Study on Swine Catastrophic Disease

Final Report for
Acquisition Services Directorate
and
Risk Management Agency

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Agralytica
CONSULTING

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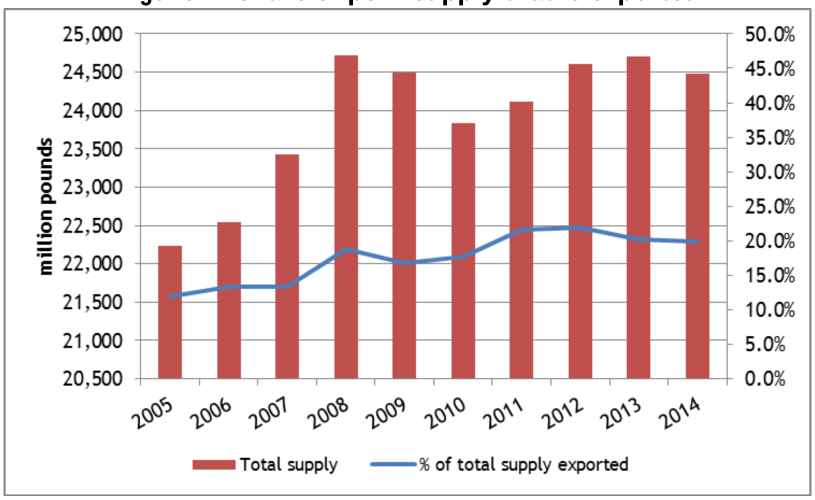
1. EXECUTIVE SUMMARY

1.1. Background

The US hog industry is an $18 billion enterprise that constitutes a major component of US agriculture. It generates an estimated 231,400 direct and indirect jobs, provides over $8 billion in wage earnings and contributes $46.7 billion to national economic activity.

Given the importance of the sector, the economic threat of the introduction of serious foreign swine diseases is considerable. If introduced, such diseases would result in immediate closure of some of the export markets that currently take 20% of the total US supply (Figure 1). Even without any impact on demand in the domestic market, hog prices would fall dramatically, causing a multi-year contraction in the industry that would be painful for everyone involved.

Figure 1: Share of pork supply that is exported



Source: USDA PSD database

USDA's Animal and Plant Health Inspection Service (APHIS) has developed a Foreign Animal Disease Preparedness and Response Plan (FAD PReP) that would help coordinate practical responses to a catastrophic swine disease event (CSDE). However, current plans would be incapable of ameliorating the severe negative economic impacts that will ensue.

Since Federal crop insurance plans have become such a major component of the support system for producers of field and specialty crops, the pork industry asked the Congress to require a study of whether a Federal insurance plan could play a role in managing this disease risk faced by a major livestock industry. The Agricultural Act of 2014 amended the Federal Crop Insurance Act to direct the Federal Crop Insurance Corporation (FCIC) to commission a study to determine the feasibility of developing an appropriate insurance program for swine producers to provide protection against a CSDE.

The feasibility of such a program is strongly influenced by the industry structure that has evolved over recent decades. There has been a significant degree of industry concentration and vertical integration that has redefined how price and production risks are managed. The 2012 Census of Agriculture indicates that ownership of the hog inventory has become fairly concentrated:

- 145 producers owned 60% of the country's inventory; and
- The 685 producers with 10,000 or more hogs owned 76% of total inventory.

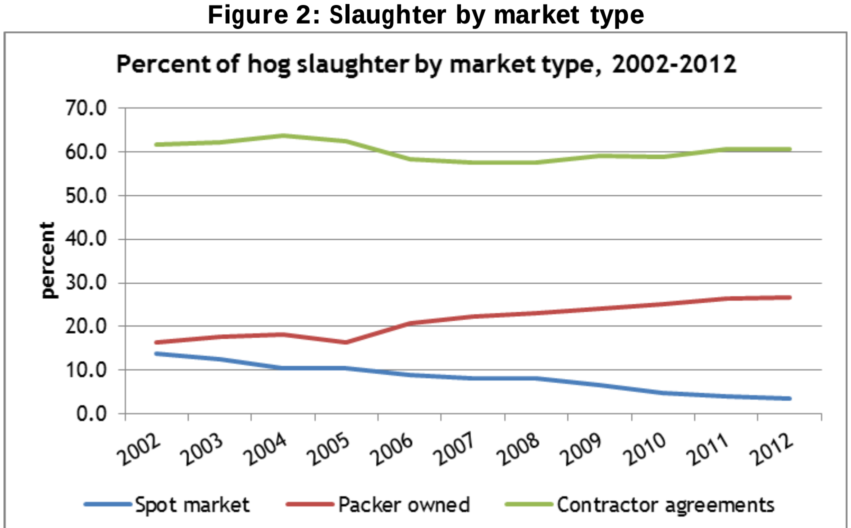
The hog market has changed significantly in the last 20 years. Historically, growers would either sell their hogs on the spot cash market or deliver under a marketing contract to a packer. However, spot market purchases by packers, which represented only 15% of sales in 2004, have since shrunk to under 4% of animals delivered.

More importantly, the structure of hog ownership has changed as hog production has followed the path of poultry, becoming more vertically integrated. The packers that own slaughter facilities now raise more of the hogs they slaughter, and they use production contracts with growers to raise other packer-owned hogs. Independent contractors also use production contracts with growers, providing both the young pigs and the feed. In both cases the grower does not own the hogs and is responsible only for having made the investment in the hog barn and then feeding, caring for, and delivering an animal of marketable weight. Based on the 2009 Agricultural Resource Management Survey of the hog industry, USDA's Economic Research Service reported that 71% of hogs were grown under such production contracts that year.

Independent growers and contractors still own a majority of the hogs slaughtered each year, and sell them to packers or intermediaries primarily through marketing contracts that can take a variety of forms.

There do not appear to be any definitive estimates of the current breakdown of hog ownership among different segments. Based on Agricultural Marketing Service data, the U.S. International Trade Commission concluded that "…the total share of slaughtered barrows and gilts owned by packers (including sales for slaughter by packers) increased slightly, from 30.6 percent in 2008 to 32.3 percent in 2012 and 33.4 percent in 2013." Our own calculations shown in Figure 2 put it slightly lower in 2012 at about 27 percent.

Figure 2: Slaughter by market type



Source: See sources for Figure 8

The Statement of Work for this study included the formal criteria that any new insurance plan must satisfy in order to be approved by the FCIC Board. These criteria are reviewed in Section 2. The research and analysis for this report was performed between February and July of 2015. We held listening sessions for swine producers, insurance agents, pork industry representatives, insurance company staff, and university specialists between March 24 and April 2 in four states: North Carolina, Indiana, Minnesota, and Iowa. We also received industry input by phone and email. The listening session and other input is reflected throughout the study.

1.2. Conclusions regarding feasibility

National Pork Producers Council representatives and our listening session participants said their primary concern is over the potential economic impacts on the industry of a disease outbreak that would cause other countries to stop importing pork from the United States. Industry experts identified the four foreign animal diseases that would result in loss of export markets as Foot and Mouth Disease, African Swine Fever, Classical Swine Fever, and Swine Vesicular Disease. We explored insurance approaches to managing the market risks of an outbreak in the United States of one of these diseases. In Section 7 we discuss the risks, who would have an insurable interest in swine, how one would define the guarantee and triggering event, and how one might establish the rates to charge for such coverage. We explore how an endorsement to the existing Livestock Revenue Protection plan might work as an insurance solution to a CSDE.

Our overall conclusion from our research and analysis is that it is not currently feasible to develop an appropriate insurance program for swine producers to provide protection against a catastrophic swine disease event. We can envision a feasible program design but it is not an insurance plan that meets the definition of “actuarially sound,” that swine producers would likely purchase in significant volume, or that successfully addresses the economic challenges stemming from a catastrophic swine disease event. The six main reasons for our overall conclusion are elaborated below.

Statutory cap on expenditure

The 2000 Agricultural Risk Protection Act (ARPA) required the Risk Management Agency to develop the two existing programs for livestock, LRP and LGM, but it established a limit on total expenditures for premium subsidies, Administrative and Operating expenses so that, to the maximum extent practicable, all costs associated with conducting the livestock programs (other than research and development costs covered by Section 522) are not expected to exceed $20,000,000. The existing programs usually exhaust the available funding.

Any new coverage for a CSDE would involve considerable Federal outlays. Our example of an endorsement described in Section 7 involves estimated subsidy costs of $18.2 million. Congressional action would be required to increase or remove the expenditure cap. The Congressional Budget Office’s March 2015 baseline projections of outlays on farm programs included an annual average of $8.4 billion for the Federal Crop Insurance Corporation for fiscal years 2015-2019. The negative impact of a CSDE on the $18 billion swine industry would be in the billions of dollars, and government costs for indemnities under an insurance plan could also be in the billions of dollars. Whether the Congress would choose to take on the additional costs of a new insurance plan for a CSDE is unknown.

Many hog operations have no insurable interest

The US swine industry is increasingly defined by contracts with growers to manage hogs provided and owned by the contractor. This gives the contractor control over the genetics and provides some geographic and management diversification of production risk. The precise share of total hogs currently grown under such contracts is not known but had reached 71% in 2009. Contract growers who do not own the animals have no significant insurable interest. The contactor or packer would have to purchase the insurance, and input we received at the listening sessions suggested that they have been more likely to use futures and options to manage at least a portion of the risk of a CSDE. If the industry begins to assign a higher probability to occurrence of a CSDE, packers, contractors and large independent producers may develop greater interest in an insurance product, especially if the cost is subsidized. However, the many growers who do not own the hogs they are raising would remain vulnerable to loss of access to hogs to raise and to contractor insolvencies.

Only current inventory could be covered

Regulations governing FCIC insurance plans dictate that only current inventory can be insured. If a corn producer experiences a drought, it is only the current crop that is insured, not crops in subsequent years. Those subsequent crops each require payment of a new premium. In the case of livestock, one can only insure what exists. Annual slaughter of market hogs is approximately twice the inventory of market pigs and hogs at any point in the year. Thus under existing FCIC regulations an insurance plan could only be covering approximately half a year's production at the time of a CSDE.

While the threat of a CSDE with adverse financial impacts is real, most producers would not be covered under a plan providing CSDE coverage for swine. Even producers that would purchase the CSDE endorsement concept we describe in Section 7 would most likely not be nearly compensated for their loss. The losses many producers would face would result from their inability to obtain pigs in periods following a CSDE. They would be stuck with fixed costs associated with their investment in hog barns and equipment, yet could be unable to obtain a contract for animal production, either because integrators and packers do not wish to contract with them due to disease at or near their facilities, or due to lack of packer demand generally.

What the swine industry was hoping for is an insurance plan that would provide indemnities over the multi-year period of adjustment of the sector to a loss of export markets. This is not feasible under current regulations.

There is no data on which to base actuarially sound rates

There have been no outbreaks of the four critical diseases since the United States became a net exporter of pork in 1995. Indeed, neither African Swine Fever nor Swine Vesicular Disease has ever been present in this country. The last US case of Classical Swine Fever in the United States was in 1978 and the last Foot and Mouth Disease case was in 1929.

During the first decade in which US pork exports gained ground, net exports averaged only 2.6% of production. However, in the most recent decade, 2005-14, net exports averaged almost 15% of production and are now near 20%. The total lack of any CSDE experience, coupled with the recent increase in vulnerability to a loss of export markets, makes it very difficult to rate any potential insurance coverage. There has been some econometric modeling of the potential effects of a CSDE, as reviewed in Section 4.3.2, but the results are very dependent on the assumptions made in each case about the location and duration of the event, the species affected, containment measures, and consumer behavior.

Existing mechanisms for risk management are available

Integrators and producers can and do use futures and options to manage price risk. It appears that most of the demand for these financial products is limited to the current inventory (since the volume for contracts greater than six months ahead is limited). USDA has also been implementing a Secure Pork Supply plan to allow business continuity where there is no disease present.

Growers focus on bioexclusion procedures (particularly given the experience with recent diseases). Also, some growers can self-insure over time on their own, as was specifically mentioned by one grower at our North Carolina listening session. Some producers have also diversified in order to limit the risk from production of any one commodity. However, with the increase in specialization within the hog sector, growers as a group are probably less diversified today than they were twenty or thirty years ago.

Producers currently appear unwilling to pay the cost to participate

Equally serious is the lack of producer interest in buying insurance coverage. Participation in the existing LRP and LGM plans is negligible – only 43 policies in 2015 covering a total of 100,000 head, i.e. one tenth of a percent of annual slaughter. Through contracting and the use of futures and options the industry seems to be able to successfully manage its near-term price risk. The existing RMA livestock insurance plans are apparently viewed as too expensive for what they provide.

In the listening sessions, producers who owned their own hogs said they would not want to pay even one dollar per animal for insurance. Some said it would have to be less than the pork checkoff amount, which is 0.40% or about $0.67 per hog. Our estimate in Section 7.5.2 of the producer cost of an LRP-Swine policy with a CSDE endorsement is 2.5 times that amount. However, one participant commented that it will actually be the producer's banker who decides whether to buy coverage. On the face of it, a producer cost of insurance equal to one percent of the value of the hogs should not be a major obstacle to purchasing the coverage if it appears to be needed.

Finally, some in the countryside believe that if there is a big enough problem in the industry, the Congress will approve ad hoc disaster payments to deal with it, in which case there is no point in paying for insurance.

2. THE OBJECTIVE OF THIS STUDY

The economic threat of the introduction of serious swine diseases is considerable. If introduced, diseases such as Foot and Mouth Disease, African Swine Fever, Classical Swine Fever, or Swine Vesicular Disease would result in immediate closure of some of the export markets that currently take more than 20% of total US production. Even without any impact on demand in the domestic market, hog prices would fall dramatically. Domestic consumption could also be impacted, hastening contraction in domestic demand.

In response to this and other swine disease threats, the pork industry asked the Congress to require a study of whether a Federal insurance plan could play a role in managing this risk faced by the industry. Consequently, the Agricultural Act of 2014 amended the Federal Crop Insurance Act to direct the Federal Crop Insurance Corporation to commission a study to determine the feasibility of developing an appropriate insurance program for swine producers to provide protection against a catastrophic swine disease event. It did not define "catastrophic" but industry representatives made it clear that their main concern was the potential impact of other countries banning pork imports from the United States.

The objective was to undertake research and develop a report that assesses the likelihood of successfully developing an insurance program for a swine catastrophic disease event. Specifically to:

- obtain information that would determine if providing swine catastrophic disease coverage would benefit agricultural producers;
- help swine producers and Congress understand how these risks are being, or could be addressed by the crop insurance system;
- evaluate any existing policies or plans of insurance that provide coverage for a swine catastrophic disease event; and
- determine what practical challenges are present that need to be overcome in order to create actuarially sound products related to a swine catastrophic disease event.

The Statement of Work also posed the following questions:

- What existing policies are available that cover losses due to a catastrophic swine disease?
- What data is available on swine catastrophic disease events?
- Can the available data be used to create an actuarially sound insurance program for swine catastrophic disease events or risks?
- Would this program be beneficial to swine producers?
- What practical challenges prevent the Federal Crop Insurance Corporation from developing an insurance program to cover swine for catastrophic disease events?
- How can these practical challenges to developing an insurance program be overcome?

Finally, the Statement of Work specified that the criteria for plan development must meet the following RMA standards:

- Conform to RMA's enabling legislation, regulations, and procedures that cannot be changed;
- Charge a premium that the insureds must be willing to pay for the insurance;
- Be effective, meaningful and reflect the actual risks of producers;
- Have best management practices that can be defined, required of insureds and monitored;

- Identify and appropriately categorize perils affecting production and/or revenue as insurable and non-insurable;
- Be ratable and operable in an actuarially sound manner;
- Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions;
- Be an appropriate geographic distribution of production to ensure a sound financial insurance program;
- Produce enough interest for the risk to be spread over an acceptable pool of insureds;
- Not allow insureds to select insurance only when conditions are adverse;
- Avoid or control moral hazards; and
- Not allow a change in market behavior or market distortions that change the quantity supplied or shift the supply curve.

This report was prepared by the staff of Agralytica and the staff of our actuarial partner, Milliman Inc. In addition, two swine industry experts contributed research and analysis on swine diseases and disease management: Dr. Derald Holtkamp and Dr. Randy Jones. Dr. Holtkamp is an Associate Professor in the Department of Veterinary Diagnostics and Production Animal Medicine (VDPAM) in the College of Veterinary Medicine at Iowa State University (http://vetmed.iastate.edu/users/holtkamp). Dr. Jones is a principal of Livestock Veterinary Services, a large veterinary practice in Kinston, North Carolina, serving the large non-integrated swine producers in the Carolinas, Georgia, and Alabama (http://www.livestockvet.com/). Section 4 is largely their work.

The research and analysis for this report was performed between February and July of 2015. We held listening sessions for swine producers, insurance agents, pork industry representatives, insurance company staff, and university specialists between March 24 and April 2 in four states: North Carolina, Indiana, Minnesota, and Iowa. We also received industry input by phone and email. This input is reflected throughout this report, but principally in Sections 6 and 7.

3. THE SWINE AND PORK SECTORS

3.1. Swine industry scale and impact

The United States slaughtered 107 million market hogs in 2014, producing 30.4 billion pounds (live weight) of pork. The United States is the world's third largest pork producer after China and the European Union. It is also the world's largest exporter. Exports have become critical to the industry: in the past ten years, they have grown from 12% to 20% of production.

The impact of the hog and pig industry is substantial. With normal production of 110 million hogs, and a price of $80 per hundredweight of carcass, the value of swine production is approximately $18 billion. This generates an estimated 231,400 direct and indirect jobs, provides over $8 billion in wage earnings and contributes $46.7 billion to national economic activity. These estimates are obtained by applying the latest (2013) US Department of Commerce RIMS II input/out multipliers to 2014 production data from USDA's National Agricultural Statistics Service (NASS).

Table 1: Economic impact of the swine sector

US	Output ($1,000)	Earnings ($1,000)	Employment (jobs)
Hogs & pigs	$46,694,612	$8,059,811	231,408

Concern has grown within the industry that introduction of a foreign animal disease could lead to major disruption of the sector due to loss of export markets and a plunge in market prices. The threat of an outbreak of a catastrophic swine disease is ever present. The global swine sector fights a continuous battle to prevent outbreaks of catastrophic diseases such as Foot and Mouth Disease, African Swine Fever, Classical Swine Fever, and Swine Vesicular disease.

These fears came to a head in 2013 and 2014 as the United States experienced an outbreak of swine diseases caused by novel viruses (swine enteric coronavirus diseases (SECD) caused by Porcine Epidemic Diarrhea Virus (PEDV) and Porcine deltacoronavirus (PDCoV)). PEDV appeared in the United States in April 2013 and was joined by an additional related virus, PDCoV in early 2014. The resulting disease outbreaks had a major impact on piglets resulting in significant morbidity and mortality. More recently, the 2015 outbreaks of Highly Pathogenic Avian Influenza that have devastated US turkey and egg layer flocks signaled the animal product industries' ongoing vulnerability to disease episodes.

Other diseases with much more serious implications will continue to threaten the United States swine sector with substantial economic impact. Various government and industry funded institutions have worked together to prepare for novel swine diseases and to identify potential responses. An example of this preparation is the Swine Industry Manual prepared as part of the Foreign Animal Disease Preparedness and Response Plan, an integral part of the national Animal Health Emergency Management System.

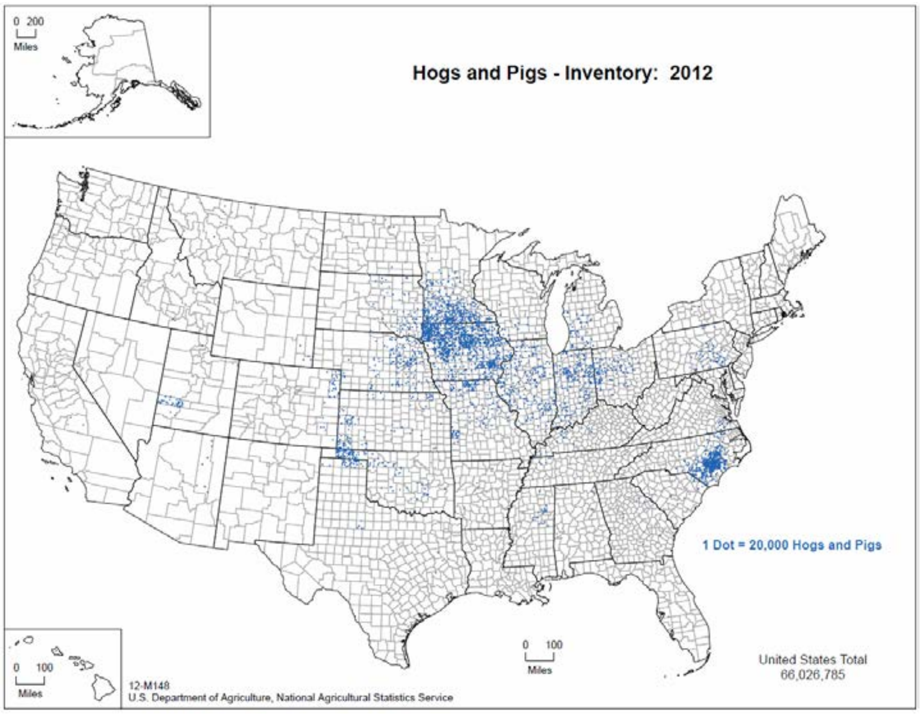
This manual identifies lessons learned from past foreign animal disease outbreaks and the challenges of dealing with any new events. This suggests that the United States has invested appropriately to combat a potential novel swine disease, including reference to plans for appraisal of losses and compensation. However, in practice, compensation for the effects of livestock diseases is not always readily available, especially when the costs are substantial. The government resources for preventing and responding to livestock disease outbreaks are further described below in Section 4.

3.2. Swine production

3.2.1. Production geography and farm types

US swine production takes place on over 63,000 farms across the country according to the 2012 US Census of Agriculture. All states had swine farms, and twenty of them had over 1,000 farms. Nevertheless, production volume is particularly concentrated in the Corn Belt states plus North Carolina, as illustrated in Figure 3.

Figure 3: Geographic distribution of hog production



A few words on terminology. Swine refers to the broad category encompassing hogs, pigs, wild boars, etc. In the United States, "pig" generally refers to animals at weights of 120 pounds or less. Above that it is a "hog". Some other countries just call all animals pigs. The breeding stock includes boars (male) and sows (female). Market hogs raised for slaughter include barrows (castrated males) and gilts (females that have not had a litter).

Swine growers are classified into independent grower farms (55,566 units), contractor/integrator farms (558), and contract grower farms (7,122). These are listed by state in Table 2.

Independent farms are found throughout the country. Most states have multiple contractor/integrator farms. The two states with the most contractor/integrator farms were Iowa (66, 12% of such farms) and North Carolina (61, 11%).

Contract grower production, by contrast, is fairly concentrated. It was most common in Iowa (2,602 farms), Minnesota (912), North Carolina (875), Indiana (499), and Ohio (482). These five states accounted for 75% of contract grower farms.

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Table 2: Swine growers by state

State	Independent grower Farms	Contractor/ integrator Farms	Contract grower Farms
	number of farms		
Alabama	671		18
Alaska	35	2	
Arizona	506	3	
Arkansas	685	2	65
California	1,411	24	2
Colorado	982	13	6
Connecticut	315	3	
Delaware	59		
Florida	1,599	43	
Georgia	839	3	24
Hawaii	231		
Idaho	676	4	
Illinois	1,681	18	346
Indiana	2,244	14	499
Iowa	3,598	66	2,602
Kansas	951	15	44
Kentucky	1,248	14	22
Louisiana	658		
Maine	748	4	
Maryland	332		1
Massachusetts	477	1	
Michigan	2,062	8	128
Minnesota	2,414	29	912
Mississippi	503	2	35
Missouri	1,923	14	191
Montana	399	7	
Nebraska	1,192	9	275
Nevada	81		
New Hampshire	357	2	
New Jersey	293	5	
New Mexico	209	2	
New York	1,881	18	13
North Carolina	1,281	61	875
North Dakota	215	3	
Ohio	2,998	14	482
Oklahoma	1,896	3	48
Oregon	1,110	14	
Pennsylvania	2,742	29	326
Rhode Island	77		
South Carolina	790	7	41
South Dakota	595		86
Tennessee	1,255	18	24
Texas	4,902	3	
Utah	651	14	4
Vermont	437	13	
Virginia	1,231	12	22
Washington	913	21	
West Virginia	719	6	
Wisconsin	2,224	15	31
Wyoming	270		
United States	**55,566**	**558**	**7,122**
		Total	**63,246**

Source: 2012 US Census of Agriculture

Despite the fact that swine are raised nationwide, the 2012 Census of Agriculture indicates that ownership of the inventory has become fairly concentrated:

- 145 producers owned 60% of the country's inventory; and
- The 685 producers with 10,000 or more hogs owned 76% of total inventory.

3.2.2. Production stages

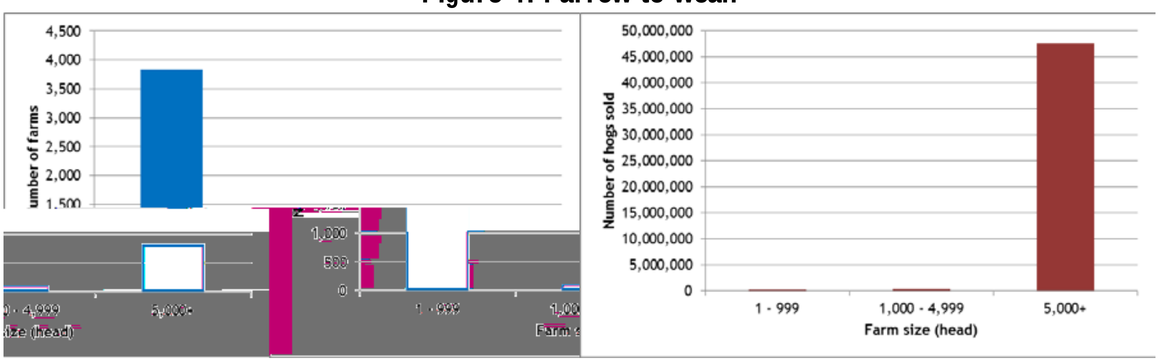
The production chain for swine begins with a small number of companies specializing in animal genetics. One participant at our listening sessions reported that there are only around 20 purebred swine breeding groups supplying the US industry

Swine production has four stages: breeding and gestation, farrowing and weaning, nursery, and finishing. After farrowing, a piglet is weaned at approximately 3 weeks and will be moved to a temperature controlled nursery where it grows to 30-80 pounds at 6-10 weeks of age. From there they are moved to a finishing operation where they grow to be 250-275 pound market hogs by 5-6 months of age.[1]

Some producers handle the whole production process (farrow to finish), while others specialize in part of the process such as farrowing to wean, farrow to feeder, or finishing only.

