

Agriculture's Vulnerabilities and Economic Impacts from Disasters

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Agriculture's Vulnerabilities... Topics



- **Describe Modern Animal Agriculture**
 - ◆ *Production Centers, Regional*
- **Characteristics Increasing Vulnerability**
 - ◆ *Large Scale, Mobile, Just-in-Time, Concentrated*
- **Lessons Learned and Costs of Outbreaks**
 - ◆ *Societal Impacts >> Agric Impacts; Multiplier Effects*
- **Models and Predictions for Future Outbreaks**
 - ◆ *Trade and Markets*



Animal Ag's Role in US Agriculture

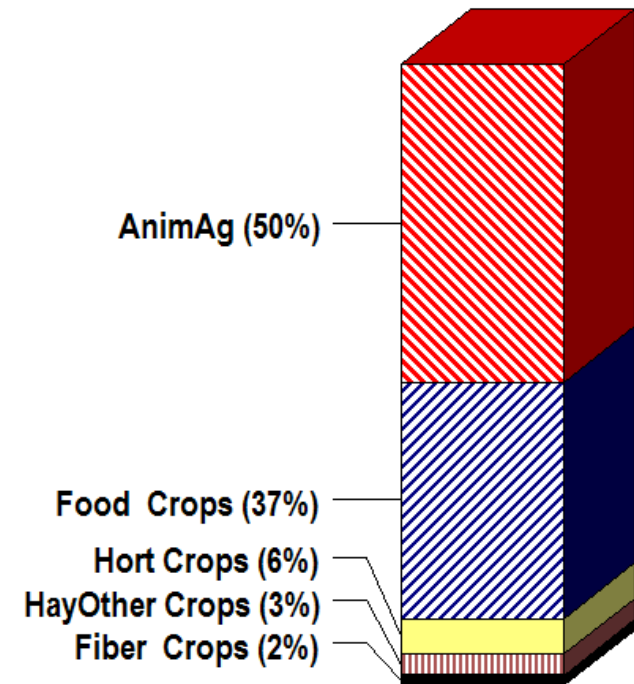
2007 Census of Agriculture

United States

Top 10 Ag Products by Market Value

Item	Farms (Thous)	Sales (\$ Billion)	Rank by Sales	Pct of Tot Sales	Cumul. % Tot Sales
TOTAL U.S. AG SALES	2,205	\$297.2	na	100.0%	na
Grains, oilseeds, dry beans/peas	479	\$77.2	1	26.0%	26%
Cattle & calves	798	\$61.2	2	20.6%	47%
Poultry & eggs	149	\$37.1	3	12.5%	59%
Milk & other dairy products from cows	70	\$31.8	4	10.7%	70%
Fruits, tree nuts, berries	113	\$18.6	5	6.3%	76%
Hogs & pigs	75	\$18.1	6	6.1%	82%
Nursery, greenhouse, floriculture, sod	51	\$16.6	7	5.6%	88%
Vegetables, mellons, potatoes, and sweet potatoes	69	\$14.7	8	4.9%	93%
Other crops and hay	435	\$10.0	9	3.3%	96%
Cotton & cottonseed	19	\$4.9	10	1.6%	98%

