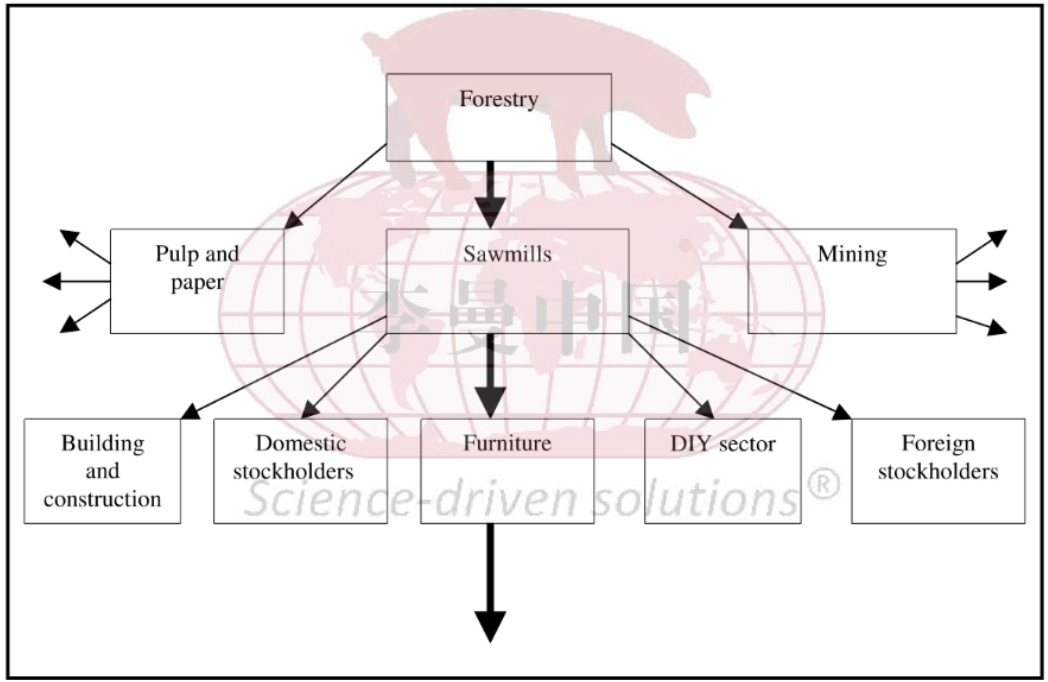
A schematic diagram of a simple value chain

Figure 1: Four links in a simple value chain

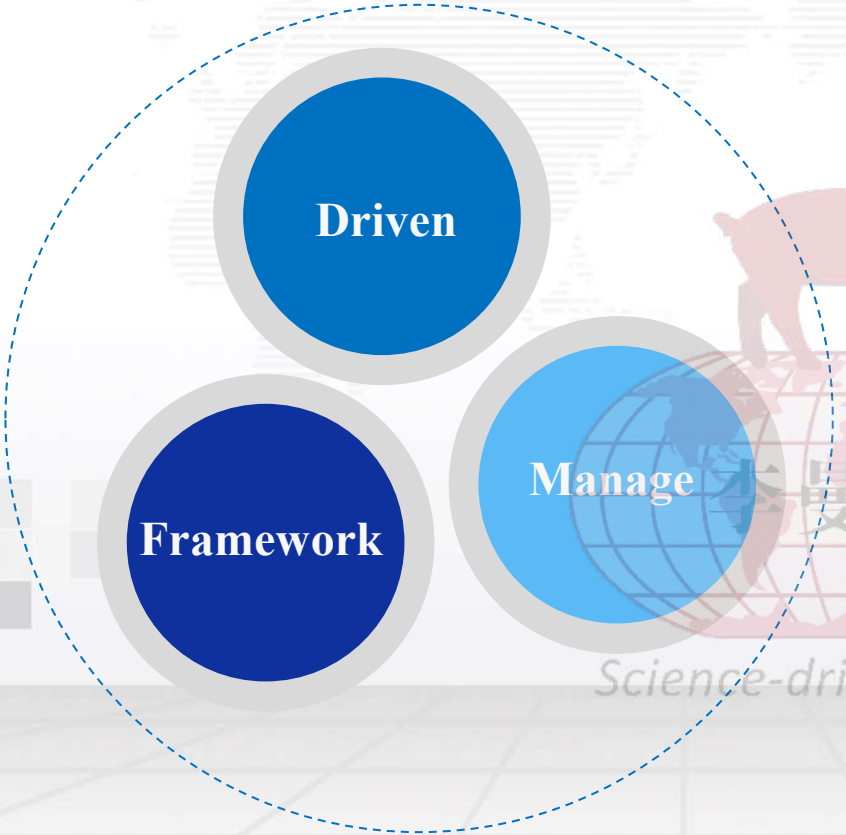


There may be more than one value chain

Figure 3: One or many value chains?