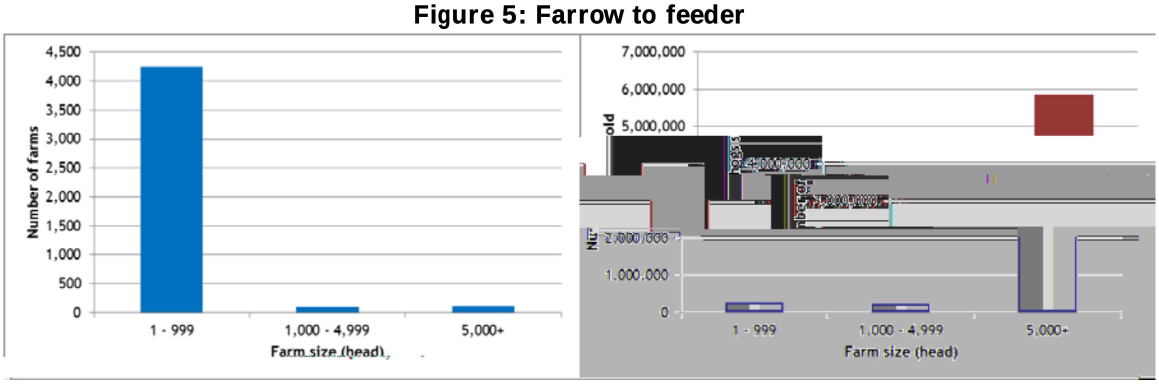
The different types of operations are shown in the graphs that follow, based on the size of the operation: small (<1,000 animals), medium (1,000-4,999), and large (5,000+). On the basis of these size groupings, the different farm types are shown in terms of farm numbers, as well as the overall number of animals managed in operations of that size.

Figure 4: Farrow to wean



Source: US 2012 Census of Agriculture

Figure 5: Farrow to feeder



Source: US 2012 Census of Agriculture

[1] http://www.epa.gov/agriculture/ag101/porkphases.html and McBride, William and Nigel Key, "Economic and Structural Relationships in U.S. Hog Production," Economic Research Service, USDA, AER 818, 2003

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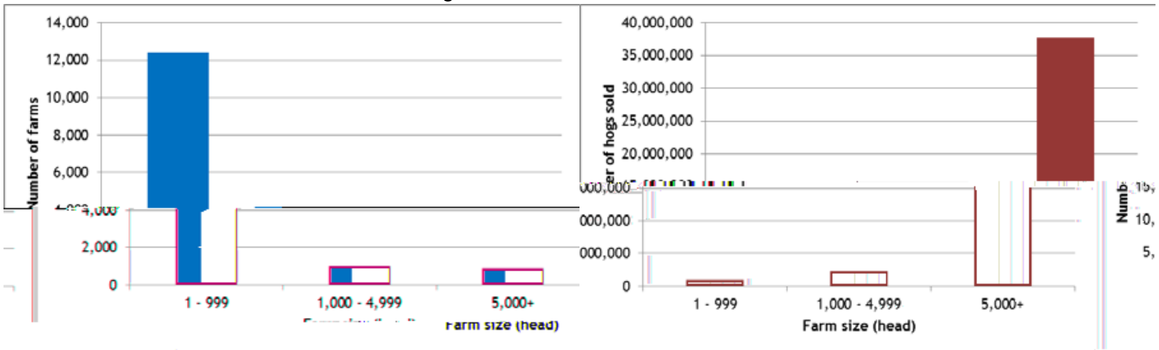
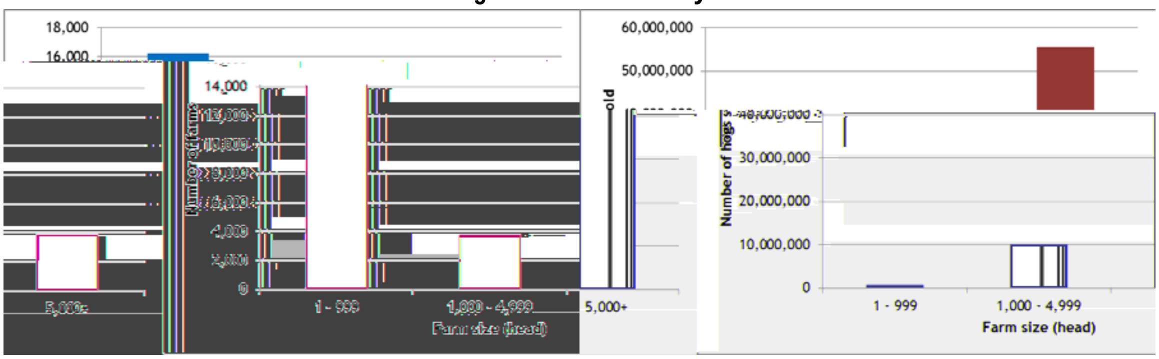
Figure 6: Farrow to finish



Source: US 2012 Census of Agriculture

Figure 7: Finish only



Source: US 2012 Census of Agriculture

In all four cases, the majority of swine farms are small, but the majority of animals are raised in operations marketing 5,000 or more hogs.

After the finishing phase, pigs are ultimately sent to a packer for slaughter. The packer is often an "integrator" that has contracted with growers to sell the packer their finished hogs or to raise hogs owned by the packer to market weight. Frequently there is a contractor in between the grower and packer that serves as the integrator. Contractors often have production contracts with growers and marketing contracts with their packer customers that specify pricing and other terms.

US swine production continues to transition to fewer, larger farms due to increased economies of scale afforded by the larger more vertically integrated operations. The percentage of hogs purchased by the packers in the United States through marketing or production agreements has been stable at around 60% while the production of hogs owned and raised by the packer has increased to close to 30% of the total purchases (Figure 8).

3.2.3. Marketing

The hog market has changed significantly in the last 20 years. Historically, growers would either sell their hogs on the spot cash market or deliver under a marketing contract to a packer. However, spot market purchases by packers, which represented only 15% of sales in 2004,[2] have since shrunk to under 4% of animals delivered.[3]

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[2] Harper, Allen. "Hog Production Contracts: The Grower-Integrator Relationship." Virginia Tech, 2009.
[3] United States International Trade Commission. "Pork and Swine: Industry & Trade Summary," p.34. October 2014.

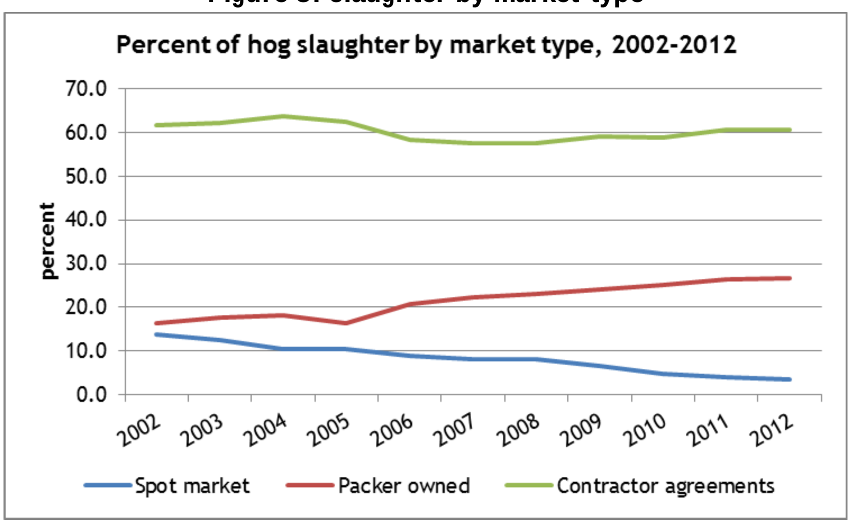
More importantly, the structure of hog ownership has changed as hog production has followed the path of poultry, becoming more vertically integrated. The packers that own slaughter facilities now raise more of the hogs they slaughter, and they use production contracts with growers to raise other packer-owned hogs. Independent contractors also use production contracts with growers. In both cases the grower does not own the hogs and is responsible only for having made the investment in the hog barn and then feeding, caring for, and delivering an animal of marketable weight. Based on the 2009 Agricultural Resource Management Survey of the hog industry, USDA's Economic Research Service reported that 71% of hogs were grown under such production contracts that year.[4]

Production contracts typically spell out not only the length of the contract, terms for its renewal, and circumstances that would result in termination, but also specific terms regarding which party is responsible for inputs like equipment, facilities, feeder pigs, feed, and other services.

Nevertheless, independent growers still own a majority of the hogs slaughtered each year, and sell them to packers or intermediaries primarily through marketing contracts that can take a variety of forms. The most common contract is a finishing contract, whereby the grower raises the animals from feeder weight to market weight (typically from 45 pounds to 250+ pounds).

There do not appear to be any definitive estimates of the current breakdown of hog ownership. Based on Agricultural Marketing Service data, the U.S. International Trade Commission concluded that "…the total share of slaughtered barrows and gilts owned by packers (including sales for slaughter by packers) increased slightly, from 30.6 percent in 2008 to 32.3 percent in 2012 and 33.4 percent in 2013."[5] Our own calculations shown in Figure 8 put it slightly lower in 2012 at about 27 percent.

Figure 8: Slaughter by market type



Sources: Grimes, G., and R. Plain. U.S. Hog Marketing Contract Study. Columbia, MO: University of Missouri Department of Agricultural Economics, 2005; Grimes, G., and R. Plain. U.S. Hog Marketing Contract Study. Columbia, MO: University of Missouri Department of Agricultural Economics, 2007; R. Plain. U.S. Market Hog Sales, 2002-2012. Columbia, MO: University of Missouri Department of Agricultural Economics, 2013.

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[4] McBride, William D., and Nigel Key. *U.S. Hog Production From 1992 to 2009: Technology, Restructuring, and Productivity Growth,* ERR-158. U.S. Department of Agriculture, Economic Research Service, October 2013, p. 14.
[5] United States International Trade Commission, op. cit., page 25

The price paid for slaughter-ready hogs is determined by the specific contract type. Prices may be defined using the spot market, the futures market or as otherwise specified in the contract. The fact that such a small percentage of hogs are sold in the spot market raises questions as to the validity of using spot cash values as a basis for contract prices.

3.2.4. Slaughter and processing

After finishing, swine are sent to packers for slaughter and processing.

US pork production has generally been rising. Although there are some cyclical periods of growth and contraction, pork production has grown by 10% over the last ten years, an average of 1% per year. Annual slaughter is shown in Figure 9. Since 2007, production has fluctuated around 110 million head, dropping to 107 million head in 2014 as a result of piglet mortality from the PEDV outbreak.

Figure 9: Hog slaughter in the United States

Source: USDA NASS

Hog slaughter, as with hog production, takes place nationwide. Nevertheless, it is more concentrated than hog farming. Table 3 shows slaughter volume (live weight) by state.

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Table 3: Hog slaughter by state, 2009-2014

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
Alabama	34,974	33,409	30,382	14,216	10,917	8,618
Alaska	240	241	(D)	173	219	264
Arizona	377	369	360	393	406	458
Arkansas	82,177	70,868	58,436	62,797	19,404	2,382
California	643,816	607,334	602,678	591,853	577,875	586,816
Colorado	2,599	2,350	2,481	3,429	3,829	3,902
DE-MD	4,454	4,500	4,535	4,421	4,331	4,612
Florida	11,809	10,212	11,563	9,176	9,589	6,617
Georgia	18,642	18,004	18,788	20,318	19,481	17,196
Hawaii	3,757	3,865	3,744	3,472	3,322	3,327
Idaho	30,723	27,673	31,220	35,551	35,122	33,902
Illinois	2,674,385	2,582,000	2,700,986	2,988,384	3,025,416	3,008,036
Indiana	2,256,328	2,265,202	2,280,616	2,288,547	2,299,170	2,301,137
Iowa	8,682,322	8,144,471	8,177,329	8,291,508	8,185,368	8,197,146
Kansas	(D)	(D)	(D)	(D)	(D)	(D)
Kentucky	(D)	(D)	(D)	(D)	(D)	(D)
Louisiana	2,515	2,182	2,193	2,246	2,234	2,436
Michigan	45,705	41,903	50,516	50,615	60,395	72,603
Minnesota	2,592,322	2,691,772	2,781,851	2,879,567	2,786,846	2,670,789
Mississippi	36,058	32,715	36,014	36,925	18,548	7,974
Missouri	2,228,686	2,195,631	2,270,487	2,295,431	2,385,686	2,450,372
Montana	3,227	3,327	3,271	3,668	3,588	3,117
Nebraska	2,067,922	2,063,582	2,104,923	2,155,431	2,076,000	2,014,836
Nevada	(D)	(D)	138	151	151	201
New England 1/	4,546	5,027	5,772	6,420	6,875	7,275
New Jersey	9,676	10,123	10,700	10,644	10,866	9,858
New Mexico	419	412	345	490	541	569
New York	5,002	5,008	5,603	7,246	7,860	8,376
North Carolina	3,218,592	3,069,404	2,997,190	3,097,925	3,226,084	(D)
North Dakota	27,041	30,329	12,609	1,303	1,159	1,104
Ohio	293,736	283,290	279,364	266,464	261,061	257,744
Oklahoma	1,472,745	1,496,690	1,553,171	1,502,169	1,491,095	1,362,893
Oregon	40,490	41,753	44,446	43,325	42,861	43,253
Pennsylvania	774,417	755,972	729,297	753,523	745,736	760,167
South Carolina	(D)	(D)	(D)	(D)	(D)	(D)
South Dakota	1,135,646	1,185,554	1,255,427	1,264,017	1,278,320	(D)
Tennessee	320,370	318,250	311,520	323,119	327,467	321,773
Texas	105,276	104,158	122,341	114,644	103,356	65,780
Utah	10,815	7,204	9,416	9,328	10,485	7,873
Virginia	600,419	629,327	631,029	676,192	676,504	(D)
Washington	5,242	(D)	(D)	(D)	(D)	(D)
West Virginia	1,784	1,590	1,887	2,084	1,875	1,864
Wisconsin	228,925	228,813	250,979	250,420	270,284	274,959
Wyoming	1,063	1,045	1,094	1,101	1,080	1,033
United States	30,723,264	30,004,639	30,422,112	31,092,083	30,964,311	30,431,080

(D) Withheld to avoid disclosing data for individual operations.

1/ New England includes Connecticut, Maine, Massachusetts New Hampshire, Rhode Island, and Vermont.

Source: USDA NASS

The top five states account for 61% of slaughter: Iowa (8.2 billion pounds, 27%), Illinois (3.0 billion, 10%), Minnesota (2.7 billion, 9%), Missouri (2.5 billion, 8%), and Indiana (2.3 billion, 8%). Pork production, shown in Table 4, is even more concentrated than slaughter.

Table 4: Pork production by state, 2009-2014

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
Alabama	95,566	65,815	53,621	50,277	60,293	45,565
Alaska	604	622	606	414	374	504
Arizona	76,521	80,582	92,934	84,118	83,730	66,385
Arkansas	109,831	86,432	85,946	86,430	101,110	71,066
California	53,886	56,575	49,542	48,031	47,708	39,304
Colorado	265,861	297,691	300,949	278,891	259,063	246,115
Connecticut	831	1,121	689	730	1,276	984
Delaware	4,241	4,466	2,810	2,722	4,124	1,129
Florida	7,879	4,173	4,251	3,633	3,489	4,119
Georgia	98,080	75,405	88,359	98,272	81,609	70,760
Hawaii	3,319	4,032	4,021	4,330	4,062	4,201
Idaho	25,984		(D)	(D)	(D)	(D)
Illinois	1,838,925	1,926,414	1,911,353	1,962,779	2,001,164	1,949,324
Indiana	1,738,802	1,753,822	1,762,434	1,753,128	1,643,591	1,639,654
Iowa	9,608,305	9,244,147	9,816,139	10,345,144	11,170,460	11,548,962
Kansas	914,694	883,829	930,878	912,876	838,461	773,202
Kentucky	174,705	185,534	176,560	168,777	175,863	170,721
Louisiana	2,757	3,212	4,275	1,337	1,520	1,621
Maine	2,135	2,305	3,130	2,842	2,211	2,075
Maryland	15,250	14,409	12,392	11,341	11,590	11,519
Massachusetts	1,813	3,539	3,029	2,561	4,265	3,016
Michigan	606,284	619,869	618,558	548,754	561,091	524,658
Minnesota	3,678,035	3,699,102	3,702,918	3,938,732	3,912,363	3,785,444
Mississippi	179,790	152,173	161,738	155,865	181,330	144,323
Missouri	1,694,338	1,288,014	1,321,770	1,313,879	1,308,522	1,481,513
Montana	78,601	79,932	77,175	81,659	84,479	83,619
Nebraska	1,359,740	1,366,535	1,317,634	1,250,968	1,176,855	1,188,096
Nevada	2,650	1,821	992	1,497	1,803	1,667
New Hampshire	1,235	1,011	783	1,382	1,168	1,420
New Jersey	1,814	1,650	1,644	1,516	1,664	1,414
New Mexico	780	553	400	375	693	744
New York	25,347	23,813	28,259	26,235	24,581	28,016
North Carolina	4,070,849	3,767,088	3,662,862	3,921,079	4,056,602	3,558,499
North Dakota	60,908	59,729	70,182	53,514	51,642	52,281
Ohio	999,093	1,049,889	1,065,596	1,080,269	1,093,003	1,046,439
Oklahoma	1,255,841	1,294,142	1,350,272	1,331,382	1,374,298	1,262,803
Oregon	9,484	8,610	7,493	5,170	3,034	2,420
Pennsylvania	414,382	504,219	479,159	505,852	490,700	516,772
Rhode Island	452	561	575	599	562	704
South Carolina	49,908	53,178	48,966	47,924	47,207	50,136
South Dakota	671,593	741,125	779,501	797,188	697,249	606,351
Tennessee	92,354	99,106	93,672	85,466	90,541	94,251
Texas	302,578	154,540	203,312	267,523	285,822	309,408
Utah	324,227	303,829	305,154	285,920	287,097	267,002
Vermont	1,285	1,177	1,230	1,367	1,304	1,316
Virginia	110,902	113,738	73,830	68,800	71,287	64,875
Washington	11,453		(D)	(D)	(D)	(D)
West Virginia	2,263	1,312	1,938	2,325	1,682	1,266
Wisconsin	190,346	173,255	175,156	171,854	167,000	143,196
Wyoming	122,787	136,550	165,446	144,125	105,066	101,832
ID & WA		46,729	45,770	50,939	45,656	40,997
United States	31,359,308	30,437,375	31,065,903	31,960,791	32,620,264	32,011,688

(D) Withheld to avoid disclosing data for individual operations.
Source: USDA NASS

The top five states (Iowa, North Carolina, Minnesota, Illinois, and Indiana) account for 70% of pork production (the top three represent 59%). Iowa alone accounts for over one-third of the nation's pork processing. The processing industry ownership is likewise concentrated, with the top 4 firms holding a 77% market share, based on slaughter estimates.[6] The top 5 firms account for 88%.

[6] "Leading pig processors, producers from around the world." Pig International. Vol 47, No. 7 (Nov-Dec 2014), p.8. Processor shares derived by comparing firm slaughter estimates with the 112 million swine slaughter figure for 2013.

3.3. Industry economics

3.3.1. Production costs

Hog production costs in the United States have been about $50-60 per hundredweight (cwt) of gain for the last six years, according to ERS production cost estimates for farrow-to-finish operators. Feed costs are the single largest expense in hog production, accounting for roughly 60% of total costs; other operating costs add another 10% share. Overhead represents about 30% of the cost of production.

Table 5: Swine production costs, farrow-to-finish

Item	2009	2010	2011	2012	2013	2014
	dollars per cwt gain					
Total, gross value of production	47.12	62.06	75.36	73.28	76.69	87.33
Operating costs						
Feed cost	24.26	23.24	34.67	32.66	36.72	34.07
Other operating costs	4.76	5.17	5.73	5.79	5.86	6.04
Total operating costs	29.02	28.41	40.40	38.45	42.58	40.11
Allocated overhead						
Overhead	11.77	11.73	12.05	10.16	10.37	10.83
Labor and Opportunity cost	7.02	7.04	7.02	7.21	7.58	7.72
Total, allocated overhead	18.79	18.77	19.07	17.37	17.95	18.55
Total costs listed	47.81	47.18	59.47	55.82	60.53	58.66
Value of production minus costs	-0.69	14.88	15.89	17.46	16.16	28.67

Source: USDA ERS Cost of production estimates

Sunk capital costs – those incurred regardless of whether hogs are grown - are substantial. They account for 15-20% of the total costs, usually around $10-11 per hundredweight of gain. These include capital recovery costs for machinery, equipment, buildings and the breeding herd, plus taxes, insurance and general farm overhead. Paid and unpaid labor represents 10-15% of costs.

Although 2009 was a year during which hogs were produced at a slight loss, in the five years since, margins have been strong, typically $0.15 per pound ($15 per hundredweight). However, in 2015 hog prices have declined significantly and are projected by USDA to remain at a similar level through 2016.

3.3.2. Supply-demand overview

Market supply, demand, trade and disappearance are shown in Table 6. Production has risen from 20.7 billion pounds (carcass weight) in 2015 to 22.9 billion pounds in 2014.

US pork imports have typically ranged from 800 million to 1 billion pounds over the past decade. This volume remains stead and accounts for less than 5% of the total pork supply.

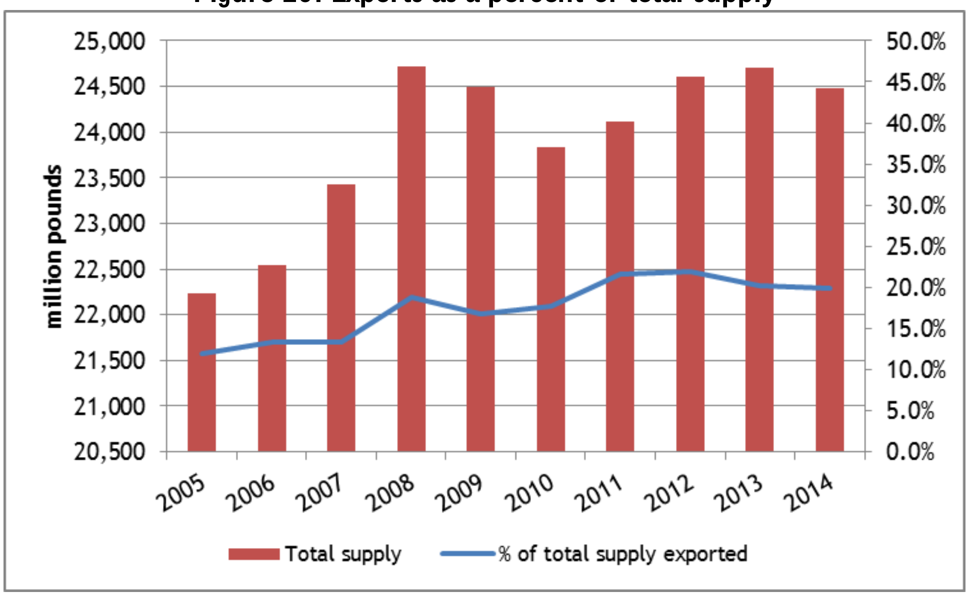
Exports, by contrast, are larger and have been growing, rising from 12% to 20% of total supply. They grew rapidly in the mid to late 2000s, virtually doubling from 2.7 billion pounds in 2005 to about 5 billion pounds in the last few years.

Table 6: US pork production, trade, and consumption, 2005-2014

	Total production	Imports	Total supply	Exports	% of total supply exported	Total disappearance	U.S. population (1,000 persons)	Per capita disappearance (pounds) Boneless retail weight
2005	20,705	1,024	22,239	2,666	12.0%	19,093	295,993	47.0
2006	21,074	990	22,543	2,995	13.3%	19,055	298,818	46.5
2007	21,962	968	23,424	3,141	13.4%	19,763	301,696	47.8
2008	23,367	832	24,717	4,651	18.8%	19,431	304,543	46.5
2009	23,020	834	24,489	4,094	16.7%	19,869	307,240	47.1
2010	22,456	859	23,840	4,223	17.7%	19,077	309,776	44.9
2011	22,775	803	24,120	5,196	21.5%	18,382	312,034	42.9
2012	23,268	802	24,612	5,380	21.9%	18,607	314,246	43.2
2013	23,200	880	24,705	4,992	20.2%	19,095	316,465	44.0
2014	22,858	1,007	24,483	4,858	19.8%	19,065	318,688	43.6

Source: USDA WASDE

Figure 10: Exports as a percent of total supply

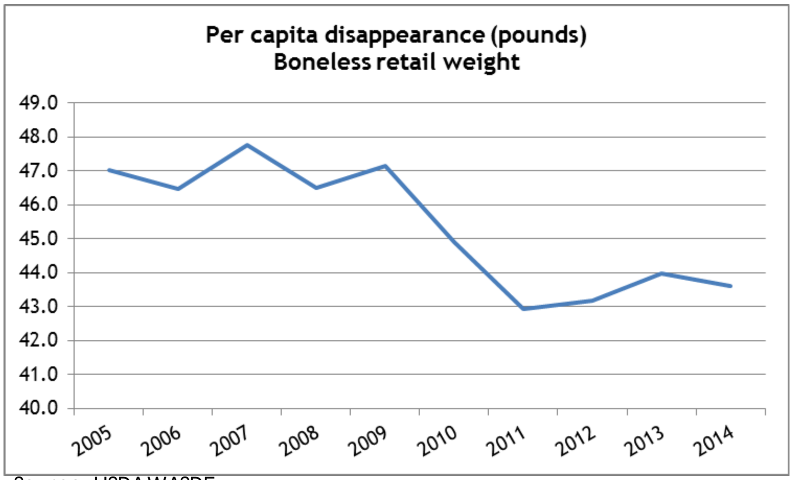


3.3.3. Domestic demand

Domestic pork consumption was 19.1 billion pounds in 2014, approximately one-quarter of total national red meat and poultry consumption. Beef accounts for another quarter and poultry for one-half.

On a per capita basis, pork demand is approximately 44 pounds per person.

Figure 11: US pork consumption per capita, 2005-2014



Source: USDA WASDE

Table 7 shows USDA projections for per capita consumption over the next decade.