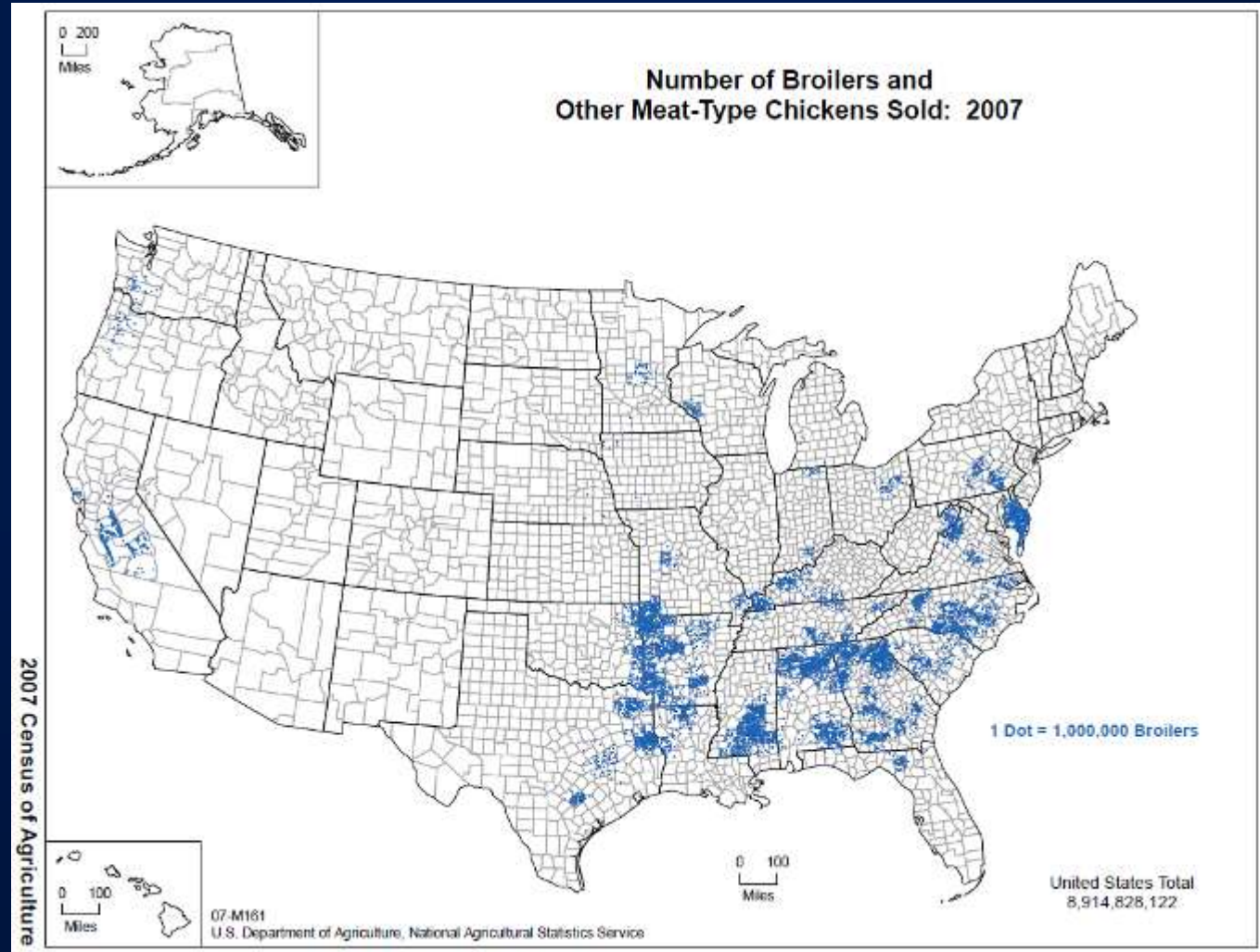
U.S. Ag Sales, Top Ten 2007 Census of Agriculture



www.agcensus.usda.gov/Publications/2007/Online_Highlights/Rankings_of_Market_Value/United_States/