Characteristics of Value Chain



01
Driven by consumer demand

02
Run within the framework of national and local laws and local customs

03
Managed by the people in the chain who set rules on how people interact, produce and transport a commodity

The objectives of value chain analysis

VALUE CHAIN ANALYSIS

The main objectives of value chain analysis as used for risk assessment are the following (Rushton, 2009):

- Identify the main people, groups and organizations in the livestock value chain from the input supplier to the producer, trader, processor, retailer and through to the final consumer.
- Identify and map the different routes to market the livestock and livestock products, which could be what currently exists and what potentially is available or could be developed.
- Assess how well the marketing chain is working.

Find Object

Find Relationships

Find Results

Risk assessment based on value chain scenario tree

Problems and Current Situation

Ask risk questions
Basic Investigation
Data sources and analysis methods

Hazard identification

Hazard identification
Confirmation of risk factors
Corresponding measures for risk factors and economic evaluation

Risk assessment

Data analysis and risk assessment
Hazard assessment of risk occurrence
Risk calculation

Risk management

Quantitative calculation of disease burden
Quantitatively evaluate the economic benefits generated by various prevention and control measures
Determine the optimal combination of prevention and control measures

Simulation and Valuation

Calculate and model simulation
Uncertainty analysis of the model
Obtain model parameter data or valuation

Scenario Tree Model

Risk Pathway
Establish a scenario tree model

Maintain risk communication throughout the entire process

Part 4

Application Cases

◎Model simulation ◎Risk Calculation
◎Economic evaluation

Quantitative risk assessment of FMD disease infection

Risk Questions

At least one pig in a certain farm is at risk of foot-and-mouth disease infection in the next six months.

Spatial information

Position
On site layout
People, animals, instruments, vehicles, or other items

表 1 血清抗体监测结果（单位：份/%）

完成月份	O 型口蹄疫			口蹄疫荧光 RT-PCR		
	检测数	合格数	合格率	检测数	阳性数	阳性率
1 月	69	59	86			
2 月	30	23	77	30	0	
3 月	68	61	90			
3 月	30	24	80%	30	0	
4 月	67	64	96			
4 月	20	20	100	20	0	
4 月	3	3	100	3	0	
5 月	81	78	96			
6 月	10	9	90			
7 月	81	73	90			
9 月	80	62	78			
11 月	85	85	100			

Breeding and immunization

livestock on hand
Immune status

History of disease

Foot-and-mouth disease
Similar symptoms
Other diseases

Hazard identification

表 2　口蹄疫欧房的风险因素。

编号。	危害描述。	可能性。	预防措施。	措施的一次性投入（万元）。	措施的日投入（万元）。
1。	场周边空气含有口蹄疫气溶胶。	1%。	加强舍内空气消毒，采购风淋进行场内空气消毒。	10。	0.2。
2。	饲料携带口蹄疫病毒。	10%。	购买安全可信的高质量的饲料。。	0。	0.2。
3。	收猪贩人携带口蹄疫病毒。	30%。	对收猪的运输工人严格消毒。	0。	0.01。
4。	收猪贩人进场消毒不彻底。	30%。	对收猪车辆严格消毒，可采用场内的半封堵。	0。	0.01。
5。	饲养员携带口蹄疫病毒。	5%。	严格限制饲养员在场区外的活动范围及接触的人和动物，去可疫地区后，再入场要先行隔离。。	0。	0。
6。	饲养员进场消毒不彻底。	1%。	持续加强饲养员入场的消毒。	0。	0。
7。	采精等设备携带口蹄疫病毒。	1%。	采购高品质的设备。	0。	0。
8。	采精等设备消毒不彻底。	1%。	加强设备消毒的监督。	0。	0。
9。	易感动物携带口蹄疫病毒。	20%。	灭鼠。	0。	0.001。
10。	对易感动物防疫屏障不足。	3%。	加强对舍内巡视，对可能的漏洞及时弥补。	0。	0。
11。	疫苗免疫无形成有效保护。	4%。	加强免疫技术。	0。	0。
12。	抗体检测结果合格，但实际抗体水平不达标。	5%。	对抗体浓度在临界值的，也按照不合	0。	0。