Table 7: US per capita meat consumption projections, by type, 2013-2024

Per capita meat consumption, retail weight

Item	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
						pounds						
Beef	56.3	54.6	52.2	49.4	48.5	49.1	49.8	50.6	51.5	52.1	52.4	52.4
Veal	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Pork	46.8	45.3	46.6	48.5	48.8	49.1	49.3	49.4	49.4	49.4	49.4	49.5
Lamb & mutton	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total red meat	104.4	101.1	99.9	99.0	98.4	99.3	100.1	101.0	101.9	102.4	102.8	102.9
Broilers	81.9	83.4	85.4	86.7	88.1	89.2	90.2	91.1	91.7	92.2	92.7	93.1
Other chicken	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Turkeys	16.0	15.7	15.8	16.2	16.5	16.7	16.8	17.0	17.1	17.2	17.3	17.3
Total poultry	99.2	100.3	102.5	104.2	106.0	107.3	108.4	109.5	110.2	110.8	111.3	111.9
Red meat & poultry	203.6	201.4	202.3	203.2	204.4	206.5	208.5	210.5	212.1	213.2	214.1	214.8

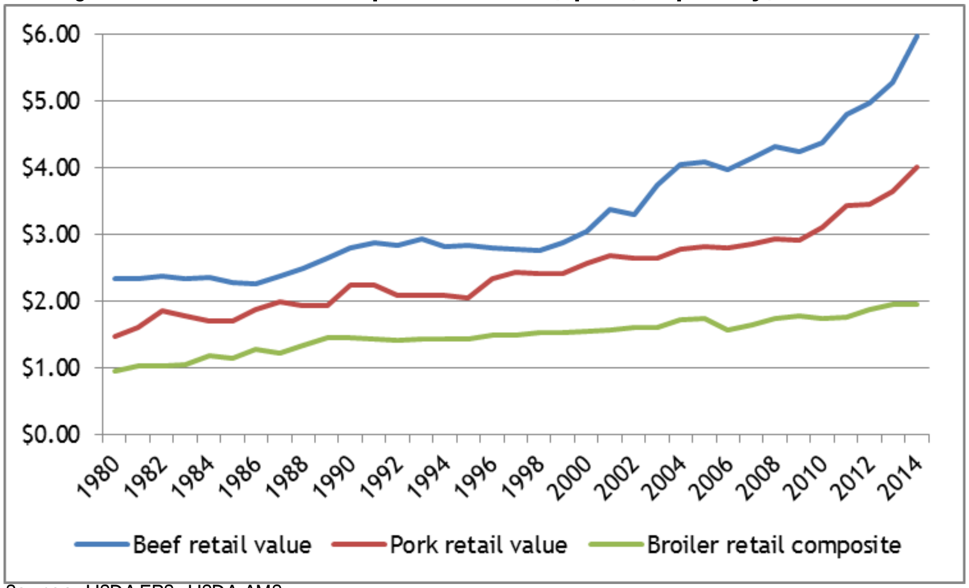
Pork share of total	23%	23%	23%	24%	24%	24%	24%	23%	23%	23%	23%	23%
Pork share of red meat	45%	45%	47%	49%	50%	49%	49%	49%	48%	48%	48%	48%

Source: USDA Baseline Projections

Over the next ten years, per capita beef consumption is expected to decline by about 5% while pork and poultry consumption are expected to grow by 10%.

A primary reason for these trends is the high price of beef relative to pork and poultry. Figure 12 shows retail prices for all three products from 1980 to 2014.

Figure 12: US meat retail prices for beef, pork, & poultry, 1980-2104



Source: USDA ERS, USDA AMS

Beef and pork prices have risen at a faster rate than prices for poultry. While broiler prices doubled between 1980 and 2014, those for pork and beef have almost tripled. The divergence in prices has been most pronounced since 2000.

There is significant correlation among these prices over time, particularly as chicken and pork serve as substitutes for beef during lean economic times. Other events, such as excess supply or consumer scares, can also trigger price changes or product substitution.

3.3.4. International markets

US exports of pork (HTS code 0203, "meat of swine, fresh, chilled or frozen") totaled almost 1.5 million tons in 2014, up from 820,000 MT in 2005 – an expansion of 80%. The largest export markets for US pork are Mexico and Japan, which account for more than half of US shipments. Next are South Korea, China, and Canada, bringing the top five markets to 80% of all exports. Of these five, demand from Mexico, China, and South Korea has doubled or more over the past decade; growth in exports to Japan and Canada has been less significant.

Table 8: Top US pork export markets, 2005-2014

Importers	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	% of total
Mexico	170,155	179,167	142,130	228,631	274,601	283,898	286,111	410,113	429,071	480,486	32.5%
Japan	338,642	325,831	346,434	419,107	392,152	391,228	464,614	421,669	402,323	368,749	24.9%
S. Korea	60,230	91,208	82,764	94,939	83,993	69,502	148,626	132,513	87,235	119,334	8.1%
China	32,669	27,652	62,860	108,164	20,838	46,834	219,216	199,376	153,596	108,109	7.3%
Canada	80,049	90,223	108,173	125,167	112,849	112,632	122,611	130,821	112,042	104,839	7.1%
Australia	18,033	20,170	23,774	30,685	38,492	44,483	55,992	59,668	48,647	44,981	3.0%
Colombia	3,224	3,419	3,475	2,831	3,745	7,371	9,676	16,247	29,795	41,449	2.8%
Hong Kong	5,863	13,111	37,260	155,081	91,472	59,738	36,779	38,609	45,885	40,279	2.7%
Other	110,708	156,582	159,257	302,996	236,531	225,093	204,758	237,989	181,796	169,988	11.5%
World	819,573	907,363	966,127	1,467,601	1,254,673	1,240,779	1,548,383	1,647,005	1,490,390	1,478,214	100.0%

Source: USITC, TradeMap

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3.3.5. International competition

World trade in pork was approximately 6.6 billion pounds in 2014, of which the US accounted for 35%. The EU is a close second as a global supplier.

USDA baseline projections show the US retaining a 34-35% share of world pork trade through 2024. Global trade is expected to grow by approximately 20% over the next decade. These projections assume no major supply shocks, trade disruptions, or changes in market access for major importers.

Table 9: USDA baseline pork projections

USDA baseline pork trade projections												
Exporters	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	Exports, thousand metric tons, carcass weight											
United States	2,264	2,298	2,381	2,438	2,495	2,540	2,574	2,608	2,642	2,676	2,710	2,744
European Union	2,236	2,150	2,200	2,213	2,257	2,293	2,354	2,400	2,450	2,498	2,547	2,595
Canada	1,245	1,180	1,180	1,195	1,217	1,235	1,245	1,253	1,262	1,271	1,280	1,290
Brazil	585	585	700	770	795	799	810	820	825	830	835	840
China	244	275	300	308	309	313	316	319	322	327	330	333
Mexico	111	120	125	128	132	136	140	145	150	155	160	165
Major exporters	6,685	6,608	6,886	7,052	7,205	7,316	7,438	7,546	7,651	7,757	7,863	7,967
US share	34%	35%	35%	35%	35%	35%	35%	35%	35%	35%	34%	34%

Source: USDA

4. IMPACT AND MANAGEMENT OF SWINE DISEASES

In this section we first describe the various swine diseases and how they are viewed in the US and world regulatory frameworks. Section 4.2 reviews the geographic incidence of disease outbreaks, and Section 4.3 discusses estimates that have been made of their economic impact. Section 4.4 describes best management practices for preventing and dealing with disease outbreaks.

For the most significant swine diseases, international and national reporting requirements and whether they are regulated by the United States Department of Agriculture (USDA) are noted. The World Organization for Animal Health, referred to as the OIE as it was formerly known as the Office International des Epizooties, maintains a list of diseases reportable at the international level. The OIE sets reporting standards for animal diseases affecting international trade. Most nations, including the US, are OIE members. Member countries submit routine reports on the disease status on the OIE listed diseases. Any change in the disease status of a country that is recognized as free of an OIE listed disease must be reported immediately.

The USDA's Animal and Plant Health Inspection Service (APHIS) maintains a list of diseases that are reportable at the national level. Reportable diseases include important transboundary, (or foreign animal) diseases, USDA Program diseases, zoonotic diseases and bioterrorism disease agents. States may have additional diseases of interest that they monitor, and thatare reportable at the state level.

The USDA-established Program Diseases have been defined when the need arises to jointly work with states and industry to control or eradicate specific animal diseases or pests.

Recently, in response to a need for more standardized reporting at the national and state levels, a National List of Reportable Animal Diseases (NLRAD) was proposed and is currently in the evaluation phase (USDA, APHIS, 2014). The NLRAD is divided into two categories: monitored diseases and notifiable diseases and conditions. The notifiable diseases section is subdivided into emergency incidents, emerging disease incidents, and regulated disease incidents. Notifiable diseases and conditions must be brought to the attention of the veterinary authority promptly, in accordance with national and State regulations. Monitored diseases are routinely tracked and data are used to monitor changes in a given population and its environment, or to report on disease occurrence.

4.1. Diseases potentially affecting the US industry

We discuss these in three groups. The first group includes those diseases that are already well established in the United States. Most can be either controlled or eliminated without completely depopulating and repopulating with uninfected animals (abbreviated as CDR in the following discussion). The next two groups are variously referred to as the transboundary pathogens or foreign animal diseases (FADs) that are not present in the United States. The first group includes those that are not so serious that if introduced here they would affect US pork exports. But the second group of four diseases would result in embargoes that would reduce foreign purchases of US pork and have a serious impact on the pork sector.

4.1.1. Significant swine diseases endemic to US

Porcine reproductive and respiratory virus (PRRSV) is the most economically significant endemic swine pathogen in the US. It causes annual productivity losses valued at $664 million dollars (Holtkamp et al., 2013). The PRRS disease is on the list of diseases reportable to USDA and to the World Organization for Animal Health. Under the USDA's newly proposed reporting structure it is designated a monitored disease. It is not a USDA program disease nor is it considered a zoonotic disease, i.e. one that can be transmitted from animals to humans. PRRSV is a systemic virus that is manifest as reproductive disease in older animals and respiratory disease in younger animals. The reproductive disease in older animals leads to late-term abortions, an increase in pigs born stillborn and in pre-weaning mortality. In young pigs it leads to variable levels of mortality, reduced growth and poorer conversion of feed to gain. While methods to control and even eliminate the virus from herds, without completely depopulating and repopulating with naïve animals (CDR) have been developed, preventing outbreaks when different strains of the virus infect herds has proven to be challenging. Within herds, immunity to different strains of the virus is variable and unpredictable. PRRS outbreaks are seasonal with most occurring in cold-weather months. PRRSV is shed in nearly every secretion and excretion of swine. It can be transmitted vertically from dam to fetuses and also to piglets after birth. It is transmitted between herds by infected pigs and contaminated semen. The PRRSV is relatively fragile in the environment but it has been demonstrated that aerosolized particles, contaminated livestock trailers, people, fresh pork and many other carrying agents can transmit the virus from one herd to another, especially in colder temperatures where the virus is more stable (Perez et al., 2015).

Swine influenza virus (SIV) type A is a widespread, difficult to control pathogen that causes respiratory disease in all ages of pigs during every season of the year. Mortality is generally low but productivity losses due to reduced growth and poorer conversion of feed to gain in growing pigs can be relatively severe. Multiple subtypes (H1N1, H1N2, and H3N2) of type A influenza viruses are present in the US swine herd and immunity to different subtypes of the virus is poor. Swine influenza is not on the list of reportable diseases for the USDA or OIE. It is not a USDA program disease. Genetic reassortment among swine, human and avian influenza viruses has been frequently demonstrated. Although infrequent, it is a potential zoonotic disease. Movement of pigs is the primary route of transmission between herds but aerosol, people and other carrying agents also likely play a role.

Porcine epidemic diarrhea virus (PEDV) was introduced into the US in 2013. How the virus entered the US will likely never be known but the strains of the virus now present most closely match strains of a virus found in China. Because the US swine population was naïve to the virus, it caused severe losses. PEDV is an enteric virus that infects only pigs. It affects all ages of pigs but is predominantly characterized by severe diarrhea and high mortality in very young piglets. As of June 2014 it is on the list of reportable diseases for the USDA but is not reportable to the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease nor is it considered to be zoonotic. Methods to eliminate the virus from herds without CDR have been developed but the duration of immunity to prevent future outbreaks is uncertain. PED outbreaks are seasonal with most occurring in cold-weather months. PEDV is relatively fragile in the environment but feed, contaminated livestock trailers, people and many other carrying agents that may come in contact with feces from infected pigs can transmit the virus from one herd to another, especially in colder temperatures where the virus is more stable.

Porcine deltacorona virus (PDCoV) is very similar to PEDV. It was introduced into the US in 2014. Like PEDV, how the virus entered the US will likely never be known but the strains of the virus now present also most closely match strains of a virus found in China. Clinically, disease caused by PDCoV is very similar to PED but typically less severe. PDCoV is an enteric virus that infects only pigs. It affects all ages of pigs but is predominantly characterized by severe diarrhea and high mortality in very young piglets. As of June 2014 it is on the list of reportable diseases for the USDA but is not reportable to the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease nor is it considered to be zoonotic. Like PEDV, methods to eliminate the virus from herds without CDR have been developed but the duration of immunity to prevent future outbreaks is uncertain. Outbreaks are seasonal with most occurring in cold-weather months. PDCoV is relatively fragile in the environment but feed, contaminated livestock trailers, people and many other carrying agents that may come in contact with feces from infected pigs can transmit the virus from one herd to another, especially in colder temperatures where the virus is more stable.

Transmissible gastroenteritis virus (TGEV) is an enteric virus that, like PEDV, infects only pigs. It affects all ages of pigs but is predominantly characterized by severe diarrhea and high mortality in very young piglets. TGE is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a monitored disease. It is not a USDA program disease nor is it considered a zoonotic disease. Methods to eliminate the virus from herds without CDR have been developed. TGE outbreaks in US swine herds are infrequent and seasonal with most occurring in cold-weather months. TGEV is relatively fragile in the environment but feed, contaminated livestock trailers, people and many other carrying agents that may come in contact with feces from infected pigs can transmit the virus from one herd to another, especially in colder temperatures where the virus is more stable.

Porcine circovirus type 2 (PCV2) emerged in the US as a major cause of porcine circovirus-associated disease (PCVAD) in the mid-2000s. It is a systemic virus that only infects pigs. The disease, which occurs in every season of the year, is most prominently characterized by a post-weaning, multisystemic wasting in growing pigs. The disease causes variable levels of mortality, reduced growth and poorer conversion of feed to gain. PCV2 is ubiquitous in the US swine population but the disease, and productivity losses associated with it, are well controlled by several commercially available vaccines. PCV2 is not on the list of reportable diseases for the USDA or OIE. It is not a USDA program disease nor is it considered to be zoonotic. Methods to eliminate the virus from herds have not been developed.

Mycoplasma hyopneumoniae (Mhyo) is a respiratory mycoplasma that causes enzootic pneumonia in swine only. It plays a primary role in porcine respiratory disease complex (PRDC) along with PRRSV, SIV, PCV2 and multiple bacterial pathogens. *Mhyo* causes variable levels of mortality, reduced growth and poor conversion of feed to gain. *Mhyo* is not on the list of reportable diseases for the USDA or OIE. It is not a USDA program disease nor is it considered to be zoonotic. Methods to eliminate *Mhyo* from herds without CDR have been developed but it remains ubiquitous in the US swine population. Movement of pigs is the primary route of between herd transmission but aerosol, people and other carrying agents also likely play a role.

Lawsonia intracellularis (L. intracellularis) is an enteric bacteria that causes multiple forms of proliferative enteropathy (PE). *L. intracellularis* can infect other domestic animal species, including horses and rabbits, and cause a similar disease to that observed in swine. *L. intracellularis* primarily causes reduced growth and poorer conversion of feed to gain in growing pigs with low levels of mortality. *L. intracellularis* is not on the list of reportable diseases for the USDA or OIE. It is not a USDA program disease nor is it considered to be zoonotic. The pathogen is present in nearly all swine farms and disease occurs commonly in the US. Methods of eliminating the pathogen from farms without CDR have not been developed.

Actinobacillus pleuropneumoniae (APP) is a respiratory bacteria that causes severe pneumonia in swine only. Multiple strains exist with varying levels of virulence. Virulent strains of *APP* cause high levels of mortality as well as reduced growth and poorer conversion of feed to gain. *APP* is not on the list of reportable diseases for the USDA or OIE. It is not a USDA program disease nor is it considered to be zoonotic. Methods of eliminating the pathogen from farms without CDR have been developed.

Brachyspira spp. are enteric bacteria that cause disease characterized by bloody diarrhea. Several species of Brachyspira have been implicated, including *hyodysenteriae, hampsonii, murdochii and pilosicoli*. *Brachyspira* primarily cause reduced growth and poorer conversion of feed in growing pigs with rare occurrences of mortality. *Brachyspira spp.* are not on the list of reportable diseases for the USDA or

OIE. They are not USDA program diseases. *B. pilosicoli* is capable of infecting and causing disease in immunocompromised people. Methods to eliminate the bacteria from herds without CDR have been developed. Movement of pigs is the primary route of transmission between herds but feed, contaminated livestock trailers, people and many other carrying agents that may come in contact with feces from infected pigs can transmit the virus from one herd to another.

Erysipelothrix rhusiopathiae is a systemic bacteria that causes erysipelas in swine. Mortality is variable in growing and adult swine, and growing pigs may have reduced growth and poorer conversion of feed to gain. Erysipelas is on the list of reportable diseases for the USDA but not OIE*.* Under the USDA's newly proposed reporting structure it is designated a monitored disease. It is not a USDA program disease but is zoonotic. Erysipelas is controlled with commercially available vaccines and antibiotics.

Leptospira spp. are bacteria that cause leptospirosis which is predominantly characterized by reproductive losses in breeding swine. Several species of Leptospira have been implicated, including *pomona, kennewicki, bratislava, canicola, grippotyphosa, hardjo* and others. Swine are not the only host of some species of Leptospira. Leptospirosis is not on the list of reportable diseases for the USDA or OIE***.*** It is not a USDA program disease but is zoonotic. Methods to eliminate the bacteria from herds without CDR have not been developed but it is well controlled with vaccines.

Vesicular stomatitis (VS) primarily affects horses and cattle and occasionally swine, sheep and other small ruminants. VS does not generally cause mortality or significant productivity losses in swine. VS is significant because clinical signs are similar to those of foot-and-mouth disease (FMD) and swine vesicular disease (SVD), both transboundary diseases that would interrupt exports. Diagnostic testing is required to distinguish among these vesicular diseases. VS is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease but is zoonotic.

Bacillus anthracis is a bacteria that causes anthrax in most animals including swine and humans. It is frequently fatal in affected animals. The geographic distribution of anthrax is global but the incidence of cases in the US is low. Anthrax is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease.

Rabies virus (RV) is primarily a zoonotic concern because it is highly fatal in humans; however, there are few documented cases of transmission from swine to humans. It is currently present in the US. Rabies is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease.

Francisella tularensis is a bacteria that causes tularemia and is primarily a zoonotic concern related to the hunting and consumption of feral pigs in the US. Tularemia is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a monitored disease. It is not a USDA program disease for swine.

Other less important, but occasionally significant, pathogens listed below are widely present on swine farms in the United States. Their contribution to disease is generally sporadic and related to management, environmental or nutritional stressors, or the presence of other infectious cofactors. None are on the list of reportable diseases for the USDA and OIE or on the list of USDA program diseases. A description of parasitic diseases of swine was not included.

Porcine parvovirus (PPV) causes reproductive losses characterized by stillborns, mummies, embryonic death and infertility (SMEDI).

Rotavirus is an enteric virus that causes severe diarrhea and mortality in neonatal pigs.

Mycoplasma hyorhinis is a systemic mycoplasma characterized by infections of the joints and ears. Mortality is rare but affected pigs may have reduced growth and poorer conversion of feed to gain.

Mycoplasma hyosynoviae is characterized by infections of the joints. Mortality is rare but affected pigs may have reduced growth and poorer conversion of feed to gain.

Actinobacillus suis is a systemic pathogen that is characterized by a wide variety of clinical signs. Mortality is variable and affected growing pigs may have reduced growth and poorer conversion of feed to gain. The bacteria can cause abortions in breeding animals.

Bordatella bronchiseptica is a respiratory pathogen that causes pneumonia and, together with *Pasteurella multocida*, atrophic rhinitis that is characterized by asymmetrical growth of the snout, reduced growth and poorer conversion of feed to gain in affected pigs.

Clostridium perfringens* Type A and C and *Clostridium difficile are enteric pathogens that cause severe diarrhea and mortality in neonatal pigs.

E. coli are systemic bacteria that cause diarrhea and edema disease in growing pigs as well as mastitis and urinary tract infections in breeding animals. Multiple serotypes with varying manifestation of disease and levels of virulence have been characterized. The magnitude of reproductive losses, mortality and reductions in growth is highly variable.

Haemophilus parasuis is a systemic bacteria that causes Glasser's disease in growing pigs. Mortality is variable and growing pigs may have reduced growth and poorer conversion of feed to gain.

Pasteurella multocida is a respiratory bacteria that causes pneumonia and, together with *Bordatella bronchiseptica*, atrophic rhinitis that is characterized by asymmetrical growth of the snout, reduced growth and poorer conversion of feed to gain in affected pigs.

Salmonella choleraesus is a systemic bacteria that causes poor growth performance and occasional mortality in growing pigs.

Salmonella typhimurium is an enteric bacteria that causes diarrhea and poor growth performance in growing pigs.

Staphylococcus hyicus is a bacteria of the skin that causes exudative epidermitis (or "greasy pig disease") in pigs. Low levels of mortality can occur in young pigs. Affected growing pigs may have reduced growth and poorer conversion of feed to gain.

Staphylococcus aureus is a systemic bacteria that can cause skin infections and is capable of infecting other organs as well. It is not a significant cause of productivity losses in pigs.

Streptococcus suis is a systemic bacteria that leads to variable levels of mortality, reduced growth and poorer conversion of feed to gain in affected pigs.

4.1.2. Significant transboundary pathogens that would not interrupt exports

Pseudorabies virus (PRV), the cause of Aujeszky's disease, was eradicated from the US domestic swine population in 2004. Eradication was accomplished by testing and removing positive animals with the aid of a very effective vaccine and diagnostic tests that were able to differentiate antibody from exposure to wild-type virus with antibody from exposure to vaccine. PRV can infect many species but swine is the only species that survives an infection. The disease is characterized by neurological signs that lead to reproductive losses in breeding animals and high levels of mortality, especially in young pigs, and by reduced growth and poorer conversion of feed to gain in growing pigs. Pseudorabies is on the list of reportable diseases for the USDA but not the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is a USDA program disease but it is not considered a zoonotic disease.

Brucella suis (B. suis), is the cause of swine brucellosis. As of February 2015, every state in the United States is classified as free of *B. suis* but it is still present in feral pig populations. Brucellosis is characterized by abortions and infertility leading to significant reproductive losses in breeding animals. *B. suis* is on the list of reportable diseases for the USDA but not the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is a USDA program disease and is zoonotic.

Rinderpest virus (RV) is the first animal pathogen to have been eradicated globally. Due to efforts of the Global Rinderpest Eradication Program, the disease is believed to have been eradicated in 2011. Rinderpest is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease and is not considered a zoonotic disease.

Nipah virus (NV) causes a relatively mild disease in pigs, but is a very serious zoonotic disease. An outbreak in Malaysia and Singapore led to nearly 300 human cases with over 100 deaths. More than a million pigs were euthanized to stop the outbreak. It is currently not present in the United States. NV is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease.

Vesicular exanthema of swine virus (VESV) is a virus that produces a disease in pigs that is clinically indistinguishable from foot and mouth disease (FMD) and swine vesicular disease (SVD) that only affects pigs. It is considered to have been eradicated from the United States in 1959. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not on the list of reportable diseases to the OIE nor is it a USDA program disease.

Ebola virus (EV) is a zoonotic concern but the role of swine in recent human outbreaks is still being studied. It is currently not present in the US. EV is not on the list of reportable diseases for the USDA and the OIE. It is not a USDA program disease.

Japanese encephalitis virus (JEV) is primarily a zoonotic concern as the virus causes a severe encephalitis in humans. Pigs act as important amplifiers of the virus, producing high levels of virus in their blood which infects mosquito vectors. It is currently not present in the US. Japanese encephalitis is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease.

4.1.3. Significant transboundary pathogens that would interrupt exports

Foot and mouth disease virus (FMDV) was last present in the United States over 85 years ago. The US has had nine FMD outbreaks since it was first recognized on the northeastern coast in 1870. It was eradicated each time, the last eradication occurring in 1929. Pigs and many other domestic and wild animals, primarily cloven hooved animals, are susceptible to the virus. FMD is a systemic disease characterized by high fevers and the formation of vesicles on the mouth and feet. Mortality associated with the disease is generally low in older animals but can be high in younger growing pigs. Growing pigs will also have reduced growth and poorer conversion of feed to gain. Reproductive losses due to abortions can occur in breeding animals. FMD is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease. FMDV is zoonotic but humans are rarely infected.

There are multiple serotypes of the virus, which complicates vaccination strategies used to eradicate the virus. Serotypes O and A are widely distributed, SAT serotypes occur mainly in Africa (with periodic incursions into the Middle East), and Asia 1 is currently found only in Asia. FMDV is a systemic virus and is shed in nearly all secretions and excretions from swine. Large amounts of virus are respired from infected pigs and therefore, the aerosol route of transmission from pigs is likely. Unlike in some ruminant species, the virus does not persist in swine and is typically cleared by 28 days. The virus is relatively stable in the environment and may survive in the environment for weeks depending on the conditions. The virus is typically inactivated by the lower pH levels reached in meat after slaughter but because the pH varies there is a risk that the virus will survive in refrigerated or frozen pork meat for long periods of time. It is also relatively resistant to many disinfectants, but acidic or alkaline disinfectants are effective.