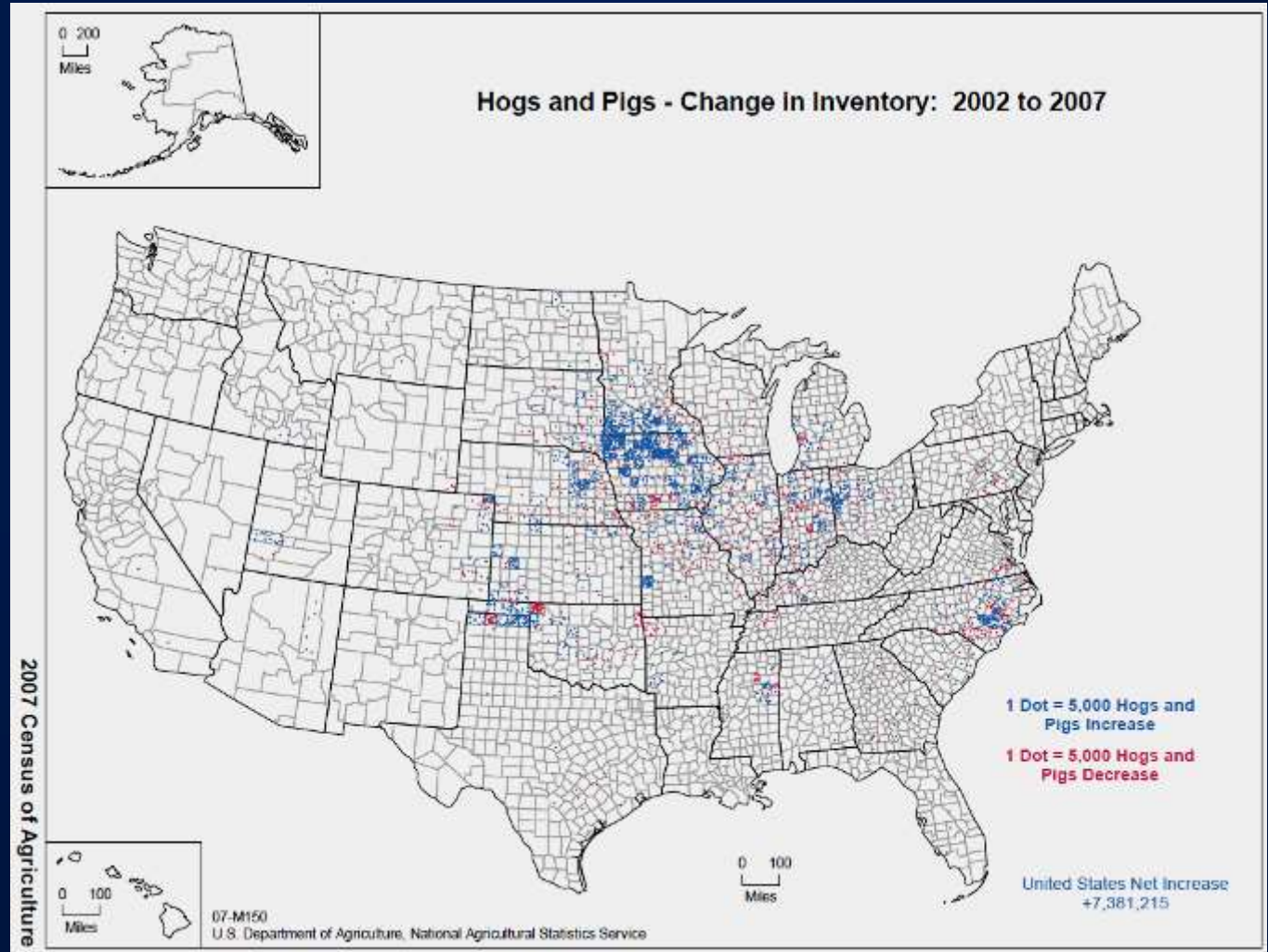
Where Broiler/Meat type Chickens are Raised

- **Regional Production**
 - ◆ *Mid-Atlantic to Gulf Coast*
- **Products and Birds travel throughout region**