Hazard identification

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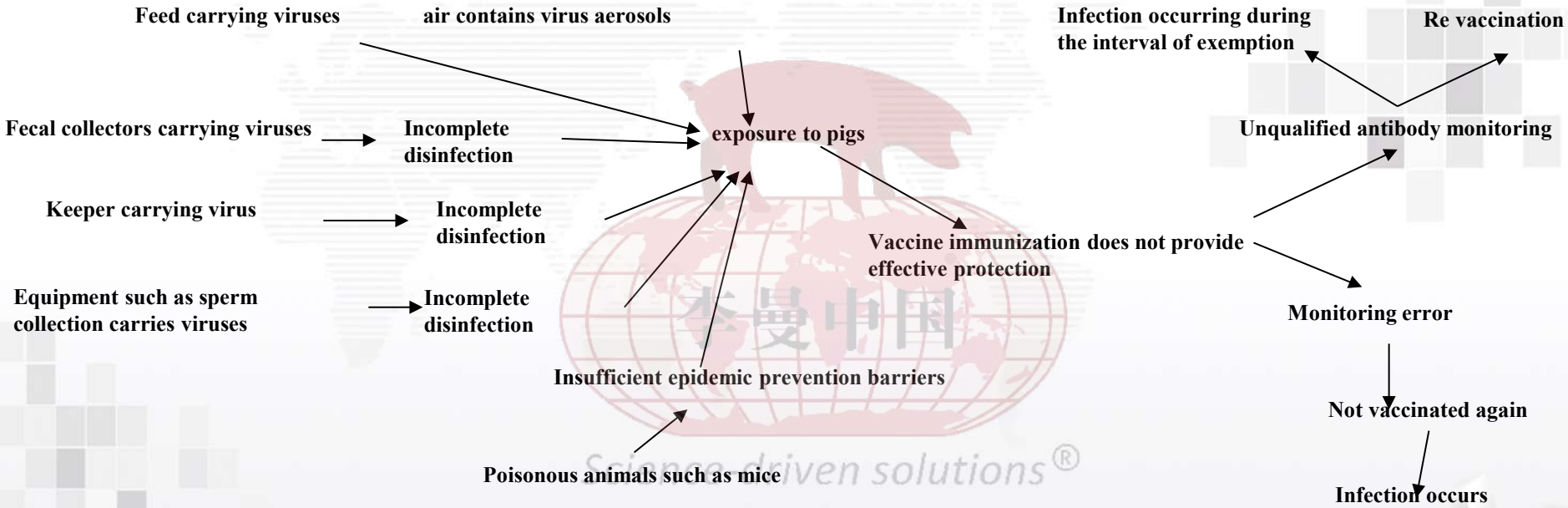
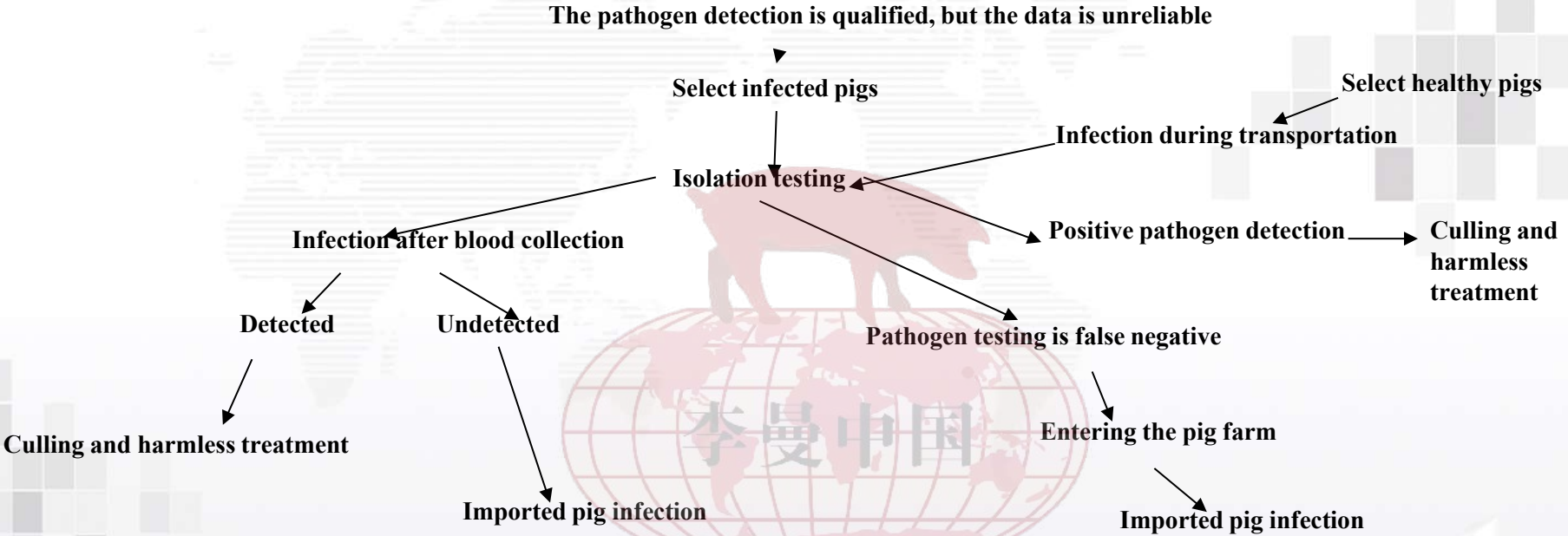
			格的进行处理。		
13。	抗体检测做合格之后未补免。	100%。	无。	0。	0。
14。	未补免就发生感染。	10%。	加强生产区平时的消毒等饲养管理。	0。	0。
15。	抗体检测结果不合格且实际抗体抗体水平也不达标。	95%。	无。	。	。
16。	抗体不合格的补免间隙发生感染。	5%。	加强生产区消毒和饲养管理。	0。	0。
17。	场中感染猪。	10%。	无。	。	。
18。	场中健康猪。	90%。	无。	。	。
19。	健康猪经验场中感染。	5%。	对场外采购认真消毒，场内减少场中的时间，减少猪与其他动物的接触。	0。	0。
20。	隔离检测病原学假阴性。	5%。	检测采取平行策略，提高敏感性。	0。	0。
21。	假阴性的隔离场的猪当作健康猪进入猪场生产区。	10%。	加强临床观察。	0。	0。
22。	未感染的猪在采血检测与入场的间隙发生感染。	5%。	加强隔离场的饲养管理。	0。	0。
23。	未感染的猪在采血检测与入场的间隙发生感染后，未被发现。	10%。	加强临床观察。	0。	0。