Classical swine fever virus (CSFV) was last present in the US over 37 years ago. It was eradicated in 1978 after a 16-year effort. This was the first and only successful eradication of CSFV in the US. The disease is native to the US and was first recognized by the federal government in 1860. Swine is the only species susceptible to the virus. CSF is a systemic disease characterized by high fevers, conjunctivitis, respiratory signs and diarrhea. Infected pigs generally stop eating and are very lethargic. Mortality is variable and depends on the strain of virus and the pig's age. Growing pigs will also have reduced growth and poorer conversion of feed to gain. Reproductive losses due to abortions can occur in breeding animals. Piglets infected in utero can become persistently infected. Persistently infected pigs may shed virus for months and they can become long term carriers of the virus. Modified live and subunit (marker) vaccines are available that make it possible to determine if exposure was to vaccine only or wild-type virus. CSF is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease. CSF is not considered a zoonotic disease. Direct contact with pigs is the primary route of transmission. Exposure to uncooked pig products is also thought to be an important route of transmission. CSFV is moderately stable in the environment. Contaminated livestock trailers, people and many other carrying agents can transmit the virus as well, especially in cold, moist and protein rich environments. It can survive in urine and feces for at least 2 weeks, depending on strain and conditions. The virus may also be transmitted by aerosol.

African swine fever virus (ASFV) has never been recognized in the US. Swine is the only species susceptible to the virus. In domestic pigs, ASFV is a systemic virus that causes disease characterized by high fevers and hemorrhaging in multiple organs. Mortality can range from 0 to 100 percent in a population depending on the strain of the virus. Growing pigs will also have reduced growth and poorer conversion of feed to gain. Reproductive losses due to abortions can occur in breeding animals. There are not effective treatment options or vaccines available for ASFV. The virus's natural hosts are wild African pigs, such as warthogs and bushpigs, which can be persistently infected with the virus with no clinical signs. A number of species of soft ticks in the genus Ornithodoros serve as reservoirs and a biological vector of the virus. Several species of these ticks that are capable of harboring and transmitting ASFV are found in North America. ASF is on the list of reportable diseases for the USDA and the OIE. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease. ASF is not considered a zoonotic disease. Direct contact with pigs is the primary route of transmission. Uncooked pig products, contaminated livestock trailers, people and many other carrying agents can transmit the virus as well. ASFV is shed at high levels in all secretions and excretions of domestic pigs and surviving pigs may harbor virus for weeks or months. ASFV is very stable in the environment and may persist for months in frozen or uncooked meat.

Swine vesicular disease virus (SVDV) is significant because of fears that the presence of SVD could mask an FMD outbreak. The clinical signs of SVD closely resemble those for FMD and historically, differentiating SVDV from FMDV diagnostically was challenging. Diagnostic tests that are now available make this much easier but trading partners remain reluctant to accept pork from countries that are seropositive for SVD. SVDV has never been recognized in the US. Like FMD, SVD is a systemic disease characterized by fever and the formation of vesicles on the mouth and feet. Unlike most other vesicular diseases, swine is the only species susceptible to SVDV. Mortality is not a feature of SVD but growing pigs may have reduced growth and poorer conversion of feed to gain. There are no vaccines available for SVDV. SVD is on the list of reportable diseases for the USDA but was removed from the list of disease reportable to OIE in 2015. Under the USDA's newly proposed reporting structure it is designated a notifiable disease. It is not a USDA program disease. SVD is not considered a zoonotic disease. Direct contact with pigs is the primary route of transmission. SVDV is exceptionally stable in the environment, and therefore, contaminated livestock trailers, people and many other carrying agents, can transmit the virus as well. The virus also remains viable for months in carcasses and processed meats. Airborne transmission of this virus is unlikely. SVDV is even more resistant to most disinfectants than FMDV. Sodium hydroxide and formaldehyde disinfectants make up a very short list of disinfectants that are effective.

4.2. Current geographic distribution and recent outbreaks of FADs

The OIE World Animal Health Information System (WAHIS) publishes current information on recent outbreaks, maps and lists of current status by country, and other useful information for OIE reportable diseases. (http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/Diseasehome; accessed April 25, 2015).

The current FMD status of OIE member countries is published in the following categories; 1) country or zone(s) within country is FMD free where vaccination is not practiced, 2) country or zone(s) within country is FMD free where vaccination is practiced, 3) Suspension of the FMD free status in country or zone(s) within a country where vaccination is not practiced and 4) Suspension of the FMD free status in country or zone(s) within a country where vaccination is practiced (http://www.oie.int/animal-health-in-the-world/official-disease-status/fmd/list-of-fmd-free-members/; accessed April 25, 2015).

FMDV is present or endemic in parts of Africa, Asia, Eastern Europe, the Middle East, and South America. Areas that are free of FMDV include North America (United States, Canada, Mexico and the Caribbean), Central America, Western Europe, Australia, and New Zealand. FMDV was last reported in North America over 60 years ago. The last outbreak in the U.S. occurred in 1929. Canada has been FMD-free since 1952 and Mexico since 1954 (USDA APHIS Foot-and-Mouth Disease (FMD) Response Plan: The Red Book (September 2014)). Recent outbreaks, between January 2015 and April 2015, have occurred in Algeria, Botswana, Zimbabwe, Namibia, China, Mongolia, South Korea and Russia:
(http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/Diseaseoutbreakmaps; accessed April 25, 2015).

CSFV is present in parts of Asia, South America, Central America, Caribbean, Eastern Europe and parts of the former Soviet Union. Areas that are free of CSFV include North America excluding the Caribbean (United States, Canada, and Mexico), Western Europe, Australia, and New Zealand (Ji et al., 2015). CSFV was last present in the US over 37 years ago. It was eradicated in 1978 after a 16-year effort. Canada has been free of CSFV since 1963 and Mexico since 2009:
(http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/statuslist; accessed April 25, 2015).

ASFV is endemic in most of sub-Saharan Africa, including the island of Madagascar and in feral pigs in Sardinia, Italy. It is also now present in Eastern Europe including Poland, Ukraine, Belarus, Estonia, Latvia and Lithuania. All other areas of the world are free of ASFV:

(http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/statuslist ; accessed April 25, 2015). The virus has never been recognized in North America (United States, Canada, and Mexico) except in the Caribbean where it was eradicated in the 1980's.

SVDV has been eradicated from all areas in Europe except southern Italy. Occasional outbreaks still occur throughout Europe. SVDV is thought to be endemic in Asia as well (CFSPH).

4.3. Costs associated with disease outbreaks, for FMD, CSF, ASF and SVD

4.3.1. Losses related to regulatory response to disease outbreaks

Regulatory responses to FMD, CSF, ASF and SVD may include quarantine, depopulation, euthanasia and animal movement restrictions. Economic losses would include the value of the animals destroyed, the cost of animal disposal, cleanup, and interruption of business. The most significant economic loss to the producer would be due to the interruption of business. The reproductive cycle, from mating-to-weaning, for swine is approximately 20 weeks. Therefore, at a minimum 20 weeks of production would be lost and when time for cleanup and downtime were factored in the losses would be even higher. The producer may be indemnified for some of the losses by USDA through APHIS or FSA programs discussed later, but very likely not all. For farms that were not depopulated, but on which movement restrictions were placed, the losses would depend on the duration of time the farm was closed. Most farms would have some flexibility to deal with movement restrictions for a few days to weeks; however, movement restrictions for longer periods of time would mean that the capacity of farms would be exceeded and that some animals would have to be euthanized.

The regulatory responses to FMD, CSF, ASF and SVD may also include vaccination and other control measures. The direct economic impact on the affected herds would be much lower than those created by quarantine, depopulation, euthanasia and animal movement restrictions. The impact would be limited to the cost of the vaccines, veterinary fees, diagnostic testing, biosecurity measures and other costs for controlling the spread of the disease.

Productivity losses

Productivity losses attributed to FMD, CSF, ASF and SVD would only be relevant in herds infected with the viruses that were not quarantined and depopulated. Losses would be dependent on whether a vaccine was used.

Market impacts

Reduced demand due to lost access to export markets would be the most serious impact of an outbreak of FMD, CSF, ASF or SVD in the United States. All four diseases would lead to a major disruption of international trade of pork meat and livestock. In 2014, 21.3 percent of the pork produced in the US was exported. An outbreak of FMD, CSF, ASF or SVD would restrict access to all or a significant portion of the export markets resulting in a significantly increased domestic supply of pork in a very short period of time and lead to a sharp drop in the price of market hogs and pork at the wholesale and retail levels.

Reduced demand due to perceived risks of consuming pork would occur if domestic consumers perceived that eating pork would put them at risk. FMDV is considered zoonotic but it rarely infects humans. CSF, ASF and SVD are all not considered to be zoonotic diseases. Therefore, it is less likely that outbreaks of FMD, CSF, ASF or SVD would lead to a reduction in domestic demand due to food safety issues or fear of contracting the viruses from eating pork meat. However, the press coverage that such an event would likely garner may propagate consumer fear that would reduce domestic demand and lead to a further drop in the price of market hogs and pork at the wholesale and retail levels.

Reduced domestic supply due to lost production would occur depending upon the response to contain the outbreak, the spread of the disease, and the clinical impact of the disease on infected herds. To the extent that the response to outbreaks of FMD, CSF, ASF or SVD results in quarantine, depopulation, euthanasia and movement restrictions, these measures would lead to a loss of pigs and breeding animals in or near infected herds. Productivity losses would occur in herds not depopulated in response to the outbreak. These losses, including reproductive losses in breeding animals as well as mortality and reduced productivity of growing pigs, would be potentially high in herds infected with FMD, CSF or ASF but much less for herds infected with SVD. The impact of productivity losses on the supply of pork would only be significant if the outbreak were not contained to a relatively small number of farms. The losses would decrease the domestic supply of pork in a very short period of time which would drive prices of market hogs and pork at the wholesale and retail levels higher, partially offsetting the effect of the lost export markets and reduced domestic demand.

Impact on the regional and national economies

Economic losses would also extend beyond the producers immediately affected to upstream and downstream industries. Employees of the depopulated farms or farms driven out of business by low prices may be terminated. Owners of facilities that are contracted to raise the pigs from closed farms would lose revenue as pigs were no longer available to be placed in their facilities. Packers, wholesalers and retailers will be impacted by a reduced supply of pigs and by shifts in gross profit margins on pigs slaughtered and on pork meat. Vendors supplying feed, genetics, animal health products, supplies and other products would lose business. Lenders would also suffer if affected producers were no longer able to service their debt. Net farm income would decline due to the loss of export markets, lost productivity, consumer fears, and the losses related to the regulatory response to the disease outbreaks. Regional business, such as grocery stores and gas stations would also suffer as economic activity of the owners, employees and vendors of affected farms slowed.

4.3.2. Review of published economic impact estimates

FMD

In 2002, Paarlberg et al estimated the economic impact of an FMD outbreak in the United States similar to the one that occurred in the United Kingdom (UK) in 2001. In the UK outbreak, it was estimated that 1.7% of swine, 4.3% of cattle and 7.9% of sheep were destroyed in an attempt to control the outbreak. These values, along with other assumptions, were used to estimate productivity losses associated with a hypothetical outbreak in the United States. A complete elimination of exports was assumed, consistent with what occurred for the UK outbreak. It is important to note that in 2002 when this estimate was made, less than 10% of US pork production was exported compared to approximately 20% currently. Paarlberg also assumed that ten percent of US consumers would stop eating red meat and dairy products because of perceived health risks. Paarlberg noted that while there was no basis for this perception, most consumers in the United Kingdom indicated confusion about the difference between FMD and Bovine Spongiform Encephalopathy (BSE) which did pose a serious health risk to humans. The resulting economic impact of an FMD outbreak in the US was a decline in gross revenues of 34 and 24 percent in the live hog and pork meat sectors respectively. US farm income declined in his scenario by US$14 billion (9.5% reduction) (Paarlberg et al., 2002).

In a later study conducted in 2008, Paarlberg et al used an integrated economic and disease spread model to estimate the cost of a hypothetical outbreak of FMD in the US (Paarlberg et al., 2008). Three alternative control strategies and three levels of disease-outbreak intensity were examined. All three strategies included destruction of "direct-contact" herds. The first was destruction of "direct-contact" only, the second added destruction of "indirect-contact" herds and the third added slaughter of all animals within a 1-km ring. Paarlberg assumed exports of beef, pork, lamb meat, cattle, hogs, lambs, and sheep were halted, with restrictions continuing for one quarter beyond the slaughter of the last confirmed case. The total loss of net returns to capital and management in agriculture and agribusiness, which included both the livestock and crop sectors in the US, ranged from US$2.8 billion to US$4.1 billion. US consumers benefited from lower prices while US exports were assumed to be halted.

In an analysis done by Ekboir in 1999, the potential losses from an FMD outbreak in California were estimated to range between $8.5 and $13.5 billion with the largest share of the losses attributed to an embargo on trade. Losses other than those associated with lost trade that were included in the total were the value of destroyed animals, costs associated with quarantining, cleaning and disinfection of depopulated sites, the value of lost production from depopulated and quarantined sites, and the indirect and induced losses in the economy of California (Ekboir et al., 1999).

CSF

Paarlberg et al, in a study conducted in 2009, estimated the economic impact in the US of a CSF outbreak similar to the 1997 outbreak in the Netherlands which lasted for 5 quarters (Paarlberg et al., 2009). In the Dutch outbreak, 8.43 million breeding animals and pigs were destroyed to contain the outbreak. They estimated that total losses to pork producers, including the value of destroyed animals, during an outbreak of CSF in the US ranged from US$2.6 to US$4.1 billion. The reduction in total returns to capital and management for all commodities, including crops and other livestock, were estimated to be US$5.8 to US$7.7 billion. The losses evaluated included the destruction of swine in infected herds, the loss of exports of pork and live swine and a reduction in domestic demand resulting from an adverse reaction by domestic consumers. Alternative supply responses of pig producers in response to expectations about the impact of the outbreak and changes in the price of market hogs and other commodities were also modeled.

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4.4. Disease management

4.4.1. Good animal husbandry practices

Introduction

Every production system or farm has a set of management practices and protocols in place to obtain the best possible production results. These procedures also address the risk of disease introduction and the management of that disease once in the farm or system. Whether this is a domestic or foreign animal disease can determine what happens after the infection occurs. The management practices after a foreign animal disease appears either in this country or on this farm can have an impact on whether this farm or system can continue to maintain its business.

The management of disease risk can be divided into both external and internal risks. External risk management is about preventing the introduction of a new pathogen into a farm or production system. Internal risk management would be aimed more at preventing disease movement within the system or farm. A major management decision is the design of the health and production pyramid. It determines how breeding stock are produced and introduced into a farm or production system. This also allows the system to manage the health of the pigs down and through the production system. Being able to introduce healthy animals into a farm and maintain that health is imperative to the profitability of the producer. This also allows for a surveillance system to monitor for diseases prior to the animals being moved at any point in the production cycle. The faster a disease problem is identified the more likely it can be minimized in the downstream pigs.

Health pyramid

The structure of a health pyramid can help the producer then establish the proper flow of people and pigs through the production system. The pyramid by nature allows animals and people to flow down the pyramid and gives production people guidance on how to flow pigs, manage people, deliver feed and attend to all other management decisions. Location of farms high in the pyramid should be away from other farms and kept healthy.

All-in-all-out pig flow

The pig flow preference is to be all-in-all-out as much as possible by site, building or air space. This allows for disruption in disease cycles. It also allows for proper cleaning and disinfection between groups and minimizes the buildup of pathogen loads within a population. It has a huge impact on pig to pig transmission which is probably the most important means of disease transmission. Pig flow management allows for better traceability and tracking of groups of animals and for monitoring their health status on a continuous basis.

Segregated production

Another major management technique that producers have adopted in the last 20 years is the decision to separate the different stages of production by location or site. So called segregated production separates pigs by age groups and minimizes transmission of pathogens from sows to pigs or from young pigs to older pigs. It also allows the producer to focus management on those specific age groups and can allow for easier depopulation of each phase, medication of each phase or vaccination of each phase. It has probably had more of an effect on bacterial pathogens than on viral infections.

People flow

The flow of people through a system can also be managed by the structure of the production pyramid both between and within production sites. Personnel would either be restricted to certain sites or not allowed to go to multiple sites or they would flow by health status and production status down the pyramid. Monitoring health status at the various sites allows the production team to make these decisions when they are different from what would normally be the expected flow through a system.

These decisions and the surveillance to make these decisions can be a very important part of maintaining the health of a farm or production system.

Feed quality assurance

As we have seen recently with the emergence of PEDV in the United States, the feed and feed ingredients can be a risk factor for the introduction and spread of a disease pathogen. The quality, formulation and manufacturing of feedstuffs also speak to the health of the pig and the ability of that animal to fend off disease pathogens and also eliminate them after infection. Contamination of a feed or ingredient with a pathogen or mycotoxin can disrupt the health of the pigs. Mycotoxins are known to affect the immune system of the pig and affect the animal's ability to fight off disease and or deal with it after infection. The quality of certain vitamins and minerals would also have a similar impact on immunity. Therefore having a feedstuff quality control program is a much needed process that impacts the health and productivity of the animal both individually and as part of a population.

Environment design and management

The pig's environment also has a huge impact on the health of the pig and its ability to handle the introduction of a disease pathogen or fight off the introduction of a disease. In the case of ventilation, the air quality when defined by temperature, humidity and dust particle load can determine whether a pathogen is able to be introduced by aerosol or whether the pathogen can survive the pig's innate immune systems to gain access to the pig's respiratory tract. Dust particles can carry bacteria and viruses and increase the transmission of disease. Dust particle reduction can be accomplished by adding fat to the feed. Controlling the humidity levels can reduce the water droplets available for pathogens to be transmitted in. The factors impacting air quality can include population density, temperature in the building, concentration of gasses, ventilation rate and dust levels.

The filtration of air into buildings is a fairly new technology that has been introduced into the swine industry. The success rate of these facilities has been good and mostly aimed at the PRRS virus. But certainly other pathogens are being excluded as well. It has become an extremely important management tool for farms in dense swine population areas to fight off transmission by aerosol means.

4.4.2. Biosecurity arrangements

Management of biologic risk is essential to any swine operation. This is without regard to their size, location or type of operation. Eliminating the risk of disease introduction is nearly impossible, but having an awareness of the risk factors involved can help the producer reduce the chance that a domestic or foreign pathogen could get introduced.

Healthy animals are more productive as we all know. But a healthy and disease free industry is also very important. The introduction of a Foreign Animal Disease could have disastrous effects on a producer that never gets infected. The steps taken by the Federal and State governments to minimize and control spread of disease can impact all producers and most importantly the markets. Loss of export markets would add a tremendous amount of pork to the US market and lower prices dramatically.

The previous discussion has centered on how the industry has structured itself to prevent, manage and control domestic disease pathogens and most of these measures would help with foreign animal disease pathogens as well. Biosecurity has always centered on a particular site or system of sites. We examine their risks and almost all have the same risk of an external pathogen entering a population. The industry is now beginning to realize that to effectively stop spread of a disease pathogen in a swine dense area, all producers in that area need to be engaged and working together to minimize transmission routes for disease.

Understanding what these risk factors are and being able to effectively control them is the current challenge. State, regional and national barriers need to be established and maintained. Without them disease will continue to spread within and throughout the swine industry. This discussion will focus on what routes of transmission we know about and what can be done by individual producers to protect themselves from external risks. But we also review what regional biosecurity measures could be implemented.

Risk assessment can be difficult unless you know what the risks are and how important they are to your situation. The Production Animal Disease Risk Assessment Program (PADRAP) was established for PRRS and has been helpful in allowing producers to complete the questionnaire and having the analysis show them the things that are of the greatest risk to them and their production system. Having this for other pathogens would be a tremendous help. Most risk management is based on analyzing the different routes of transmission and then looking to mitigate the risk that each imposes. Therefore this discussion will focus on the major routes of disease transmission that would put a farm or the swine industry at risk for a FAD.

Location is probably the single most important risk factor for the introduction of new disease into a farm site. This risk is from aerosol transmission but also transmission by “local spread”. These indirect methods of disease spread can be multiple and not always well defined. Changing location is not always feasible. However, planning for a new site should take location into consideration.

Aerosol transmission of swine disease has been researched for many different pathogens. Factors that influence whether a pathogen can be aerosol or not include survival time in air, air conditions, air speed, topography, cloud cover, size of the virus or bacteria and the amount of the pathogen available for dispersal. Research studies have confirmed transmission of PRRS, PRV, FMDV, SIV and many others. Factors to help mitigate aerosol transmission include air filtration of swine facilities, vaccination of animals to reduce shedding of organisms, and optimization of herd health to prevent animals from getting sick.

Oral transmission of pathogens can be direct via contact with infected pigs or indirect via water, feed, feces or any item in the environment that would contact the pig’s mouth. The amount of virus on objects and its survival time both play a role in whether the items can be involved in transmission of the pathogen. One feedstuff to be concerned about with foreign animal disease is food waste or garbage. Most states require this product to be cooked prior to it being fed to pigs. Pathogens known to be transmitted this way are CSV, FMDV, ASV, SVDV, *Salmonella*, *Trichinella* and *Toxoplasmosis*.

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Spray dried plasma gained attention with the PCV2 disease outbreaks as well as with PEDV. The spray dry process should eliminate concern for the presence of the virus. A concern is always whether every batch gets properly treated. Producers should be sure to acquire their spray-dried plasma from a reputable supplier that they trust.

Water can be a concern when it is possible for it to be contaminated by wild animals, birds, or other processes. Deep wells and water from treatment plants are probably the safest. If using water from a stream pond or other open source, testing would be indicated and chlorination would also be a good idea.

Direct pig to pig contact is one of the most effective methods to spread disease. The industry maintains most endemic infections by this method. New introductions to herds can also be from farms that buy infected breeding stock. Failing to isolate and test these animals can be disastrous depending on the level of the health pyramid into which the animals are introduced. The previously mentioned management practice of all-in-all-out pig flow, offsite production, early weaning, herd closure and parity segregation can all help prevent direct pig contact and exposure.

Semen is also a route of transmission that requires producers to have isolated boar studs with filtered incoming air, and constant testing of boars and semen for the presence of pathogens that can be transmitted downstream to sow farms and then to pigs. PRRS is the ideal example of how this has happened in the swine industry. Foreign animal disease pathogens could be transmitted the same way.

Disease can also be spread by inanimate objects (fomites) such as feeders, boots, clothing, sorting boards, and a multitude of other objects. Good sanitation of facilities, and all the equipment used to move, treat, breed, etc., animals is needed to prevent these objects from spreading disease to animals. Requiring people to shower and change clothes prior to entry to a facility is also an effective way to keep them from being a fomite.

Transport vehicles enter and exit production sites many times during a week. They deliver feed, pigs and supplies to farms. The interaction between these vehicles and people on the farm always creates a risk of disease introduction if not handled properly. Dedication of trucks to different phases of production can reduce the risk of disease introduction. An example of this would be having trucks and trailers dedicated to internal movements of weaned pigs and feeder pigs. These trucks would never visit a market or slaughter facility and this reduces the amount of pathogens that could be present on these vehicles. The PED virus highlighted the ease with which trucks could transport a virus from a market or slaughter facility back to the farm.

The ability to clean a truck of all the dirt and fecal material is far easier than being sure all the disease pathogens on that truck are gone. A lot of research has been done on how to properly clean and disinfect a truck and trailer. Much emphasis has been placed on the type of disinfectant, drying time and many other factors. This lead to the development of thermo-assisted drying and disinfection of trailers (TADD). Facilities are constructed that allow trailers to be heated to temperatures >140 degrees Fahrenheit. The high temperature is maintained for 10 minutes and the vehicle is then allowed to cool. This has proven to eliminate many pathogens and stop disease transmission. The cost is very high, however, and not many are available at this time.

Educating farm personnel on how to load and unload trucks at the farms without introducing a disease pathogen is a high priority task. The truck almost always represents a risk and there should be no crossing of paths by farm personnel and the truck driver. The load out chutes should then be washed and disinfected once the truck leaves the farm.

Visitors to the farm are also a risk for disease introduction to that site. Previous exposure to pigs from another farm can be a problem if that person does not have a shower, change of clothes and downtime between sites. Research has shown that if people are properly cleaned the downtime needs are minimal. But this can differ according to the pathogen. A lot of inconsistency still exists in the industry due to confusion and fear of infection.

United States citizens visiting other countries and foreign citizens visiting this country can pose a risk depending on whether they had contact with livestock while in that country and what diseases are present in those counties, Food brought back from those countries can contain diseases such as Foot and Mouth disease. The U.S. Customs and Border Protection and USDA inspectors expend a lot of energy and money trying to prevent these food products from entering this country and to be sure that people that have been around livestock stay away from livestock for an appropriate period of time.

Vectors such as rodents, feral animals, birds, pets and insects can also be significant carriers and in some cases revivers of disease pathogens. Control programs need to be in place for each of these vectors and these programs need to be monitored on a daily basis.

4.4.3. Preparedness and response plans

Foreign animal disease response plan

USDA APHIS established FAD PReP to provide a framework for FAD preparedness and response. FAD PReP was developed to meet the recommendation of many stakeholders that FAD preparedness and response capabilities needed improvement. It is intended to integrate and synchronize the principles and applied systems of the National Response Framework (NRF) and the National Incident Management System (NIMS) by providing outbreak response goals, guidelines, strategies, and procedures for local, State, Federal, and Tribal responders. FAD PReP is intended to raise awareness of response activities and veterinary countermeasures, identify gaps or shortcomings in current preparedness planning, and provide a framework for States, Tribes, and other stakeholders to use in developing their own response plans. The link below provides a detailed account of how the federal government plans to respond to a foreign animal disease.

http://www.aphis.usda.gov/animal_health/emergency_management/downloads/intro_fadprep.pdf

Planning and trials of the system are ongoing. In cooperation with the animal industry stakeholders, veterinarians, and state regulatory people, extensive planning and preparation is done on all the known diseases. One aspect of a Federal response that has changed in recent years is the replacement of massive herd depopulations with vaccination and testing to eliminate the disease. While vaccine and testing technology for some diseases may be lacking at this time, work is being done now to develop that technology. Testing capacity has been increased in various state laboratories and a new national lab is planned and being built in Kansas. Regulators recognize the challenge of euthanizing millions of animals and the bigger challenge associated with their proper disposal.

The scope of any disease outbreak will most likely dictate the initial response. If the outbreak is deemed to have been found early and is containable, depopulation could be the best course of action. If the scope of the outbreak is already too large, then vaccination could be used to control the spread of the disease and allow the animals to be cleared in a timelier manner.

One part of the USDA response is to have a program in place that would allow business continuity in places where there is no disease present. The Secure Pork Supply (SPS) plan would provide a business continuity plan for commercial pork producers that is credible to State and Federal health officials and provides a safe supply of pork to the consumer. This plan is being developed and should be in place prior to an FAD break. It will require producer participation, and those that participate will be certified to be able to move animals under permit when no evidence of infection is present. It requires surveillance and traceability programs that give authorities assurance that the animals in question are healthy.