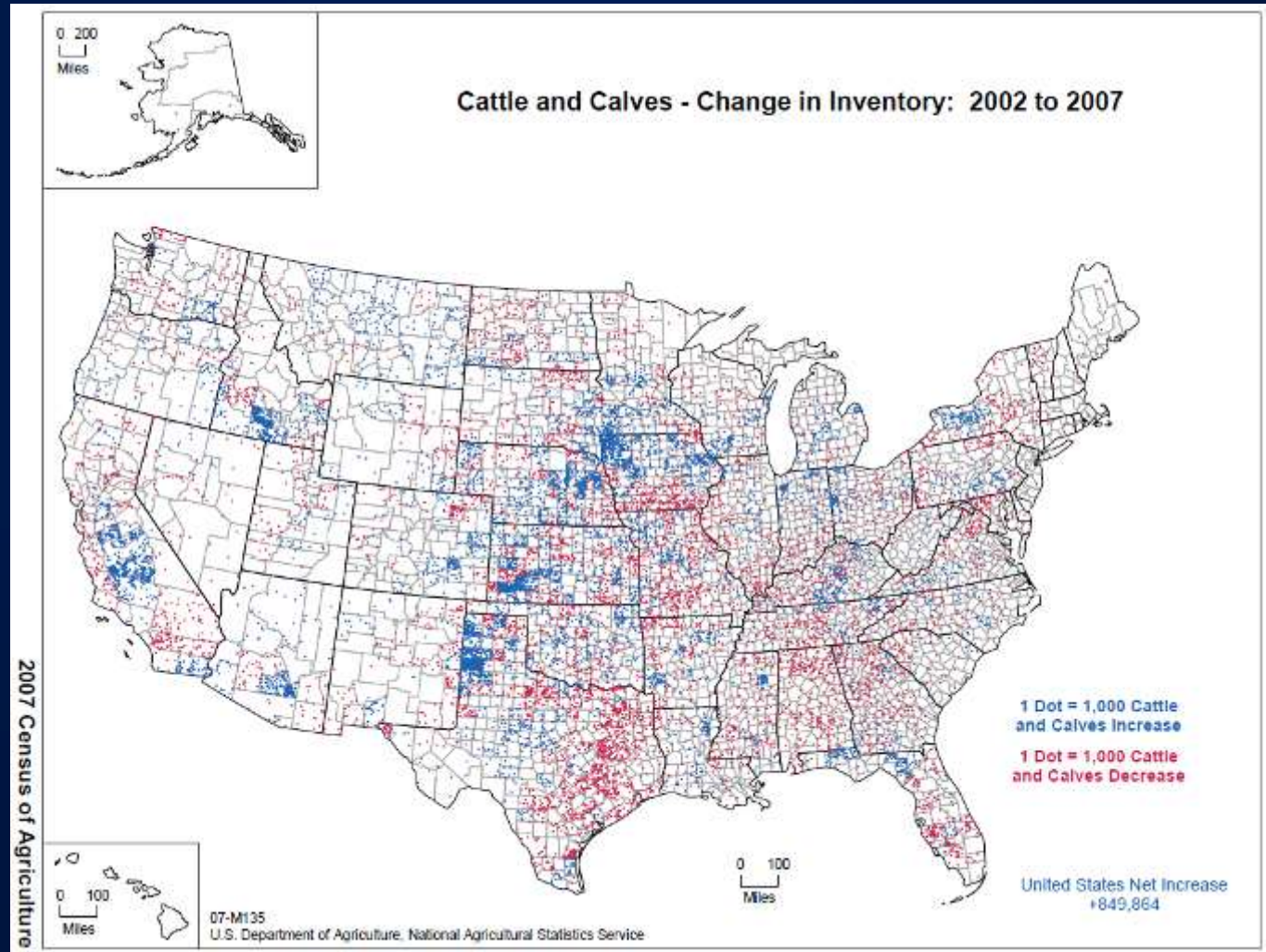
Where Pigs are Raised w/ Changes

- **Three areas, one (IA/IN/MN) is a region**
 - ♦ *Note that 1/3 of NC pigs are finished in one of the other areas*
 - ♦ *Note the companies work in all areas*