Risk Pathway and Scenario Tree



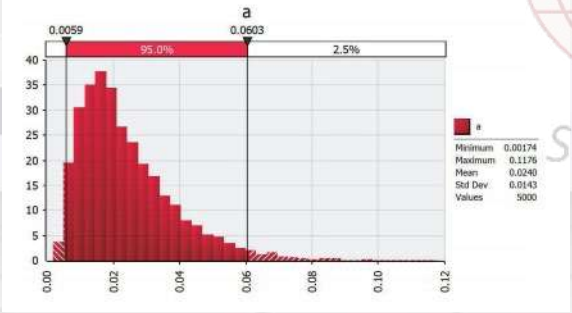
Risk pathways of infectious substances entering the site from outside the site (non introduced)

Risk Pathway and Scenario Tree



The risk pathway of infectious substances entering the field from outside the field (introduction)

Risk assessment



可能发生猪感染口蹄疫的风险路径分析

序号	路径描述	发生概率(%)
1	风险因子 1~6、7~8 或 9~10 接触猪后，发生风险因子 11~14	0.004 1
2	风险因子 1~6、7~8 或 9~10 接触猪后，发生风险因子 11~16	0.98
3	风险因子 17 或 18~19 发生，隔离检测后，发生 20~21	0.073
4	风险因子 17 或 18~19 发生，隔离检测后，发生 22~23	0.073

Risk management

01 Communicated the results of risk assessment with stakeholders such as pig farm managers, veterinarians, and breeders. It believes that a 1.13% risk of infection is unacceptable and urgent measures need to be taken to reduce the risk.

02 Among the four risk pathways, the probability of infection occurring in pathway 2 is 0.98%, indicating a relatively high risk. It is recommended to take control measures for this. In path 2, risk factors 2, 3, 4, 9, and 16 contribute significantly to the increase in risk, and control measures should be taken. Recommend purchasing reliable and high-quality feed; Strictly disinfect the transportation workers responsible for collecting manure; Strictly disinfect the collection vehicles, and if conditions permit, use on-site vehicles for transportation; Strengthen rodent control work; Strengthen disinfection and feeding management in the production area.

03 The third and fourth risk pathways are all aimed at imported pigs. It is recommended to strengthen the disinfection management of the isolation site and conduct an additional foot-and-mouth disease pathogen test before transferring from the isolation site to the production site.

Welcome to communicate.