Traceability allows regulators to know where pigs originate and the status of the site of origination and where the animals are going. Biosecurity of the sites and systems is also crucial to their being able to maintain participation in the program. The above discussion on biosecurity and management practices is very relevant to this business continuity plan. Disease surveillance will be the backbone of the program; the ability to test a large number of animals and prove their status to regulators will also be a necessity of participating in the SPS plan. This also include observational surveillance for clinical disease as well as the testing component.

Packers and processors will also be key participants in the program as they will have traceability capabilities to their customers and communication with regulators. Their feedback will assist in determining where the disease is and where it is not. Biosecurity at these collection points is crucial to preventing the spread of the disease to areas where it is not currently present.

State animal health officials are important to the plan as they issue the premises identification numbers, approve movement to and from their state and are involved in the Controlled Movement Component of the plan. They will communicate with laboratories, producers and packers. They also will communicate with other state officials.

USDA-APHIS will be the main coordinating agency in the plan. They will analyze and communicate lab results and disease status of various areas, and will integrate all the data needed to implement the plan. They will have geospatial data to help determine what areas are free of disease and what areas are infected. The National Animal Health Lab Network is essential to provide the data on samples submitted by accredited veterinarians and producers. The timely testing and validation of these tests are the real backbone of being able to determine which areas can continue business and function as normal.

This plan is being developed in conjunction with producers, veterinarians, Federal and State health officials and individuals in academia and industry. The Center for Food Security and Public Health at Iowa State University is coordinating the activities. This plan represents the industry's best effort at maintaining some business continuity in the case of a FAD outbreak and hopefully mitigating the economic devastation that could result from such an event.

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Secure Pork Supply Plan: http://www.cfsph.iastate.edu/Secure-Food-Supply/pork-supply.php
http://www.aphis.usda.gov/animal_health/emergency_management/downloads/intro_fadprep.pdf

5. GENERAL AGRICULTURAL POLICY SUPPORT FOR THE PORK SECTOR

While there are no explicit support programs for livestock producers that are similar to support programs for the major field crops (corn, soybeans, wheat, cotton, etc.), there are a number of ways, other than the insurance plans discussed in the next section, through which the Federal government provides support and assistance to the hog and pork industries. These include avoiding undue levels of market price support for crops used for animal feed, assistance with promotion of pork exports, and assistance with animal disease outbreaks and weather-related disaster payments. While payments from the government as compensation for losses from weather or disease play a role in producers' risk management decisions, we include them here as longstanding elements of Federal agricultural policy.

5.1. Market oriented grain and oilseed prices

For the most part, federal crop support policies in recent years have adhered to a philosophy of market orientation, i.e. not distorting normal market prices by either promoting excessive production or trying to put a floor under prices that is higher than the market-clearing level. The rationale for this approach has had both offensive and defensive components. Since the United States is a leading agricultural producer with comparatively modest production costs, allowing the marketplace to direct supplies to their highest uses benefits domestic producers of livestock and poultry, enabling them to be competitive in world export markets. From the defensive perspective, it also means that the United States is following world trade rules by not operating farm programs that provide excessive support to farmers.

That being said, the livestock industry has been quite critical of US renewable fuel policies that have diverted a large part of the corn supply to production of fuel ethanol, and caused corn prices to be higher than those that would otherwise have prevailed.

5.2. Export promotion

USDA has two main foreign market development programs that benefit the pork sector. The Market Access Program (MAP) supplements market development funds raised by the private sector to develop commercial export markets for US crop, livestock and fiber products. Total MAP funding in the 2015 fiscal year is $173.2 million. The Foreign Market Development Program (FMD) focuses on generic promotion of US commodities through reduction in foreign import constraints and other means. Total FY15 funding is $26.7 million. A smaller Emerging Markets Program (EMP) provides funding for technical assistance activities.

The U.S. Meat Export Federation (USMEF) promotes beef, pork and lamb exports and will receive $10.7 million in MAP funds and $1.4 million in FMD funds in fiscal year 2015 for these purposes. USMEF receives 16% of its funding from the Pork Checkoff and 38% from USDA programs (MAP, FMD, and FAS).

5.3. Animal and Plant Health Inspection Service

As discussed above, APHIS plays the lead role in managing major animal disease outbreaks such as the 2015 highly pathogenic avian influenza outbreak that has resulted in death or destruction of millions of turkeys and layers. When depopulation of an infected flock is required under the National Animal Health Emergency Management System (NAHEMS), USDA provides compensation to the grower for the destroyed animals and assistance with cleaning up and disinfecting the facility.

5.4. Disaster assistance

USDA has historically provided various types of disaster assistance to crop and livestock producers. Currently there are two programs applicable to swine producers: the Livestock Indemnity Program (LIP) and the Emergency Assistance for Livestock, Honeybees and Farm-Raised Fish Program (ELAP). Both were reauthorized by the 2014 Farm Bill, retroactive to October 2011. A third type of assistance is provided in cases of drought through the Livestock Forage Program (LFP). However, swine are generally not grazed in the United States.

The LIP provides benefits to livestock producers for animal deaths in excess of normal mortality caused by adverse weather, with payments equal to 75% of the market value of the animal. To be eligible for LIP, a contract grower must have had the following on the day the livestock died:

- Possession and control of the eligible livestock and
- A written agreement with the eligible livestock owner setting the specific terms, conditions and obligations of the parties involved regarding the production of livestock.

In addition to the requirements listed for livestock owners above, the only eligible livestock of contract growers under LIP are poultry and swine.

For swine, the ELAP program covers death losses (including from disease), feed and grazing losses that are not due to drought or wildfires on federally managed lands, and the cost of transporting water to livestock due to an eligible drought.

For 2012 and subsequent program years, no person or legal entity, excluding a joint venture or general partnership, may receive directly or indirectly, more than $125,000 total in payments under LFP, ELAP, and LIP combined. There are also additional limitations regarding the Supplemental Revenue Assistance Payments (SURE) program as well as Adjusted Gross Income (AGI) limitations.

Based on historic experience, however, many swine producers probably believe that in the event of a major disease problem, the Congress would provide some type of special disaster assistance to cushion the impact on the industry. This was a comment we heard in our listening sessions. To the degree that this belief is widely held, it undermines producer willingness to pay for insurance.

6. RISK MANAGEMENT TOOLS

National Pork Producers Council representatives and our listening session participants said their primary concern is over the potential economic impacts on the industry of a disease outbreak that would cause other countries to stop importing pork from the United States. Industry experts identified the four foreign animal diseases that would result in loss of export markets as Foot and Mouth Disease, African Swine Fever, Classical Swine Fever, and Swine Vesicular Disease. As noted elsewhere in this report, the insurance solution that is being considered would provide coverage in the event of a decline in market prices due to a catastrophic disease event. The following sections discuss five risk management tools that swine producers can use to manage price risk:

- Futures or options products;
- Contract with buyer;
- Diversification;
- Livestock Gross Margin (LGM) insurance program with RMA; and
- Livestock Revenue Protection (LRP) insurance program with RMA.

Each of these risk management tools is reviewed below with a discussion of how they could be used or modified to cover a catastrophic swine disease event (CSDE). Here we define a CSDE as an outbreak that will close export markets.

6.1. Non-Insurance risk management tools

6.1.1. Futures and options forward contracts

Lean hog futures are traded on the global electronic trading market, and via open outcry on trading floors in New York and Chicago until it ended on July 2, 2015 after 167 years. The electronic futures are abbreviated as "HE" with the contract month and year added at the end. For example:

Table 10: Futures contract terminology

Month	Symbol	Year	Ticker Symbol CME Globex
May	K	2015	HEK15
June	M	2015	HEM15
July	N	2015	HEN15
August	Q	2015	HEQ15
October	V	2015	HEV15
December	Z	2015	HEZ15
February	G	2016	HEG16
April	J	2016	HEJ16

The latest futures contract available is currently August 2016, which is approximately sixteen months in the future. There is typically little volume traded in futures contracts with an expiration date later than six months (or the time from piglet to maturity). A CSDE would likely impact market prices for longer than six months.

For Lean Hog futures contracts, all outstanding contracts that remain open after the last trading day will be automatically closed out at a price set equal to the CME Lean Hog Index on the last trading day. There is no physical delivery requirement for lean hogs.

Each futures contract size is 40,000 pounds (or 400 hundredweight, abbreviated as "cwt") of carcass. Using an example of the CME Live Hog Index, the average live weight is 277 lbs. while the average carcass weight is 209 lbs. (or approximately 75% of live weight). Dividing the 400 cwt by the average carcass weight gives about 190 hogs per futures contract.

A swine producer has two simple mechanisms to hedge against declining prices using futures contracts:

- Shorting a futures contract or
- Buying a put option on a futures contract.

We will illustrate these simple methods in order to further discuss the possibility of using these to hedge against price declines resulting from a CSDE. More complicated hedging can be used depending on what the producer (or buyer) is trying to accomplish. The following table shows a simple hedging strategy by shorting a futures contract. For convenience we set the target and actual prices equal to the futures price. As noted below, a disconnect between the futures and market prices is referred to as basis risk, which can reduce the effectiveness of the strategy.

Table 11: Examples of futures transactions

	Transaction	Example 1	Example 2	Notes
(A)	Target Price @8/15 on 3/15	$75	$75	
(B)	Sell HEQ Futures on 3/15	$75	$75	
(C)	Buy HEQ Futures on 8/15	$70	$80	
(D)	Futures Gain/Loss	$5	($5)	(B) – (C)
(E)	Actual Price @ 8/15	$70	$80	
(F)	Difference from Target	($5)	$5	(E) – (A)
(G)	Overall hedge profit/loss	$0	$0	(D) + (F)

In both examples above, at 3/15 the producer is looking to hedge against the price of lean hogs falling below $75/cwt (Target Price) at the time of sale (expected to be 8/15). The producer can sell a futures contract (HEQ) on 3/15 that is currently valued at $75. On 8/15, the HEQ futures has dropped to $70. Since the producer is in a short position he/she can now buy the $70 HEQ, yielding a profit of $5. The producer can sell his swine at only $70/cwt so he/she "loses" $5/cwt from the target price on 3/15. Overall, the producer breaks even from the hedge (excluding transactional costs).

Example 2 shows the opposite situation, when prices rise. In this case, the producer receives $80/cwt for the swine, but loses $5 on the futures contract.

There are two significant issues that should be understood when considering futures:

- There will be costs associated with the futures transactions (commission, margin, etc.) and
- There is additional basis risk associated with an actual hedge.

Basis risk refers to the difference between the measuring index and the actual price received. The actual price received by the producer at the local market level will differ from the futures price. The hedge will work as long as the price difference between the local market and the futures remains constant. In the event the local price drops more than the futures price, the producer would have an adverse effect. A complication would arise in the event of a CSDE that is regionalized. For example if one region is quarantined due to a CSDE, the price in the region may drop significantly. Prices in other regions may increase if demand remains the same or decrease if the CSDE impacts global demand. In both cases the basis relative to the futures price would change.

The second type of hedging a producer can use is to buy a put option. A put option provides the right to sell the underlying futures contract at a certain (strike) price. A producer must pay a premium for the put option, but this gives the producer an opportunity to make returns if the selling price is greater than expected. In the following examples, the premium is simply an estimate for illustration purposes.

Table 12: Examples of options transactions

	Transaction	Example 1	Example 2	Example 3	Notes
(A)	Target Price on 3/15	$75	$75	$75	
(B)	Put Strike Price	$75	$75	$75	
(C)	Put Premium @ 3/15	$2	$2	$2	
(D)	Ending Futures @ 8/15	$70	$90	$50	
(E)	Option Gain/Loss	$3	($2)	$23	IF (D) < (B) then (B) – (D) – (C)
(F)	Actual Price @ 8/15	$70	$90	$50	
(G)	Difference from Target	($5)	$15	($25)	(F) – (A)
(H)	Overall hedge profit/loss	($2)	$13	($2)	(E) +(G)

As shown in Examples 1 and 3, the producer can lock in a price by paying the premium for the put option. Thus, as with the futures contract, when the price declines the difference (from target) is offset by the reduction in the futures price. However in Example 2, where the price is greater than the target, unlike the futures contract the producer gets the benefit of the higher price. Similar to the futures contract, an additional cost for commission will also need to be considered (but not the margin costs). Basis risk would also exist in the put option strategy.

Currently these hedging strategies are used mainly for current inventory, judging from the volume of the various forward contracts. If producers are truly concerned about price risk running longer than six months (as in a CSDE) we would expect more activity in the later futures/options. However there are some reasons why there is light demand for these, including the following:

- Price volatility for both inputs (corn) and outputs (hogs) is high, causing the premiums for longer term futures to be perceived as too expensive;
- There may be little demand for the offsetting futures or option to make a market for longer term futures/options;
- The producer may have other needs for any available capital that could be used for longer-term hedging; and
- Producers are subject to margin calls on their futures positions as market prices change.

6.1.2. Contracting

Contracting in the swine sector takes a number of forms, as discussed earlier in Section 3. Marketing contracts provide price certainty. Production or management agreements can also provide a degree of certainty on volume of livestock handled, or total revenue for the year.

A producer who has his own sows or buys feeder pigs and raises the pigs to market weight may have a marketing contract with a slaughter facility. Prices in such a contract would typically be linked to futures prices. Alternatively, the swine may be owned by an integrator who contracts with producers to manage the care and feeding of the animals. During our research and at the listening sessions, many different kinds of contracts were reported to be used. For certain growers, the hogs are never owned by the producers. In other cases the feed is also supplied by the buyer. In North Carolina, contracts usually provide a fixed fee per animal with bonuses for high feed conversion rates and lower than normal mortality. In Minnesota, the contract amounts are not linked to the number of animals that go through the house. The barns and their management are in effect leased.

It was our understanding that these contracts could run three to five years or more into the future. It was not clear what would happen if a CSDE occurred that would stop further production. The producers would clearly have fixed cost expenses such as mortgages and maintenance. In the listening sessions, being able to cover such expenses while the industry adjusts to a CSDE was a major concern of producers.

6.1.3. Diversification

Section 4.4 discussed the disease management activities that swine producers use to mitigate risks from disease. Swine producers can also use diversification as an economic risk management tool. This can include investing in production of other agricultural products or in other industries. Some of the main diversification opportunities are the following:

- Produce other livestock with differing disease risks;
- Produce feed inputs (corn, soybeans, etc.);
- Geographic diversification to reduce chances that disease will affect all owned animals; and
- Maintain operations or off-farm employment in a completely separate industry.

The success of these diversification techniques can depend on the correlation between the price of swine and the prices of the other products or services. For example, a CSDE may cause the demand for poultry to increase as it is substituted for pork, or alternatively all meat prices could be depressed by overhanging supplies of pork that cannot be exported. A severe drought may increase the price of corn and the swine producer's feed costs; however if the drought is located in the same area as the producer, the producer would likely suffer similar yield losses on corn that he is producing.

6.2. Insurance plans

6.2.1. FCIC insurance products

RMA has offered two main insurance plans for livestock producers (Cattle, Swine, Lamb, and Dairy-LGM only) since 2003:

- Livestock Revenue Protection (LRP) and
- Livestock Gross Margin (LGM).

In addition, livestock can be covered to some degree under the Whole Farm Revenue Protection Plan (WFRP) included in the 2014 farm bill. On the plus side, in most cases the government pays 80% of the premium for the WFRP insurance coverage. However, no more than 35% of expected revenue can be from animals and animal products and that amount is capped at $1 million. With those two constraints it does not meet the needs of most commercial swine producers.

LRP is designed to insure against declining market prices. LRP works much like buying a put option where the producer pays a premium for coverage against declining prices. The swine producer can choose certain coverage prices ranging from 70 to 100 percent of the expected ending value. The prices are typically shown in $2/cwt increments and there are up to five options for a given ending date. The length of insurance coverage is for 13, 17, 21, or 26 weeks. If the actual ending value is below the coverage price, the producer receives an indemnity payment for the difference between the coverage price and the actual ending value.

For LRP, a producer may insure as many as 32,000 hogs per year with up to 10,000 hogs for each specific coverage endorsement. (As will be discussed below, this is one feature of the program that would need to be changed if the LRP were to be used for protection against a CSDE). There is a 13% subsidy to partially offset the producer's premium. An additional 22.2% of premium is paid as A&O expense subsidy to the Approved Insurance Provider (AIP).

LGM is similar to LRP but includes the cost of feed as another component of the equation. LGM only covers the margin between the swine price and feed price. The expected gross margin is based on the future swine price less the feed costs using CME futures prices. The feed equations are based on an optimal feeding ration developed through Iowa State University.

LGM is offered twelve times per year and insures over a six month insurance period. Producers can allocate swine to the upcoming five months. LGM is sold on the last business day Friday of each month. The sales period begins as soon as RMA reviews data submitted by the developer after the close of markets on the last day of the price discovery period. The sales period ends at 8pm Central Time the following day (Saturday). (This timing has reportedly reduced the incentive for agents to market the product.)

For LGM, a producer may insure as many as 30,000 hogs per year with up to 15,000 hogs for any 6-month insurance period. There is a 3% surcharge added to the producer's premium. An additional 22.2% of premium is paid as A&O expense subsidy to the AIP.

Table 13 displays various scenarios for the LRP and LGM programs for Swine. The premium shown is just for illustration purposes.

Table 13: Examples of LRP and LGM coverage for swine

		LRP Scenario 1	LGM Scenario 1	LRP Scenario 2	LGM Scenario 2	Notes
(A)	Expected End Value	$75	$75	$75	$75	
(B)	Coverage Price	$70	N/A	$70	N/A	
(C)	Feed Costs[7]	N/A	$50	N/A	$50	
(D)	Gross Margin	N/A	$25	N/A	$25	
(E)	LGM Deductible	N/A	$5	N/A	$5	
(F)	Premium	$3	$4	$3	$4	
(G)	Final End Value	$65	$65	$80	$80	
(H)	Final Feed Costs	N/A	$55	N/A	$40	
(I)	Final Gross Margin	N/A	$10	N/A	$40	= (G) – (H)
(J)	Indemnity	$5	$10	$0	$0	LRP = If (G) < (B) then (B) – (G) LGM = If (I) < [(D)-(E)] then [(D)-(E)]-(I)
(K)	Insurance Gain/Loss	$2	$6	($3)	($4)	= (J) – (F)
(L)	Swine or GM Gain/Loss	($10)	($15)	$5	$15	LRP = (G) – (A) LGM = (I) – (D)
(M)	Overall Gain/Loss[8]	($8)	($9)	$2	$11	= (K) + (L)

[7] Example only – based on ISU feed study.

Both the LRP and LGM insurance products only cover the current "crop" of hogs. Theoretically the premium for these products should match similar costs using the futures/options markets (prior to the subsidies). Table 14 compares and contrasts the various risk management strategies:

Table 14: Comparison of risk management strategies

	Futures	Options	Contracting	LRP	LGM
Maximum Length	16 Months	16 Months	3-5 years	26 weeks	Six months
Basis Risk	Yes	Yes	No	Yes	Yes
Downside price protection	Yes	Yes	Yes	Yes	Possible
Upside price potential	No (other than basis risk)	Yes	Possible	Yes	Possible
Transactional Costs	Commission, margin	Commission	None	Subsidy of 13%	Surcharge of 3%
Input (feed) price protection	No – could be added	No – could be added	Possible	No	Yes
Flexibility	Moderate	Moderate	Minimal	Significant	Significant

6.2.2. FCIC insurance product experience

This section discusses the insurance experience for both the LGM and LRP programs. A major change to the program was the addition of a 28% premium subsidy for Dairy Cattle in 2011. As mentioned previously the LRP program has a 13% premium subsidy and LGM (excluding Dairy Cattle) has a 3% premium surcharge. Since 2011, Cattle-Dairy has comprised most of the insured liability for the program, and it is our understanding that it depletes the $20 million administrative cap on an annual basis. It is difficult to estimate how many producers have not participated due to the endorsement limit. From the 2012 Census of Agriculture we found that 27% of the swine producers have an inventory of over 5,000 hogs, which comprises almost half of the total inventory. For the next several charts we show all livestock first and just swine on the second chart to better visualize the swine products.

Policies earning premium for LGM – Dairy increased significantly in 2011 when the 28% subsidy was added. Policies earning premium for LRP-Cattle have fluctuated between roughly 500 and 2,000 annually throughout the history of the program. The LRP-Lamb product was withdrawn during 2014 following an RMA commissioned study, but it is now available again.

The number of policies earning premium for swine has decreased from a high of 380 in 2005 to 42 in 2013. As of April 20, 2015, there were 43 swine policies earning premium in 2015. The livestock insurance years run from July 1 of the prior year to June 30 of the current year – so 2015 was nearly complete at that point. We discussed the declining participation in LGM/LRP swine during the listening sessions, but no real reasons were offered. It should be noted that less than 1% of the total annual swine population of 110 million head was insured in the year of highest participation.

[8] Excludes feed costs for LRP product.

Figure 13: Policies earning premium, all species

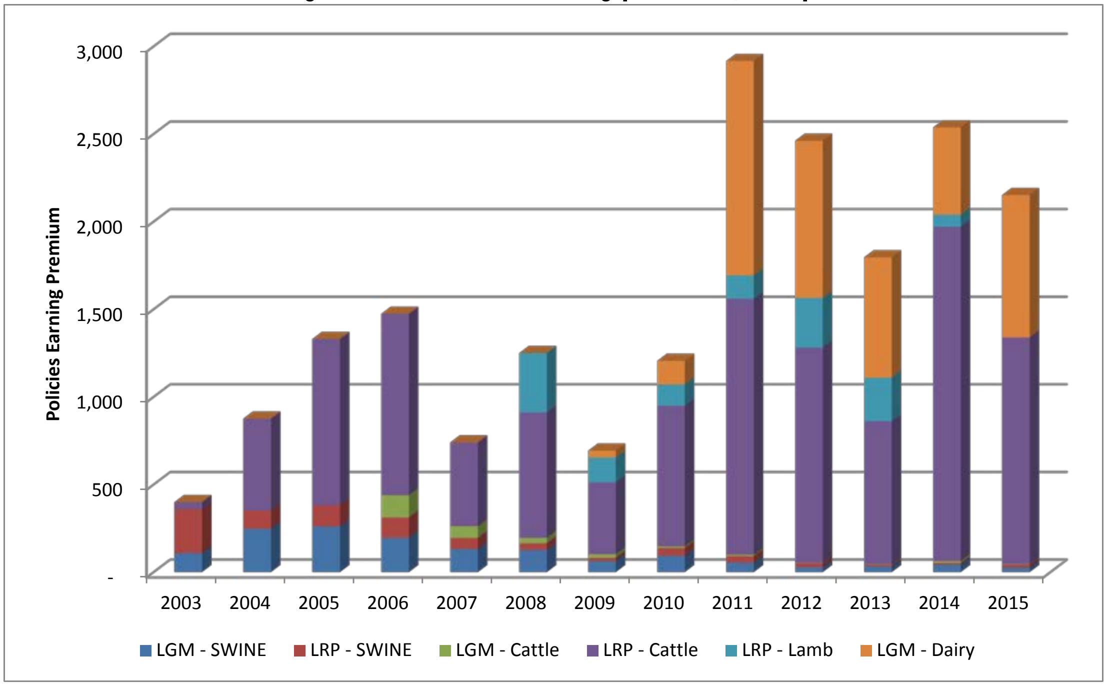


Figure 14: Policies earning premium, swine only

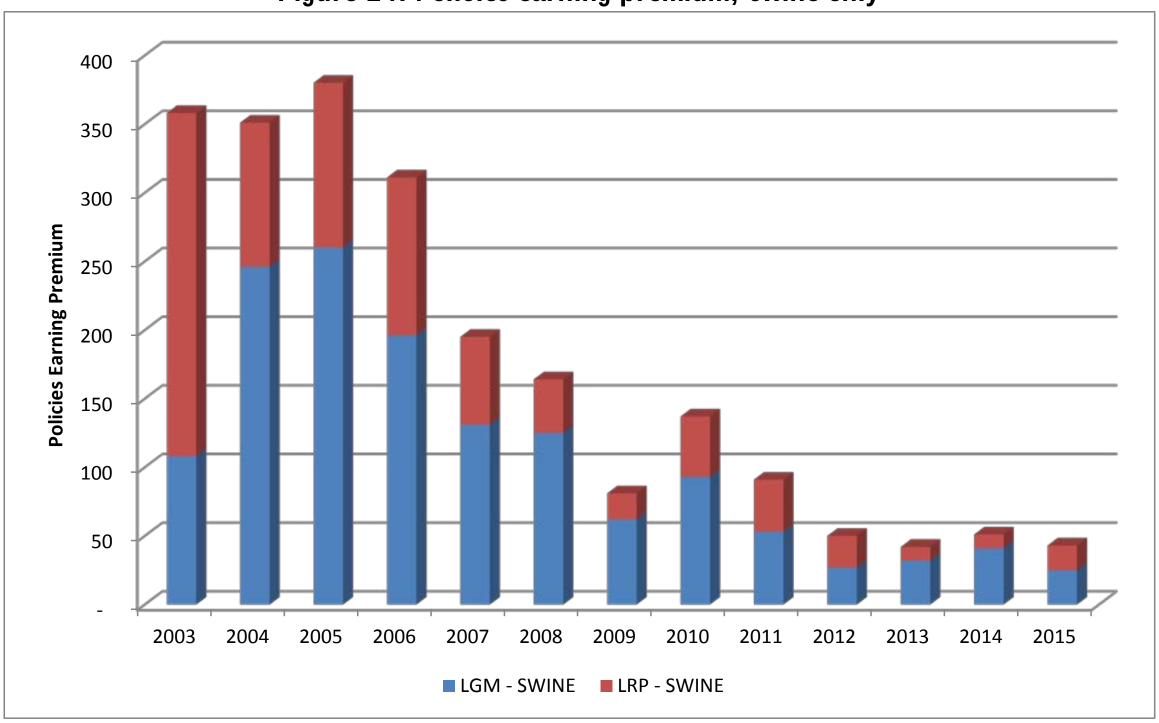


Figure 15 shows the insured liability for each product. LGM-Dairy has had the most insured liability since 2011. LRP-Lamb had the most insured liability in 2008 and second most in 2012. Figure 16 shows the insured liability for swine by year. The insured liability decreased after 2008 to around $30 million a year.

Figure 15: Insured liability, all species

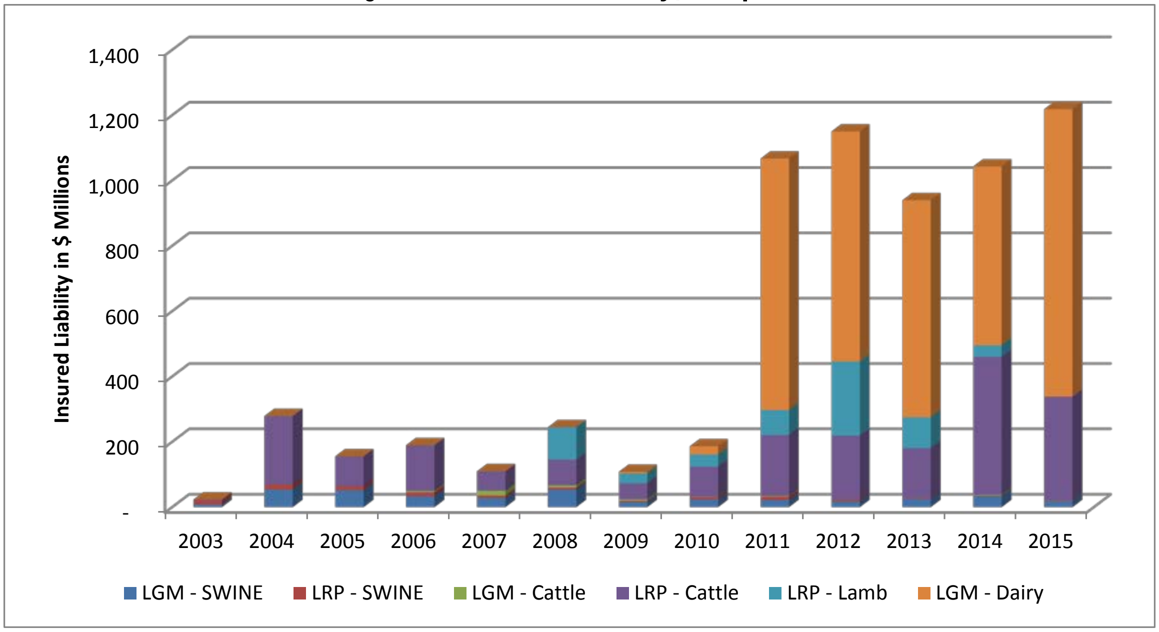
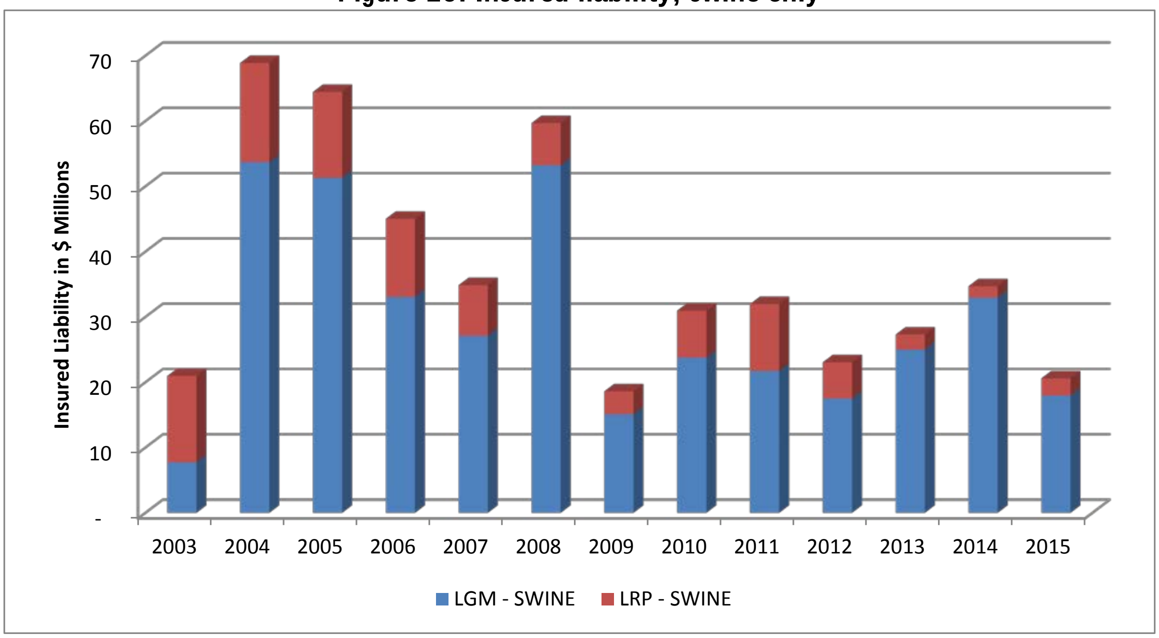


Figure 16: Insured liability, swine only



The next charts show the premium for each product associated with the liability shown in Figure 15 and Figure 16.

Figure 17: Premium paid, all species

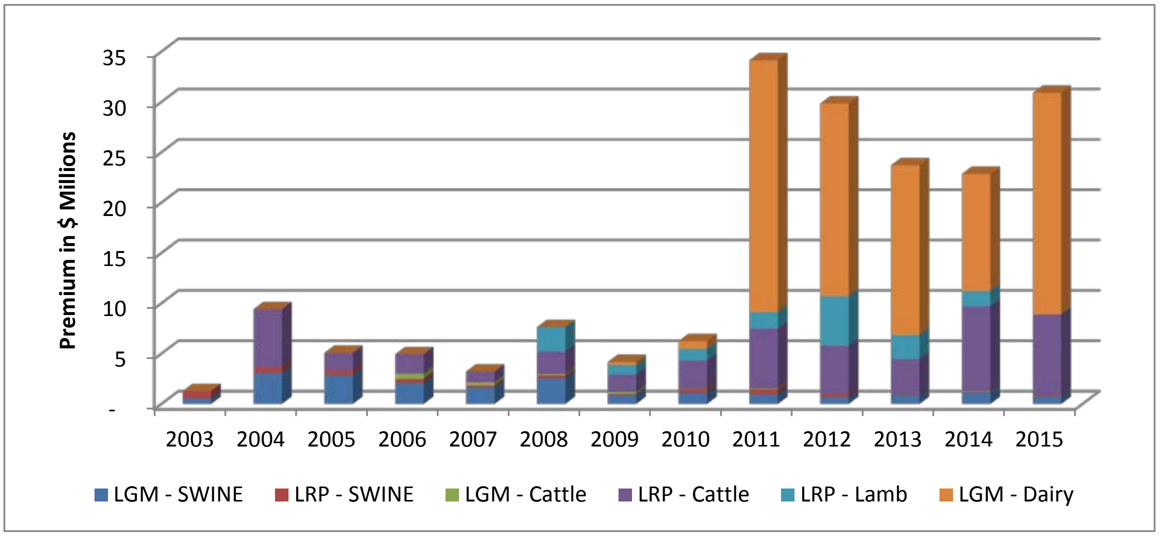


Figure 18: Premium paid, swine only

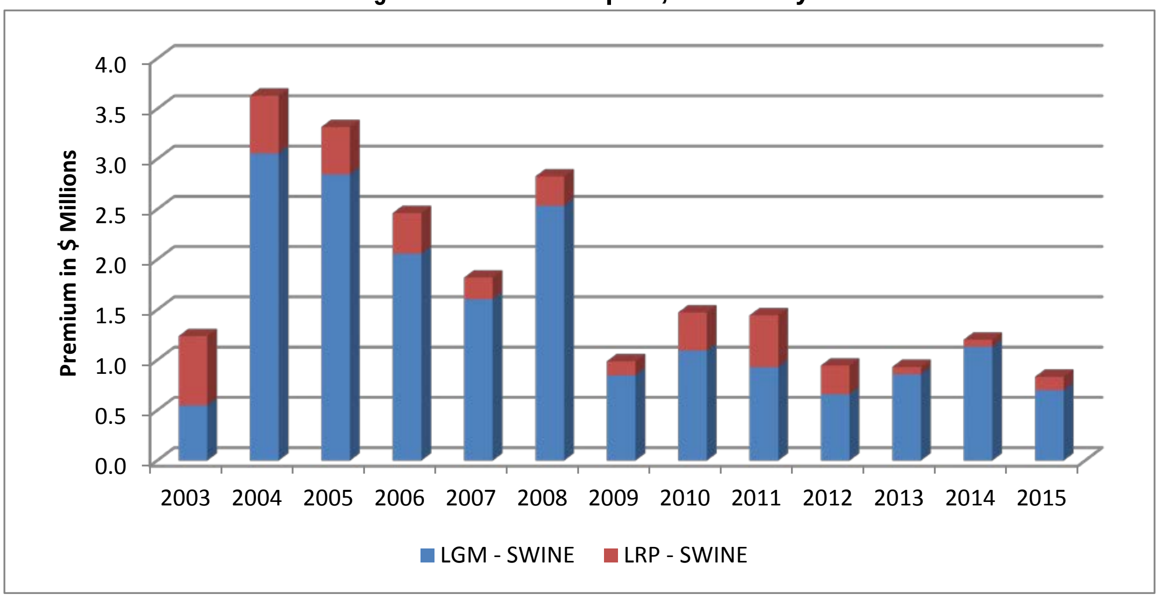


Figure 19 and Figure 20 show the insured headcount for each product, excluding LGM-Dairy which insured on a pound of milk basis. LRP-Lamb had the most insured animals between 2008 and 2013. There was a large decline in swine since 2004.

Figure 19: Insured head, all species

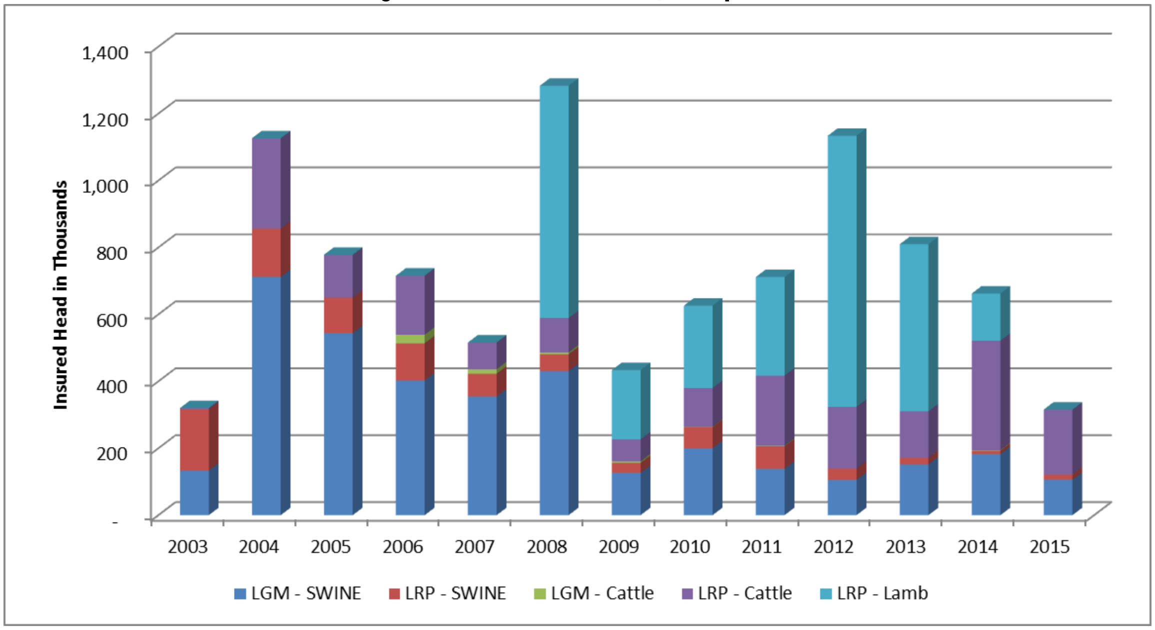
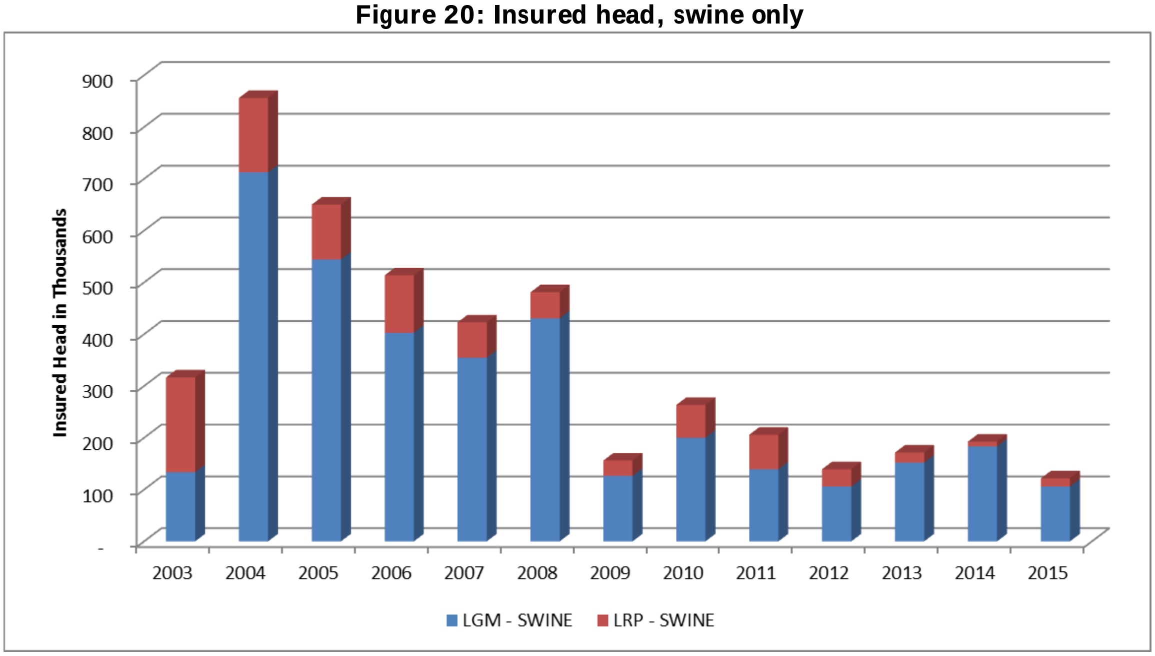


Figure 20: Insured head, swine only



The next chart displays the loss ratio (Indemnity divided by Premium) for the plans by year. Overall, the loss ratio is 62% for the 2003-2015 years (although more indemnities may be payable in 2015). The LRP-Lamb product had very high loss ratios in most years. This may explain the higher participation for LRP-Lamb for these years and the subsequent change in the program. The higher participation may also be due to the fact that, unlike the other commodities insured under LRP and LGM there is no futures market for lamb. The overall loss ratio for LGM-Dairy has been only 6%; however it has been the most popular product by far. For both swine products the overall loss ratio is 95%, with significant volatility by year.

Figure 21: Loss ratios, all species

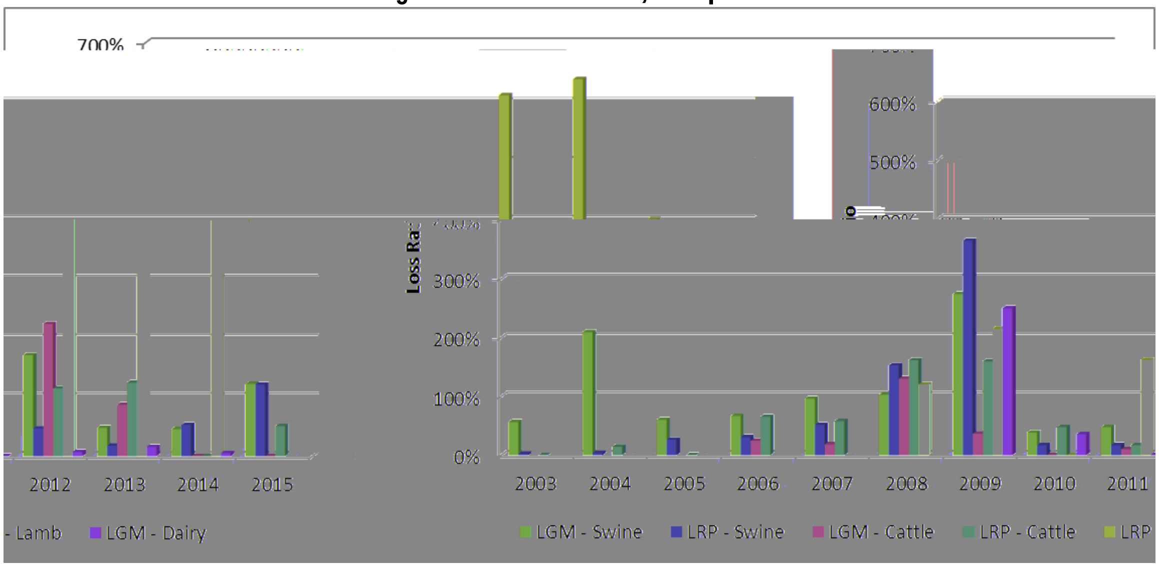
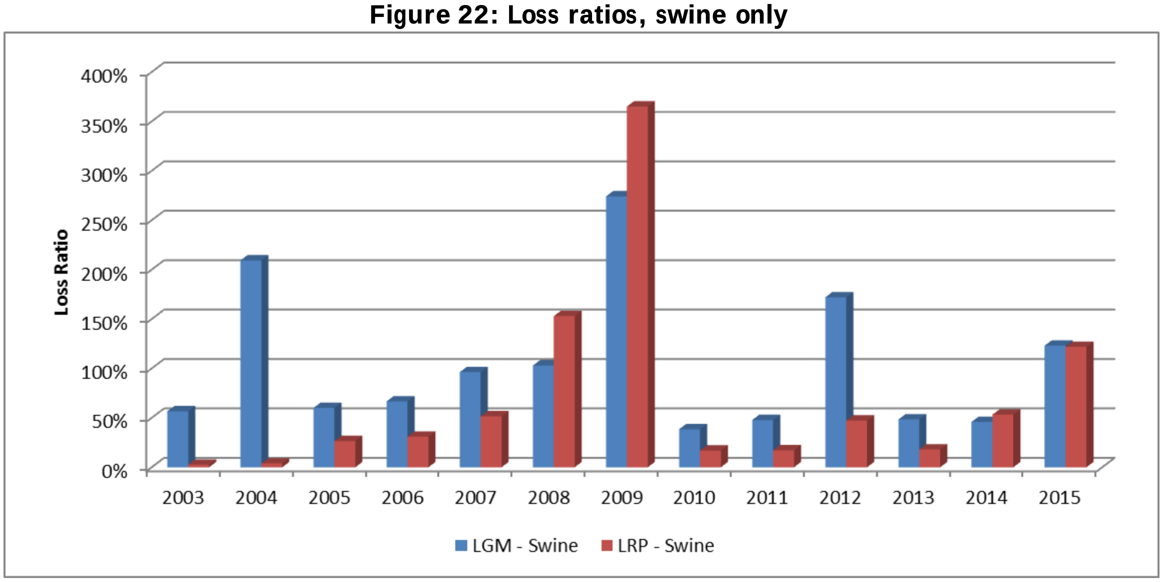


Figure 22: Loss ratios, swine only



Overall, the insurance experience shows a lack of demand for any of the LRP/LGM products except LGM-Dairy. It should be noted that the 2014 Farm Bill introduced a Margin Protection Program (MPP) similar to LGM-Dairy. Even with the MPP, the participation in LGM-Dairy increased for the 2015 year. The low loss ratios and relatively higher participation rates for LGM-Dairy seem counterintuitive compared to the LRP/LGM–Swine products.

The following are possible reasons for low participation rates in the LRP/LGM swine insurance products:

- Many producers have production or marketing contracts that negate the need to hedge price risk.
- Number of head limitations by insurance period or by year may discourage participation by large producers.
- Prices for coverage may appear high.
- The one month lag between sale and coverage for LGM may be viewed as risky. If the gross margin increases during the month, then the premium could be too high (although the opposite could happen).
- Comparison to options or futures hedges is difficult.
- While one could buy LRP any business day, one would first need to fill out an application and then buy a specific coverage endorsement. With futures/options prices changing constantly, this may make it difficult for the producer to decide whether it makes sense.
- Sales limitations due to the high Cattle-Dairy interest and the cap on total FCIC expenditure on livestock insurance products may discourage any interest in the swine products.
- Some livestock producers do not want to be reliant on government programs.
- Based on past experience, other livestock producers expect the Congress to provide emergency assistance when there is a major problem due to weather or other factors.

6.2.3. Private insurance products

Private insurance products are available to cover mortality and liability risks for swine producers. These coverages are typically included in a Farm Owner's policy. However, these products are limited to certain perils that cause the death of the swine such as a fire or tornado. Liability due to the actions of the livestock may be covered as well (such as swine escaping and digging up a neighbor's field). We found no instances of disease being covered in any private products and no coverage for price changes.

From our detailed search, we found no private insurance program to cover a CSDE.

7. FEASIBILITY OF DEVELOPING AN INSURANCE PLAN

As part of the research on the feasibility of developing an insurance plan, we held four listening sessions for swine producers and the insurance industry in late March and early April. They were held in North Carolina, Indiana, Minnesota and Iowa, all of which are leading swine producing states. We also received input by phone from a number of producers and industry representatives.

The main themes that emerged from this industry feedback were the following:

- There is a sense that the probability of introduction of foreign animal diseases has increased and that this is now a more significant risk for the industry.
- With the share of pork production exported having grown to 20%, there is concern that a foreign ban on imports of pork from the United States due to a disease outbreak would sharply lower prices.
- The negative effects on the industry could last one to three years or more, and drive many producers into bankruptcy.
- An insurance plan should cover only the four most serious diseases and provide indemnities over an extended period, i.e. more than one production cycle.
- Existing insurance plans and other risk management tools are not able to address this risk.
- However, willingness to pay for additional insurance coverage appears to be very limited.

Below we discuss the risks that the swine industry faces, how to define the insured, the guarantee, and the trigger for a loss, what one would have to charge for the insurance, producer willingness to pay, potential market impacts, and our conclusions about the feasibility of developing an appropriate plan.

7.1. The risks

There are many financial risks in producing swine. For this report we have considered both risks to an individual farm and risks to the industry. An individual producer is exposed to both sets of risks.

Table 15: Swine Sector Risks

Individual Risk	Industry Risk
• Property damage causing death to inventory	• Price decline due to over production
• Localized disease causing mortality, reducing efficiency or making inventory unmarketable	• Price decline due to closure of export market due to a CSDE
• Price basis risk (when hedging strategies are used)	• Increase of input (feed) costs
• Inability to obtain pigs to feed	• Demand reduction and price decline due to negative news scare
• Buyer/contractor insolvency	• Exit of firms due to lack of profitability

Specifically for this report we focus on a CSDE (Catastrophic Swine Disease Event). According to research and evidence from our listening sessions, it is believed that a CSDE could close exports markets for a year or more. On a short term basis, this could decrease prices by as much as 50%. According to one study, prices might remain under 70% of the study baseline for over two years.[9] Once inventory is cleared, producers would limit or stop production until a future expectation of a positive margin appeared. It also should be noted that the farms where the disease is found would be cleaned and not allowed to resume production again until all signs of the disease are gone. The number of farms that would be affected would depend on how the disease is transmitted. It is also unclear how the domestic market would react. While it would depend on the disease itself, domestic demand may fall due to consumer fear of disease whether warranted or not.

An individual producer without the disease being detected on their farm would still have to market the hogs at significantly lower prices. These prices could vary from those on the futures market due to basis risk and regionalization of the disease outbreak. Thus, use of futures contracts or put options might not fully indemnify the producer in the event of a price decline.

Additional risk beyond that on the current inventory relates to the loss associated with continued expenses without offsetting revenue. This is commonly referred to as Business Interruption (BI) Insurance in the commercial insurance marketplace. BI can be added to the business' property insurance policy or package policy such as a Business Owner's Policy (BOP) or a Commercial Multi-Peril (CMP) policy. BI can provide the following coverages:

- Lost income;
- Fixed costs;
- Temporary moving expenses; and
- Extra rental expenses.

BI is typically only triggered when an insured event causes property damage to the place of business. Generally, there is a waiting period and time limit (such as one-year) for coverage. BI coverages vary significantly depending on the size and complexity of the business.

For swine producers there is considerable BI risk in case of a CSDE that significantly reduces demand. The impacts would be different depending on the producer type:

- A sow/farrowing/nursery operation would likely have an overstock of supply initially. Decisions would need to be made regarding the current inventory and whether to continue to breed. Gestation takes about 16 weeks and growing to the feeder pig stage takes another 8 to 10 weeks. Projecting future demand in six months would be difficult given a CSDE. The producers would still incur many costs such as feeding if they decide to stop or reduce breeding. Decisions would also be made about the sows, which would have a very low value in the marketplace during a low demand period.
- A grow/finish operation would also suffer in the event of a catastrophic swine disease outbreak. For these producers the financial impact would depend on the ownership of the swine and the contract wording. Regardless, these producers would still have many fixed costs during the period of industry adjustment.

There is considerable risk associated with a CSDE to swine producers, both with the current inventory and the business interruption effects. The next section discusses insurable interest and the current regulations and guidelines from RMA.

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[9] Hayes, Dermot et al, "Economy Wide Impacts of a Foreign Animal Disease in the United States" – Center for Agricultural and Rural Development; Iowa State University; Working Paper 11-WP 525, November 2011. See also Hayes, Dermot, "Preparing the US Livestock Industry for Low Probability Catastrophic Events", December 2011

7.2. Defining the insured

Insurable interest is defined in the Code of Federal Regulations section 7 CFR 400.561 as:

> *"The value of the producer's interest in the crop that is at risk from an insurable cause of loss during the insurance period. The maximum indemnity payable to the producer may not exceed the indemnity due on the producer's insurable interest at the time of loss*."

Under a document released by RMA - **General Guidelines, Considerations, and Criteria for Feasibility of Insurance Product Development March 2012** – it states:

> *"The party to be insured must have an 'insurable interest' in the commodity. This means some portion of the commodity at risk must be 'owned' by the insured party. (For example: Contract growers of livestock often provide labor and housing but have no ownership of the actual animals so do not have an insurable interest.)"*

Based on the definition above, it would be difficult to conclude that contract growers managing packer-owned hogs would be eligible to any significant degree for any insurance program administered by RMA. While contracts may offer bonuses for achieving high feed conversion rates, an indemnity based on the incremental payment of a few dollars per animal would not significantly address the problems arising from a CSDE.

A swine producer or contractee who owns the animals clearly has an insurable interest. However, according to the regulations, the indemnity may not exceed the current inventory value. Therefore designing a product with Business Interruption coverage does not appear to be feasible under the current regulations. RMA staff have given some thought to whether a livestock BI coverage could be modeled on the Citrus Tree Policy's Comprehensive Tree Value Endorsement. The endorsement indemnifies the net present value of the tree based on the value of the fruit a mature tree would have produced while a new tree is getting back into production. This could work as an insurance plan for sows that might have produced three or four litters of pigs, but it would be challenging to apply the concept to market hogs.

Some RMA insurance plans base guarantees on inventory values that are periodically reassessed during the insurance year based on numbers of insured items and their stage of growth. This is the case for the Nursery plan and the Cultivated Clam Pilot. However, in both cases the guarantee is reset at the beginning of each insurance year. It does not appear to us that this approach would overcome the barrier to providing coverage for more than the inventory value during the current insurance year.

7.3. Defining the guarantee and trigger for a loss

Most insurance policy language includes a trigger or cause of loss that needs to occur during the insurance period before any indemnity is made. For example, the causes of loss listed for the Coarse Grains Crop Provisions are as follows:

a) Adverse weather conditions;
b) Fire;
c) Insects, but not damage due to insufficient or improper application of pest control measures;
d) Wildlife;
e) Earthquake;
f) Volcanic eruption;
g) Failure of the irrigation water supply due to a cause of loss specified in sections 8(a) through (g) that also occurs during the insurance period; or
h) For Revenue Protection, a change in the harvest price from the projected price, unless FCIC can prove the price change was the direct result of an uninsured cause of loss specified in section 12(a) of the Basic Provisions.

For the LRP program, the trigger is simply whether the actual ending value is less than the coverage price. Both of these values are clearly defined in the policy. It is an important insurance principle to have clear triggers in order to avoid disputes between the insurer and insured. Therefore any insurance program to protect against a CSDE should have a clear cause of loss. Clear definitions would need to be made in the policy.

One approach could be to add an endorsement for a CSDE. Endorsements typically add coverage to the existing policy. As discussed in the previous section, it appears that RMA guidelines prohibit insurance above the current inventory, so an endorsement with additional coverage for a CSDE may not be available. There could be an endorsement that limits the LRP indemnity to a CSDE. An indemnity would only be paid in the event a CSDE is declared and the price declines below the coverage amount. The endorsement would need to be carefully worded to ensure understanding of the terms for both the insured and insurer.

7.4. Rating analysis

As stated in the RFP, any possible insurance program should be "ratable and operable in an actuarially sound manner". In the statement of work describing this project, RMA provided the following definition: "Actuarially sound – For the purpose of the Federal Crop Insurance Program, a classification and premium rate determination system, where risk premium collected is sufficient to cover expected future losses and to build a reasonable amount of reserve."

The Casualty Actuarial Society provides the following principles with respect to insurance rates:[10]

- A rate is an estimate of the expected value of future costs;
- A rate provides for all costs associated with the transfer of risk;
- A rate provides for the costs associated with an individual risk transfer; and
- A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

Under RMA sponsored programs, the expenses are provided under the Administrative and Operating (A&O) subsidy, which is out of the scope of this project. The RMA definition of actuarially sound as discussed above implies that the long-term loss ratio should be close to but less than 100%.

The overall loss ratio for the LRP and LGM program is 71% through 2014 which may imply that the current methodology used in the LRP and LGM rating is not unreasonable.

However, in developing an insurance plan to cover a CSDE, one important obstacle is that there is no historical data on which to base rates. The future frequency and scale of potential CSDE events is unknown, and this makes it challenging to determine how much to charge for the insurance coverage.

7.4.1. Comparison between LRP and Options

We compared the rates from the LRP-Swine plan to comparable put options on a given date. We needed to make several adjustments to make sure the comparisons were similar. For example, the LRP-Swine rates are based on the insured value which is defined as:

[10] Casualty Actuarial Society, *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* (1988).

$$Insured\ Value = Number\ of\ Head\ \times Target\ Weight\ \times Coverage\ Price\ \times Share$$

Target Weight is the expected lean market weight in hundred pounds (cwt). A Lean Weight Conversion Factor of 0.74 converts live weight to lean weight. The Target Weight should fall between 1.50 and 2.25 cwt. The coverage price is the amount shown in the actuarial documents and is a percentage of the expected ending value amount. The implied coverage level is the coverage price divided by the expected ending value amount. The rates for each coverage price and endorsement length (13, 17, 21, or 26 weeks) change each day due to changing prices and volatilities. These are stored on the RMA ADM database which is publicly available.

Using the options market we converted the following terms from the LRP as follows:

Table 16: Comparison of terms

	LRP – Swine	Put Options	Notes
(A)	Expected Ending Value Amount	Current Futures Amount	
(B)	Coverage Price	Strike Price	
(C)	Coverage level	Coverage Level	= (B) / (A)

We then needed to calculate a comparable insured value amount for the options. This was calculated as:

$$Insured\ Value = 400\ cwt\ X\ Current\ Futures\ Amount \times Coverage\ Level$$

The comparable rate for options was calculated as:

$$Options\ Rate = Quoted\ Premium \div Insured\ Value$$

We used similar lengths of time to expiration to compare to the 13, 17 and 26 week endorsements. For example, the July 15 futures expires on July 17, 2015 so we compared options prices on April 17th, which is 13 weeks before expiration. We also needed to interpolate rates between strike prices in order to compare with the exact same LRP-Swine coverage level. Table 17 displays the outcome of our analysis.

Table 17: Comparison of rates between RMA and Put Options

Weeks to Expiration	RMA Coverage Level	ADM Rate	Options Rate	Options Price Difference
13	97.5%	0.05603	0.03827	-31.7%
13	87.2%	0.01678	0.01245	-25.8%
13	82.1%	0.00873	0.00655	-25.0%
17	97.5%	0.05309	0.04634	-12.7%
17	87.3%	0.01822	0.01664	-8.7%
17	82.1%	0.01036	0.00923	-10.9%
26	99.4%	0.08272	0.06356	-23.2%
26	96.6%	0.06877	0.05240	-23.8%
26	85.4%	0.02808	0.02048	-27.1%
26	79.8%	0.01744	0.01321	-24.3%

Our simplified analysis found the put option rates to be approximately 20% to 30% lower than the comparable LRP-Swine rates. We would expect the opposite due to the ability of the put option being exercised before expiration (American versus European options). One explanation may be that RMA products typically include a risk load of 13.6%. However this does not fully explain the difference. In our listening sessions, it was mentioned that a risk load of 30% is included in the LRP-Swine rates, but we have no way of verifying this comment.

7.4.2. Catastrophic coverage discussion

We reviewed a 2011 Iowa State University working paper[11] that estimates the impact of a CSDE in the United States. Using December lean hog futures the paper calculated a 2.38% probability of a price reduction in excess of 40% and a 0.76% probability of a price reduction of 50% or more. This working paper projected that the price of swine would fall to 50% of the study's baseline price soon after the CSDE as a result of other countries not accepting pork imports from the United States. The paper predicted the price would stay more than 30% below the baseline for two years.

The paper suggested adding the Catastrophic Risk Protection Endorsement, known as CAT coverage, to livestock policies to address the CSDE risk. One issue of offering a CAT type policy similar to other commodities is that production volume has to decline more than 50%, and then indemnification is based on only 55% of the projected price. There also would be no compensation for the duration of the major price decline caused by the CSDE. It is also unclear if this risk can be covered under the current Federal Crop Insurance Act (FCIA). Current CAT policies insure yield loss only. The FCIA states:

> *Except as provided in subparagraph (B), the Corporation shall offer a catastrophic risk protection plan to indemnify producers for crop loss due to loss of yield or prevented planting, if provided by the Corporation, when the producer is unable, because of drought, flood, or other natural disaster (as determined by the Secretary), to plant other crops for harvest on the acreage for the crop year.*

This would imply that CAT coverage would only be for yield loss. However, the following states that a CAT policy could be designed on a uniform national basis including price and yield:

> *(3) ALTERNATIVE CATASTROPHIC COVERAGE.—Beginning with the 2001 crop year, the Corporation shall offer producers of an agricultural commodity the option of selecting either of the following:*
> *(A) The catastrophic risk protection coverage available under paragraph (2)(A).*
> *(B) An alternative catastrophic risk protection coverage that—*
> *(i) indemnifies the producer on an area yield and loss basis if such a policy or plan of insurance is offered for the agricultural commodity in the county in which the farm is located;*
> *(ii) provides, on a uniform national basis, a higher combination of yield and price protection than the coverage available under paragraph (2)(A); and*
> *(iii) the Corporation determines is comparable to the coverage available under paragraph (2)(A) for purposes of subsection (e)(2)(A).*

The current CAT policies for crops only offer coverage for yields under 50% of expected levels and only provide 55% of the projected price. We do not believe this type of coverage would provide significant assistance in a CSDE. Even if the CAT coverage is defined on a revenue basis, revenue would have to fall more than 72.5% before any indemnity would be paid. According to the paper, the price would decline to about 50% of the baseline, which would provide no (or very little) indemnity under any type of CAT policy.

7.4.3. Endorsement Concept

One way to utilize the LRP policy to provide CSDE coverage is to design an endorsement that would pay out an additional amount in the event of a CSDE. The endorsement would require a trigger only in the event of a declaration of a CSDE. The endorsement would only pay an additional amount when a CSDE is

[11] Hayes, Dermot et al, Op cit

declared. It would not provide additional coverage for a non-CSDE situation such as an oversupply event like the one occurring in 1998 that reduced prices by more than 50%.

Under this endorsement concept a separate coverage level would be included for the CSDE. In this example we are using 75%. If a CSDE occurs and the price declines by more than 25%, then an additional indemnity would be paid. The producer would also be paid under the traditional LRP-Swine policy purchased at whatever coverage level they selected. In order to illustrate this concept we display payment factors (Indemnity = Payment Factor times Insured Liability) for both a traditional price decline and a CSDE endorsement event in the following tables.

Table 18 shows the payment factors for the regular LRP policy. Table 19 shows an example of CSDE enhancement payment factors. For this example, the CSDE coverage level begins at 75%:

$$Payment\ Factor\ = \{\ Min(\ 75\%\ ,Coverage\ Level) - (1 - Price\ Decline)\ \} \div Coverage\ Level$$

Table 18: LRP payment factors

Price Decline	Coverage Level				
	90%	85%	80%	75%	70%
25%	17%	12%	6%	0%	0%
30%	22%	18%	13%	7%	0%
35%	28%	24%	19%	13%	7%
40%	33%	29%	25%	20%	14%
45%	39%	35%	31%	27%	21%
50%	44%	41%	38%	33%	29%
55%	50%	47%	44%	40%	36%
60%	56%	53%	50%	47%	43%
65%	61%	59%	56%	53%	50%

Table 19: CSDE enhancement payment factors

Price Decline	Coverage Level				
	90%	85%	80%	75%	70%
25%	0%	0%	0%	0%	0%
30%	6%	6%	6%	7%	0%
35%	11%	12%	13%	13%	7%
40%	17%	18%	19%	20%	14%
45%	22%	24%	25%	27%	21%
50%	28%	29%	31%	33%	29%
55%	33%	35%	38%	40%	36%
60%	39%	41%	44%	47%	43%
65%	44%	47%	50%	53%	50%

Table 20 displays the sum of the two previous tables, which would be the payment factor if a CSDE is triggered.

Table 20: Combined payment factors

Price Decline	Coverage Level				
	90%	85%	80%	75%	70%
25%	17%	12%	6%	0%	0%
30%	28%	24%	19%	13%	0%
35%	39%	35%	31%	27%	14%
40%	50%	47%	44%	40%	29%
45%	61%	59%	56%	53%	43%
50%	72%	71%	69%	67%	57%
55%	83%	82%	81%	80%	71%
60%	94%	94%	94%	93%	86%
65%	106%	106%	106%	107%	100%

In this example, the indemnity could exceed the insured value of the LRP-Swine policy. However this would only occur in an extreme low price scenario. This example would have several benefits compared to the current LRP-Swine policy regarding a CSDE:

- The insured would not be unduly compensated for a small price change;
- The insured would gain additional indemnity in the event of a CSDE, which is likely to last longer in duration than a "typical" price decline;
- The insured's premium rates would be relatively lower than if the CSDE endorsement applied to any price change rather than a lower amount (25% in our example); and
- Increasing the indemnity in the event of a CSDE would also help deal with the expected duration of a CSDE price decline without compromising the "insurable interest" concept of RMA insurance plans.

The current LRP-Swine rates would need to be increased due to this endorsement. However, the current rates for coverage levels below 75% are very low. A review of current ADM rates found the rates to be lower than 0.010 for coverage levels around 75%. If we assume that one-half of the times the price falls below 75% it is due to a CSDE, then the rate for this enhancement would be approximately 0.005 at the 75% coverage level. Using an $80/cwt price, this coverage would translate to approximately $0.63 per hog.

The actual rates for the CSDE would need to be updated daily in the same way as for the LRP-Swine rates. If one changes the parameters in the CSDE endorsement (coverage level or amount of coverage), the rates would change as well.

7.5. Producer willingness to pay

Developing a new insurance plan to cover the impacts of a CSDE would serve no purpose if no one is going to buy it. There are several indicators that point to a lack of willingness among swine producers to buy such coverage. First and foremost is the lack of participation in the existing swine insurance plans. The number of policies sold and the number of hogs covered have both been negligible, as illustrated in Figure 13, Figure 14, Figure 19 and Figure 20 in Section 6.2.

In our listening sessions we specifically asked producers whether they would buy such insurance and the response was decidedly mixed. As noted earlier, there are a number of potential reasons for this:

- Much production is under contracts in which the producer has no price risk;
- Livestock producers have historically had some degree of pride in not being dependent on government programs;
- Several said that the big integrators would self-insure rather than buy coverage; and
- It may be viewed as both too expensive and optional.

On the question of how much producers would be willing to pay for coverage, the most candid discussion occurred at the Ames, Iowa listening session. The consensus was that it would have to be less than the pork checkoff amount, which is 0.40% of market value. At $80/cwt for a carcass weight of 210 pounds, the market value is $168 and the checkoff amount is $0.67. Thus one might think of $0.50 per animal as the upper limit of what a producer would pay. In our CSDE endorsement concept, we estimated an additional cost of $0.63 per hog but this was based on fairly simple assumptions since there is no historical data on which to base rates.

7.5.1. Potential outline of plan design

There are many different possible elements of a plan design. Among other things, it would have to consider the following:

- Defining the guarantee for animals with varying functions or at different stages of growth: sows, boars, piglets, feeder pigs, and market hogs.
- Defining buyup coverage levels and any catastrophic coverage element.
- Defining the trigger for an indemnity, and the period of coverage.
- Defining when the coverage must be purchased.
- Developing actuarially sound rates.

Here we simply define a basic program for purposes of developing estimates of potential liability, indemnities, and cost to the government. It would cover those market hogs from the feeder pig stage onwards that would be expected to be slaughtered within one year of the date of a CSDE declaration and include only buyup coverage with a maximum coverage level of 75%. The total premium is assumed to be 1.5% of the guarantee, of which 0.5% is for the additional CSDE endorsement.

7.5.2. Impact analysis

Table 21 presents estimates of the hypothetical plan's liabilities, premiums, indemnities, and government costs under specified assumptions. This table assumes that the addition of a CSDE endorsement entices swine producers to purchase an LRP-Swine policy at a lower coverage level (75%) than what is currently being purchased. Annual hog slaughter is about 110 million head and average live weight at slaughter the past two years has been about 280 pounds, for a carcass weight of about 210 pounds. Total carcass weight of annual slaughter is therefore 231 million cwt. At $80/cwt the total value is $18.5 billion. One can easily envision the large adverse impacts on those in the swine industry and on US agriculture if there were a multi-billion dollar decline in the value of output due to a disease outbreak.

If we assume that 25% of production is enrolled at a coverage level of 75%, the total liability under the plan would be about $3.5 billion. In view of the various factors pointing to a low level of interest in such a product, a participation rate of 25% seems a plausible assumption. With a premium rate of 1.5%, total premiums collected would be $52 million. This figure includes the 1% for a traditional LRP-Swine product and the CSDE endorsement of 0.5%.

Table 21: Impact analysis

Estimate of liability	
Hog slaughter (millions)	110
cwt per hog carcass	2.1
Total cwt hog carcass (millions)	231
Price per cwt	$80
Value of hogs ($ millions)	$18,480
Coverage level	75%
Participation rate	25%
Insured value ($ millions)	$3,465
Estimate of premium	
Premium rate (assumed)	1.5%
Annual Premium ($ millions)	$52.0
Estimate of indemnity	
CSDE price decline	50%
CSDE price per cwt	$40
CSDE indemnity (Millions)	$2,310
Estimated government costs	
Premium subsidy @13% ($ millions)	$6.8
A&O subsidy ($ millions)	$11.5
Total subsidy costs ($ millions)	$18.3

Drawing on the analysis by Dermot Hayes et al cited in Section 7.1, we assume that there is a price decline of 50% to $40/cwt that results in an indemnity of $2.3 billion. This number pales in comparison to the $35 billion estimated by Hayes as the total economic damage caused by a CSDE.[12] However, it is the same order of magnitude as other estimates of economic impact cited in Section 4.3.2. Due to the assumed limited participation in the plan, this only makes a partial contribution to the hog sector's adjustment problems in the event of a CSDE. In terms of actuarial soundness, the premiums would cover the one-time indemnity once every 44.4 years.

The producer-paid premium would be higher than what the input from our listening sessions revealed producers are willing to pay. At $80/cwt for a 210 pound carcass, the value is $168. With a 75% coverage level and a 1.5% premium, the total premium would be $1.89. After a 13% government subsidy the producer would be paying $1.64 per animal, or roughly two and a half times the pork checkoff amount

Costs to the government under the specified assumptions would be significant at $18.3 million for the premium subsidy of 13% and the A&O subsidy of 22.2%. This is almost equal to the total $20 million cap on expenditure on livestock insurance programs, and could obviously not be accommodated as an addition to the current insurance plans without action by the Congress to lift the cap.

With different assumptions in Table 21, one could come up with indemnity and government cost estimates that are within plus or minus 50% of the figures cited above, i.e. indemnities of $1.2-3.5 billion and government costs of $9-27 million. However, we believe that our estimates are the most plausible.

[12] Hayes et al, Op cit

7.5.3. AIP acceptance of a CSDE endorsement

There is a separate livestock price reinsurance agreement (LPRA) between approved insurance providers (AIPs) and the Federal Crop Insurance Corporation (FCIC) for livestock programs administered by RMA. The 2016 LPRA offers two funds where an AIP can place a policy:

- Private Market Fund – AIPs can cede between 5% and 65% of premium and liability (quota share) to the FCIC; and
- Commercial Fund – AIPs can cede between 0% and 65% of premium and liability (quota share) to the FCIC. Additionally, the FCIC provides stop-loss protection of 90% for the 350% excess over a 150% loss ratio and 100% over a 500% loss ratio. AIPs pay 4.5% of retained premium for this stop-loss coverage.

AIPs also receive a 22.2% A&O subsidy to cover administrative and commission expenses.

There are nineteen AIPs listed to provide crop insurance and fourteen AIPs listed to provide livestock insurance. Only one company provides livestock insurance without providing crop insurance. It appears there is enough demand from the AIPs to provide livestock insurance. Given that AIPs can limit their exposure to a CSDE through the Commercial Fund, we find no reason why AIPs would not be interested in providing this coverage.

7.6. Market impacts

One of the requirements for a Federal insurance program is that it "not allow a change in market behavior or market distortions that change the quantity supplied or shift the supply curve." Setting aside the cap on expenditure on livestock insurance plans, it appears to us that the regulatory constraints on what could be offered imply an insurance plan that would provide only limited indemnities for a CSDE, in part because participation would probably be very low due to the cost and other factors cited in Section 6.2.2.

We also found no evidence that swine producers are curtailing production plans out of fear of a CSDE. Consequently we conclude that there would be no significant changes in market behavior.

If significant subsidies were added to the LRP-Swine program, this could impact the commodities markets by making the hedging strategies less attractive than insurance programs.

7.7. Conclusions on feasibility

Our overall conclusion from our research and analysis is that it is not feasible to develop an appropriate insurance program for swine producers to provide protection against a catastrophic swine disease event. We can envision a feasible program design but it is not an insurance plan that meets the definition of "actuarially sound," that swine producers would purchase, or that successfully addresses the economic challenges stemming from a catastrophic swine disease event. The six main reasons for our overall conclusion are elaborated below.

7.7.1. Statutory cap on expenditure

The 2000 Agricultural Risk Protection Act (ARPA) required the Risk Management Agency to develop the two existing programs for livestock, LRP and LGM, but it established a limit on total expenditures for premium subsidies, Administrative and Operating expenses so that, to the maximum extent practicable, all costs associated with conducting the livestock programs (other than research and development costs covered by Section 522) are not expected to exceed $20,000,000. The existing programs usually exhaust the available funding.

Any new coverage for a CSDE would involve considerable Federal outlays. Our example of an endorsement described above involved estimated subsidy costs of $18.2 million. Congressional action would be required to increase or remove the expenditure cap. The Congressional Budget Office's March 2015 baseline projections of outlays on farm programs included an annual average of $8.4 billion for the Federal Crop Insurance Corporation for fiscal years 2015-2019. The negative impact of a CSDE on the $18 billion swine industry would be in the billions of dollars, and government costs for indemnities under an insurance plan could also be in the billions of dollars. Whether the Congress would choose to take on the additional costs of a new insurance plan for a CSDE is unknown.

7.7.2. Many hog operations have no insurable interest

The US swine industry is increasingly defined by contracts with growers to manage hogs provided and owned by the contractor. This gives the contractor control over the genetics and provides some geographic and management diversification of production risk. The precise share of total hogs currently grown under such contracts is not known but had reached 71% in 2009. Contract growers who do not own the animals have no significant insurable interest. The contactor or packer would have to purchase the insurance, and input we received at the listening sessions suggested that they have been more likely to use futures and options to manage at least a portion of the risk of a CSDE. If the industry begins to assign a higher probability to occurrence of a CSDE, packers, contractors and large independent producers may develop greater interest in an insurance product, especially if the cost is subsidized. However, the many growers who do not own the hogs they are raising would remain vulnerable to loss of access to hogs to raise and to contractor insolvencies.

7.7.3. Only current inventory could be covered

Regulations governing FCIC insurance plans dictate that only current inventory can be insured. If a corn producer experiences a drought, it is only the current crop that is insured, not crops in subsequent years. Those subsequent crops each require payment of a new premium. In the case of livestock, one can only insure what exists. Annual slaughter of market hogs is approximately twice the inventory of market pigs and hogs at any point in the year. Thus under existing FCIC regulations an insurance plan could only be covering approximately half a year's production at the time of a CSDE.

While the threat of a CSDE with adverse financial impacts is real, most producers would not be covered under a plan providing CSDE coverage for swine. Even producers that would purchase the CSDE endorsement concept we describe in Section 7 would most likely not be nearly compensated for their loss. The losses many producers would face would result from their inability to obtain pigs in periods following a CSDE. They would be stuck with fixed costs associated with their investment in hog barns and equipment, yet could be unable to obtain a contract for animal production, either because integrators and packers do not wish to contract with them due to disease at or near their facilities, or due to lack of packer demand generally.

What the swine industry was hoping for is an insurance plan that would provide indemnities over the multi-year period of adjustment of the sector to a loss of export markets. This is not feasible under current regulations.

7.7.4. There is no data on which to base actuarially sound rates

There have been no outbreaks of the four critical diseases since the United States became a net exporter of pork in 1995. Indeed, neither African Swine Fever nor Swine Vesicular Disease has ever been present in this country. The last US case of Classical Swine Fever in the United States was in 1978 and the last Foot and Mouth Disease case was in 1929.

During the first decade in which US pork exports gained ground, net exports averaged only 2.6% of production. However, in the most recent decade, 2005-14, net exports averaged almost 15% of production and are now near 20%. The total lack of any CSDE experience, coupled with the recent increase in vulnerability to a loss of export markets, makes it very difficult to rate any potential insurance coverage. There has been some econometric modeling of the potential effects of a CSDE, as reviewed in Section 4.3.2, but the results are very dependent on the assumptions made in each case about the location and duration of the event, the species affected, containment measures, and consumer behavior.

7.7.5. Existing mechanisms for risk management are available

Integrators and producers can and do use futures and options to manage price risk. It appears that most of the demand for these financial products is limited to the current inventory (since the volume for contracts greater than six months ahead is limited). USDA has also been implementing a Secure Pork Supply plan, discussed in Section 4.4.3, to allow business continuity where there is no disease present.

Growers focus on bioexclusion procedures (particularly given the experience with recent diseases). Also, some growers can self-insure over time on their own, as was specifically mentioned by one grower at our North Carolina listening session. Some producers have also diversified in order to limit the risk from production of any one commodity. However, with the increase in specialization within the hog sector, growers as a group are probably less diversified today than they were twenty or thirty years ago.

7.7.6. Producers currently appear unwilling to pay the cost to participate

Equally serious is the lack of producer interest in buying insurance coverage. Participation in the existing LRP and LGM plans is negligible – only 43 policies in 2015 covering a total of 100,000 head, i.e. one tenth of a percent of annual slaughter. Through contracting and the use of futures and options the industry seems to be able to successfully manage its near-term price risk. The existing plans are apparently viewed as too expensive for what they provide.

In the listening sessions, producers who owned their own hogs said they would not want to pay even one dollar per animal for insurance. Some said it would have to be less than the pork checkoff amount, which is 0.40% or about $0.67 per hog. Our estimate in Section 7.5.2 of the producer cost of an LRP-Swine policy with a CSDE endorsement is 2.5 times that amount. However, one participant commented that it will actually be the producer's banker who decides whether to buy coverage. On the face of it, a producer cost equal to one percent of the value of the hogs should not be a major obstacle to purchasing the insurance if it appears to be needed.

Finally, some in the countryside believe that if there is a big enough problem in the industry, the Congress will approve ad hoc disaster payments to deal with it, in which case there is no point in paying for insurance.

APPENDIX 1: SECTION 508 DATA

These are the data for Figure 1: Share of pork supply that is exported:

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Production	20,705	21,074	21,962	23,367	23,020	22,456	22,775	23,268	23,200	22,858
Exports	2,666	2,995	3,141	4,651	4,094	4,223	5,196	5,380	4,992	4,858
% of total supply exported	12.0%	13.3%	13.4%	18.8%	16.7%	17.7%	21.5%	21.9%	20.2%	19.8%
Total supply	22,239	22,543	23,424	24,717	24,489	23,840	24,120	24,612	24,705	24,483

These are the data for Figure 2: Slaughter by market type:

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MPR carcass weight priced				*% of Fed. Inspected barrow & gilt slaughter*							
Spot market	13.8	12.6	10.4	10.4	9	8.2	8.1	6.5	4.9	4.1	3.4
Packer owned	16.4	17.8	18.1	16.4	20.7	22.3	23.1	24	25.2	26.5	26.6
Total	94.1	94.8	94.2	94.6	93.9	94.2	94.7	95.2	94.4	95.7	95.0
Contractor agreements	61.7	62.3	63.8	62.5	58.3	57.6	57.6	59.1	59	60.8	60.8

These are the data for Table 2: Swine growers by state:

State	Independent grower Farms	Contractor/ integrator Farms	Contract grower Farms
	number of farms		
Alabama	671		18
Alaska	35	2	
Arizona	506	3	
Arkansas	685	2	65
California	1,411	24	2
Colorado	982	13	6
Connecticut	315	3	
Delaware	59		
Florida	1,599	43	
Georgia	839	3	24
Hawaii	231		
Idaho	676	4	
Illinois	1,681	18	346
Indiana	2,244	14	499
Iowa	3,598	66	2,602
Kansas	951	15	44
Kentucky	1,248	14	22
Louisiana	658		
Maine	748	4	
Maryland	332		1
Massachusetts	477	1	
Michigan	2,062	8	128

State	Independent grower Farms	Contractor/ integrator Farms	Contract grower Farms
	number of farms		
Minnesota	2,414	29	912
Mississippi	503	2	35
Missouri	1,923	14	191
Montana	399	7	
Nebraska	1,192	9	275
Nevada	81		
New Hampshire	357	2	
New Jersey	293	5	
New Mexico	209	2	
New York	1,881	18	13
North Carolina	1,281	61	875
North Dakota	215	3	
Ohio	2,998	14	482
Oklahoma	1,896	3	48
Oregon	1,110	14	
Pennsylvania	2,742	29	326
Rhode Island	77		
South Carolina	790	7	41
South Dakota	595		86
Tennessee	1,255	18	24
Texas	4,902	3	
Utah	651	14	4
Vermont	437	13	
Virginia	1,231	12	22
Washington	913	21	
West Virginia	719	6	
Wisconsin	2,224	15	31
Wyoming	270		
United States	**55,566**	**558**	**7,122**
		Total	**63,246**

These are the data for Figure 4: Farrow to wean:

Farm size	Farrow to wean Farms	Hogs
1 - 999	3841	189,184
1,000 - 4,999	108	286,840
5,000+	828	47,616,575

These are the data for Figure 5: Farrow to feeder:

Farm size	Farrow to feeder Farms	Hogs
1 - 999	4246	279,863
1,000 - 4,999	98	241,969
5,000+	112	5,861,186

These are the data for Figure 6: Farrow to finish:

Farm size	Farrow to finish Farms	Hogs
1 - 999	12446	994,295
1,000 - 4,999	1004	2,274,801
5,000+	885	37,724,298

These are the data for Figure 7: Finish only:

Farm size	Finish only Farms	Hogs
1 - 999	16228	809,867
1,000 - 4,999	3784	10,104,483
5,000+	3903	55,559,197

These are the data for Figure 8: Slaughter by market type:

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MPR carcass weight priced	*% of Fed. Inspected barrow & gilt slaughter*										
Spot market	13.8	12.6	10.4	10.4	9	8.2	8.1	6.5	4.9	4.1	3.4
Packer owned	16.4	17.8	18.1	16.4	20.7	22.3	23.1	24	25.2	26.5	26.6
Total	94.1	94.8	94.2	94.6	93.9	94.2	94.7	95.2	94.4	95.7	95.0
Contractor agreements	61.7	62.3	63.8	62.5	58.3	57.6	57.6	59.1	59	60.8	60.8

These are the data for Figure 9: Hog slaughter in the United States:

	Hogs, total slaughter (thousand head)
2003	101,042.7
2004	103,573.4
2005	103,690.1
2006	104,842.3
2007	109,277.5
2008	116,558.4
2009	113,732.3
2010	110,367.0
2011	110,956.3
2012	113,246.6
2013	112,160.5
2014	106,957.7

These are the data for Table 3: Hog slaughter by state, 2009-2014:

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
Alabama	34,974	33,409	30,382	14,216	10,917	8,618
Alaska	240	241	(D)	173	219	264
Arizona	377	369	360	393	406	458
Arkansas	82,177	70,868	58,436	62,797	19,404	2,382
California	643,816	607,334	602,678	591,853	577,875	586,816
Colorado	2,599	2,350	2,481	3,429	3,829	3,902
DE-MD	4,454	4,500	4,535	4,421	4,331	4,612
Florida	11,809	10,212	11,563	9,176	9,589	6,617
Georgia	18,642	18,004	18,788	20,318	19,481	17,196
Hawaii	3,757	3,865	3,744	3,472	3,322	3,327
Idaho	30,723	27,673	31,220	35,551	35,122	33,902
Illinois	2,674,385	2,582,000	2,700,986	2,988,384	3,025,416	3,008,036
Indiana	2,256,328	2,265,202	2,280,616	2,288,547	2,299,170	2,301,137
Iowa	8,682,322	8,144,471	8,177,329	8,291,508	8,185,368	8,197,146
Kansas	(D)	(D)	(D)	(D)	(D)	(D)
Kentucky	(D)	(D)	(D)	(D)	(D)	(D)
Louisiana	2,515	2,182	2,193	2,246	2,234	2,436
Michigan	45,705	41,903	50,516	50,615	60,395	72,603
Minnesota	2,592,322	2,691,772	2,781,851	2,879,567	2,786,846	2,670,789
Mississippi	36,058	32,715	36,014	36,925	18,548	7,974
Missouri	2,228,686	2,195,631	2,270,487	2,295,431	2,385,686	2,450,372
Montana	3,227	3,327	3,271	3,668	3,588	3,117
Nebraska	2,067,922	2,063,582	2,104,923	2,155,431	2,076,000	2,014,836
Nevada	(D)	(D)	138	151	151	201
New England 1/	4,546	5,027	5,772	6,420	6,875	7,275
New Jersey	9,676	10,123	10,700	10,644	10,866	9,858
New Mexico	419	412	345	490	541	569
New York	5,002	5,008	5,603	7,246	7,860	8,376
North Carolina	3,218,592	3,069,404	2,997,190	3,097,925	3,226,084	(D)
North Dakota	27,041	30,329	12,609	1,303	1,159	1,104
Ohio	293,736	283,290	279,364	266,464	261,061	257,744
Oklahoma	1,472,745	1,496,690	1,553,171	1,502,169	1,491,095	1,362,893
Oregon	40,490	41,753	44,446	43,325	42,861	43,253
Pennsylvania	774,417	755,972	729,297	753,523	745,736	760,167
South Carolina	(D)	(D)	(D)	(D)	(D)	(D)
South Dakota	1,135,646	1,185,554	1,255,427	1,264,017	1,278,320	(D)
Tennessee	320,370	318,250	311,520	323,119	327,467	321,773
Texas	105,276	104,158	122,341	114,644	103,356	65,780
Utah	10,815	7,204	9,416	9,328	10,485	7,873
Virginia	600,419	629,327	631,029	676,192	676,504	(D)
Washington	5,242	(D)	(D)	(D)	(D)	(D)
West Virginia	1,784	1,590	1,887	2,084	1,875	1,864
Wisconsin	228,925	228,813	250,979	250,420	270,284	274,959
Wyoming	1,063	1,045	1,094	1,101	1,080	1,033

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
United States	30,723,264	30,004,639	30,422,112	31,092,083	30,964,311	30,431,080

(D) Withheld to avoid disclosing data for individual operations.
1/ New England includes Connecticut, Maine, Massachusetts
New Hampshire, Rhode Island, and Vermont.

These are the data for Table 4: Pork production by state, 2009-2014:

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
Alabama	95,566	65,815	53,621	50,277	60,293	45,565
Alaska	604	622	606	414	374	504
Arizona	76,521	80,582	92,934	84,118	83,730	66,385
Arkansas	109,831	86,432	85,946	86,430	101,110	71,066
California	53,886	56,575	49,542	48,031	47,708	39,304
Colorado	265,861	297,691	300,949	278,891	259,063	246,115
Connecticut	831	1,121	689	730	1,276	984
Delaware	4,241	4,466	2,810	2,722	4,124	1,129
Florida	7,879	4,173	4,251	3,633	3,489	4,119
Georgia	98,080	75,405	88,359	98,272	81,609	70,760
Hawaii	3,319	4,032	4,021	4,330	4,062	4,201
Idaho	25,984		(D)	(D)	(D)	(D)
Illinois	1,838,925	1,926,414	1,911,353	1,962,779	2,001,164	1,949,324
Indiana	1,738,802	1,753,822	1,762,434	1,753,128	1,643,591	1,639,654
Iowa	9,608,305	9,244,147	9,816,139	10,345,144	11,170,460	11,548,962
Kansas	914,694	883,829	930,878	912,876	838,461	773,202
Kentucky	174,705	185,534	176,560	168,777	175,863	170,721
Louisiana	2,757	3,212	4,275	1,337	1,520	1,621
Maine	2,135	2,305	3,130	2,842	2,211	2,075
Maryland	15,250	14,409	12,392	11,341	11,590	11,519
Massachusetts	1,813	3,539	3,029	2,561	4,265	3,016
Michigan	606,284	619,869	618,558	548,754	561,091	524,658
Minnesota	3,678,035	3,699,102	3,702,918	3,938,732	3,912,363	3,785,444
Mississippi	179,790	152,173	161,738	155,865	181,330	144,323
Missouri	1,694,338	1,288,014	1,321,770	1,313,879	1,308,522	1,481,513
Montana	78,601	79,932	77,175	81,659	84,479	83,619
Nebraska	1,359,740	1,366,535	1,317,634	1,250,968	1,176,855	1,188,096
Nevada	2,650	1,821	992	1,497	1,803	1,667
New Hampshire	1,235	1,011	783	1,382	1,168	1,420
New Jersey	1,814	1,650	1,644	1,516	1,664	1,414
New Mexico	780	553	400	375	693	744
New York	25,347	23,813	28,259	26,235	24,581	28,016
North Carolina	4,070,849	3,767,088	3,662,862	3,921,079	4,056,602	3,558,499
North Dakota	60,908	59,729	70,182	53,514	51,642	52,281
Ohio	999,093	1,049,889	1,065,596	1,080,269	1,093,003	1,046,439
Oklahoma	1,255,841	1,294,142	1,350,272	1,331,382	1,374,298	1,262,803
Oregon	9,484	8,610	7,493	5,170	3,034	2,420
Pennsylvania	414,382	504,219	479,159	505,852	490,700	516,772
Rhode Island	452	561	575	599	562	704
South Carolina	49,908	53,178	48,966	47,924	47,207	50,136
South Dakota	671,593	741,125	779,501	797,188	697,249	606,351

State	2009	2010	2011	2012	2013	2014
			(1,000 pounds)			
Tennessee	92,354	99,106	93,672	85,466	90,541	94,251
Texas	302,578	154,540	203,312	267,523	285,822	309,408
Utah	324,227	303,829	305,154	285,920	287,097	267,002
Vermont	1,285	1,177	1,230	1,367	1,304	1,316
Virginia	110,902	113,738	73,830	68,800	71,287	64,875
Washington	11,453		(D)	(D)	(D)	(D)
West Virginia	2,263	1,312	1,938	2,325	1,682	1,266
Wisconsin	190,346	173,255	175,156	171,854	167,000	143,196
Wyoming	122,787	136,550	165,446	144,125	105,066	101,832
ID & WA		46,729	45,770	50,939	45,656	40,997
United States	31,359,308	30,437,375	31,065,903	31,960,791	32,620,264	32,011,688

(D) Withheld to avoid disclosing data for individual operations.

These are the data for Table 5: Swine production costs, farrow-to-finish:

Item	2009	2010	2011	2012	2013	2014
			dollars per cwt gain			
Total, gross value of production	47.12	62.06	75.36	73.28	76.69	87.33
Operating costs						
Feed cost	24.26	23.24	34.67	32.66	36.72	34.07
Other operating costs	4.76	5.17	5.73	5.79	5.86	6.04
Total operating costs	29.02	28.41	40.40	38.45	42.58	40.11
Allocated overhead						
Overhead	11.77	11.73	12.05	10.16	10.37	10.83
Labor and Opportunity cost	7.02	7.04	7.02	7.21	7.58	7.72
Total, allocated overhead	18.79	18.77	19.07	17.37	17.95	18.55
Total costs listed	47.81	47.18	59.47	55.82	60.53	58.66
Value of production minus costs	-0.69	14.88	15.89	17.46	16.16	28.67

These are the data for Table 6: US pork production, trade, and consumption, 2005-2014:

	Total production	Imports	Total supply	Exports	% of total supply exported	Total disappearance	U.S. population (1,000 persons)	Per capita disappearance (pounds) Boneless retail weight
		million pounds			%			
2005	20,705	1,024	22,239	2,666	12.0%	19,093	295,993	47.0
2006	21,074	990	22,543	2,995	13.3%	19,055	298,818	46.5
2007	21,962	968	23,424	3,141	13.4%	19,763	301,696	47.8
2008	23,367	832	24,717	4,651	18.8%	19,431	304,543	46.5

	Total production	Imports	Total supply	Exports	% of total supply exported	Total disappearance	U.S. population (1,000 persons)	Per capita disappearance (pounds) Boneless retail weight
		million pounds			%			
2009	23,020	834	24,489	4,094	16.7%	19,869	307,240	47.1
2010	22,456	859	23,840	4,223	17.7%	19,077	309,776	44.9
2011	22,775	803	24,120	5,196	21.5%	18,382	312,034	42.9
2012	23,268	802	24,612	5,380	21.9%	18,607	314,246	43.2
2013	23,200	880	24,705	4,992	20.2%	19,095	316,465	44.0
2014	22,858	1,007	24,483	4,858	19.8%	19,065	318,688	43.6

These are the data for Figure 10: Exports as a percent of total supply:

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Production	20,705	21,074	21,962	23,367	23,020	22,456	22,775	23,268	23,200	22,858
Exports	2,666	2,995	3,141	4,651	4,094	4,223	5,196	5,380	4,992	4,858
% of total supply exported	12.0%	13.3%	13.4%	18.8%	16.7%	17.7%	21.5%	21.9%	20.2%	19.8%
Total supply	22,239	22,543	23,424	24,717	24,489	23,840	24,120	24,612	24,705	24,483

These are the data for Figure 11: US pork consumption per capita, 2005-2014:

	Per capita disappearance (pounds) Boneless retail weight
2005	47.0
2006	46.5
2007	47.8
2008	46.5
2009	47.1
2010	44.9
2011	42.9
2012	43.2
2013	44.0
2014	43.6

These are the data for Table 7: US per capita meat consumption projections, by type, 2013-2024:

Per capita meat consumption, retail weight

Item	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
						pounds						
Beef	56.3	54.6	52.2	49.4	48.5	49.1	49.8	50.6	51.5	52.1	52.4	52.4

Per capita meat consumption, retail weight

Item	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
						pounds						
Veal	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Pork	46.8	45.3	46.6	48.5	48.8	49.1	49.3	49.4	49.4	49.4	49.4	49.5
Lamb & mutton	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total red meat	104.4	101.1	99.9	99.0	98.4	99.3	100.1	101.0	101.9	102.4	102.8	102.9
Broilers	81.9	83.4	85.4	86.7	88.1	89.2	90.2	91.1	91.7	92.2	92.7	93.1
Other chicken	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Turkeys	16.0	15.7	15.8	16.2	16.5	16.7	16.8	17.0	17.1	17.2	17.3	17.3
Total poultry	99.2	100.3	102.5	104.2	106.0	107.3	108.4	109.5	110.2	110.8	111.3	111.9
Red meat & poultry	203.6	201.4	202.3	203.2	204.4	206.5	208.5	210.5	212.1	213.2	214.1	214.8

Pork share of total	23%	23%	23%	24%	24%	24%	24%	23%	23%	23%	23%	23%
Pork share of red meat	45%	45%	47%	49%	50%	49%	49%	49%	48%	48%	48%	48%

These are the data for Figure 12: US meat retail prices for beef, pork, & poultry, 1980-2104:

	Beef retail value	Pork retail value	Broiler retail composite
1980	$2.336	$1.475	$0.970
1981	$2.347	$1.612	$1.040
1982	$2.384	$1.856	$1.032
1983	$2.341	$1.797	$1.053
1984	$2.355	$1.714	$1.193
1985	$2.286	$1.708	$1.151
1986	$2.268	$1.888	$1.279
1987	$2.384	$1.994	$1.236
1988	$2.503	$1.940	$1.341
1989	$2.657	$1.935	$1.466
1990	$2.810	$2.249	$1.455
1991	$2.883	$2.242	$1.434
1992	$2.846	$2.095	$1.418
1993	$2.934	$2.091	$1.440
1994	$2.829	$2.095	$1.450
1995	$2.843	$2.061	$1.441
1996	$2.802	$2.337	$1.505
1997	$2.795	$2.450	$1.506
1998	$2.771	$2.427	$1.537
1999	$2.878	$2.414	$1.544
2000	$3.064	$2.582	$1.553
2001	$3.377	$2.694	$1.577
2002	$3.315	$2.658	$1.618
2003	$3.746	$2.658	$1.613
2004	$4.065	$2.792	$1.728

	Beef retail value	Pork retail value	Broiler retail composite
2005	$4.091	$2.827	$1.741
2006	$3.970	$2.807	$1.571
2007	$4.158	$2.871	$1.651
2008	$4.326	$2.937	$1.746
2009	$4.258	$2.920	$1.780
2010	$4.384	$3.113	$1.753
2011	$4.807	$3.434	$1.767
2012	$4.986	$3.467	$1.893
2013	$5.289	$3.644	$1.965
2014	$5.970	$4.019	$1.963

These are the data for Table 8: Top US pork export markets, 2005-2014:

Top 8 US swine meat export markets, tons, 2005 -2014											
Importers	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	% of total
Mexico	170,155	179,167	142,130	228,631	274,601	283,898	286,111	410,113	429,071	480,486	32.5%
Japan	338,642	325,831	346,434	419,107	392,152	391,228	464,614	421,669	402,323	368,749	24.9%
S. Korea	60,230	91,208	82,764	94,939	83,993	69,502	148,626	132,513	87,235	119,334	8.1%
China	32,669	27,652	62,860	108,164	20,838	46,834	219,216	199,376	153,596	108,109	7.3%
Canada	80,049	90,223	108,173	125,167	112,849	112,632	122,611	130,821	112,042	104,839	7.1%
Australia	18,033	20,170	23,774	30,685	38,492	44,483	55,992	59,668	48,647	44,981	3.0%
Colombia	3,224	3,419	3,475	2,831	3,745	7,371	9,676	16,247	29,795	41,449	2.8%
Hong Kong	5,863	13,111	37,260	155,081	91,472	59,738	36,779	38,609	45,885	40,279	2.7%
Other	110,708	156,582	159,257	302,996	236,531	225,093	204,758	237,989	181,796	169,988	11.5%
World	819,573	907,363	966,127	1,467,601	1,254,673	1,240,779	1,548,383	1,647,005	1,490,390	1,478,214	100.0%

These are the data for Table 9: USDA baseline pork projections:

USDA baseline pork trade projections												
Exporters	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	Exports, thousand metric tons, carcass weight											
United States	2,264	2,298	2,381	2,438	2,495	2,540	2,574	2,608	2,642	2,676	2,710	2,744
European Union	2,236	2,150	2,200	2,213	2,257	2,293	2,354	2,400	2,450	2,498	2,547	2,595
Canada	1,245	1,180	1,180	1,195	1,217	1,235	1,245	1,253	1,262	1,271	1,280	1,290
Brazil	585	585	700	770	795	799	810	820	825	830	835	840
China	244	275	300	308	309	313	316	319	322	327	330	333
Mexico	111	120	125	128	132	136	140	145	150	155	160	165
Major exporters	6,685	6,608	6,886	7,052	7,205	7,316	7,438	7,546	7,651	7,757	7,863	7,967
US share	34%	35%	35%	35%	35%	35%	35%	35%	35%	35%	34%	34%

These are the data for Figure 13: Policies earning premium, all species:

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	108	250	-	41	-	-
2004	246	105	-	525	-	-
2005	260	120	-	950	-	-
2006	196	115	127	1,036	-	-
2007	131	64	66	479	-	-
2008	125	39	32	715	339	-
2009	62	19	21	410	141	40
2010	93	44	9	803	122	134
2011	53	38	8	1,460	133	1,224
2012	27	23	2	1,228	284	897
2013	32	10	3	815	249	687
2014	41	10	11	1,908	69	498
2015	25	18	3	1,293	-	812

These are the data for Figure 14: Policies earning premium, swine only:

	LGM - SWINE	LRP - SWINE
2003	108	250
2004	246	105
2005	260	120
2006	196	115
2007	131	64
2008	125	39
2009	62	19
2010	93	44
2011	53	38
2012	27	23
2013	32	10
2014	41	10
2015	25	18

These are the data for Figure 15: Insured liability, all species:

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	7,712,020	13,241,615	-	2,161,803	-	-
2004	53,689,863	15,175,457	-	209,702,664	-	-
2005	51,303,923	13,130,637	-	90,978,303	-	-
2006	33,038,188	11,967,502	4,482,446	140,041,723	-	-
2007	27,071,367	7,783,355	15,105,949	59,550,393	-	-
2008	53,230,491	6,430,383	6,710,064	78,985,076	99,141,737	-
2009	15,100,783	3,497,876	4,850,582	49,563,481	30,132,001	4,715,858
2010	23,727,690	7,224,235	886,440	91,820,944	37,210,228	24,914,997
2011	21,710,391	10,242,482	1,862,313	187,204,972	76,122,106	769,644,504
2012	17,471,053	5,575,340	93,210	195,224,424	227,439,484	703,999,855
2013	24,993,452	2,298,450	208,554	152,950,408	94,538,570	664,077,985
2014	32,944,391	1,745,589	2,823,041	421,821,821	35,498,554	547,981,656
2015	17,947,075	2,635,105	600,555	316,847,983	-	880,022,170

These are the data for Figure 16: Insured liability, swine only:

	LGM - SWINE	LRP - SWINE
2003	7,712,020	13,241,615
2004	53,689,863	15,175,457
2005	51,303,923	13,130,637
2006	33,038,188	11,967,502
2007	27,071,367	7,783,355
2008	53,230,491	6,430,383
2009	15,100,783	3,497,876
2010	23,727,690	7,224,235
2011	21,710,391	10,242,482
2012	17,471,053	5,575,340
2013	24,993,452	2,298,450
2014	32,944,391	1,745,589
2015	17,947,075	2,635,105

These are the data for Figure 17: Premium paid, all species:

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	548,385	688,349	-	32,297	-	-
2004	3,056,051	573,339	-	5,770,857	-	-
2005	2,845,589	471,971	-	1,749,839	-	-
2006	2,057,279	403,970	547,268	1,919,284	-	-
2007	1,605,630	213,885	326,592	1,058,937	-	-
2008	2,534,208	291,896	144,343	2,209,994	2,439,003	-
2009	847,788	138,393	198,803	1,739,002	946,171	287,201
2010	1,093,067	379,104	20,254	2,805,459	1,150,102	781,589
2011	929,394	514,307	75,798	5,952,704	1,643,281	25,012,757
2012	657,733	286,540	2,835	4,820,833	4,920,700	19,143,689
2013	856,726	73,493	4,873	3,522,376	2,374,279	16,873,156
2014	1,132,366	68,930	51,506	8,409,042	1,549,971	11,632,184
2015	699,563	132,819	12,645	8,049,175	-	22,004,122

These are the data for Figure 18: Premium paid, swine only:

	LGM - SWINE	LRP - SWINE
2003	548,385	688,349
2004	3,056,051	573,339
2005	2,845,589	471,971
2006	2,057,279	403,970
2007	1,605,630	213,885
2008	2,534,208	291,896
2009	847,788	138,393
2010	1,093,067	379,104
2011	929,394	514,307
2012	657,733	286,540
2013	856,726	73,493
2014	1,132,366	68,930
2015	699,563	132,819

These are the data for Figure 19: Insured head, all species:

	LGM - SWINE	LRP - SWINE	LGM - Cattle	LRP - Cattle	LRP - Lamb
2003	133,423	183,076	-	3,643	-
2004	712,267	143,904	-	270,189	-
2005	544,217	106,095	-	127,919	-
2006	402,774	110,927	25,655	176,354	-
2007	354,647	68,257	13,219	79,852	-
2008	430,764	50,173	5,517	102,645	694,184
2009	126,539	29,672	4,561	65,650	207,096
2010	200,190	63,264	787	115,555	246,136
2011	139,010	66,873	1,480	209,745	294,525
2012	105,720	33,690	65	184,472	809,806
2013	152,055	19,471	135	138,605	499,341
2014	183,170	9,476	1,732	327,281	140,546
2015	105,960	15,595	303	193,557	-

These are the data for Figure 20: Insured head, swine only:

	LGM - SWINE	LRP - SWINE
2003	133,423	183,076
2004	712,267	143,904
2005	544,217	106,095
2006	402,774	110,927
2007	354,647	68,257
2008	430,764	50,173
2009	126,539	29,672
2010	200,190	63,264
2011	139,010	66,873
2012	105,720	33,690
2013	152,055	19,471
2014	183,170	9,476
2015	105,960	15,595

These are the data for Figure 21: Loss ratios, all species:

Year	LGM - Swine	LRP - Swine	LGM - Cattle	LRP - Cattle	LRP - Lamb	LGM - Dairy
2003	57%	3%		0%		
2004	209%	4%		15%		
2005	60%	27%		0%		
2006	67%	31%	25%	65%		
2007	96%	52%	19%	58%		
2008	103%	153%	130%	162%	121%	
2009	274%	365%	37%	160%	215%	250%
2010	38%	17%	0%	48%	0%	36%
2011	48%	17%	10%	17%	162%	0%
2012	172%	47%	225%	115%	612%	7%
2013	48%	18%	88%	125%	640%	16%
2014	46%	53%	0%	0%	401%	5%
2015	123%	122%	0%	51%		

These are the data for Figure 22: Loss ratios, swine only:

Year	LGM - Swine	LRP - Swine
2003	57%	3%
2004	209%	4%
2005	60%	27%
2006	67%	31%
2007	96%	52%
2008	103%	153%
2009	274%	365%
2010	38%	17%
2011	48%	17%
2012	172%	47%
2013	48%	18%
2014	46%	53%
2015	123%	122%