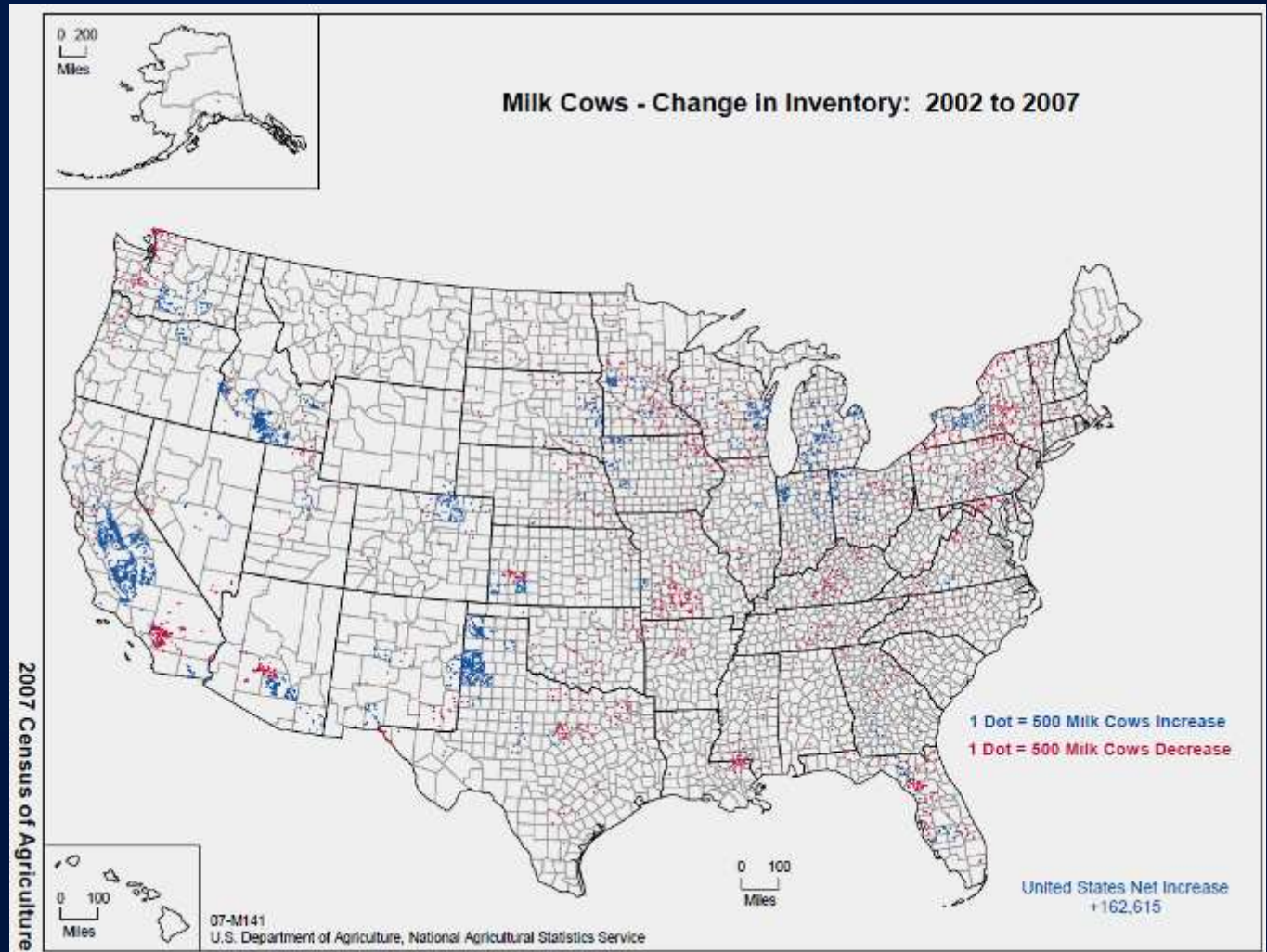
Cattle (Mostly Beef), w/ Changes

- **Growing in High Plains and upper midwest, plus sporadic in far west**



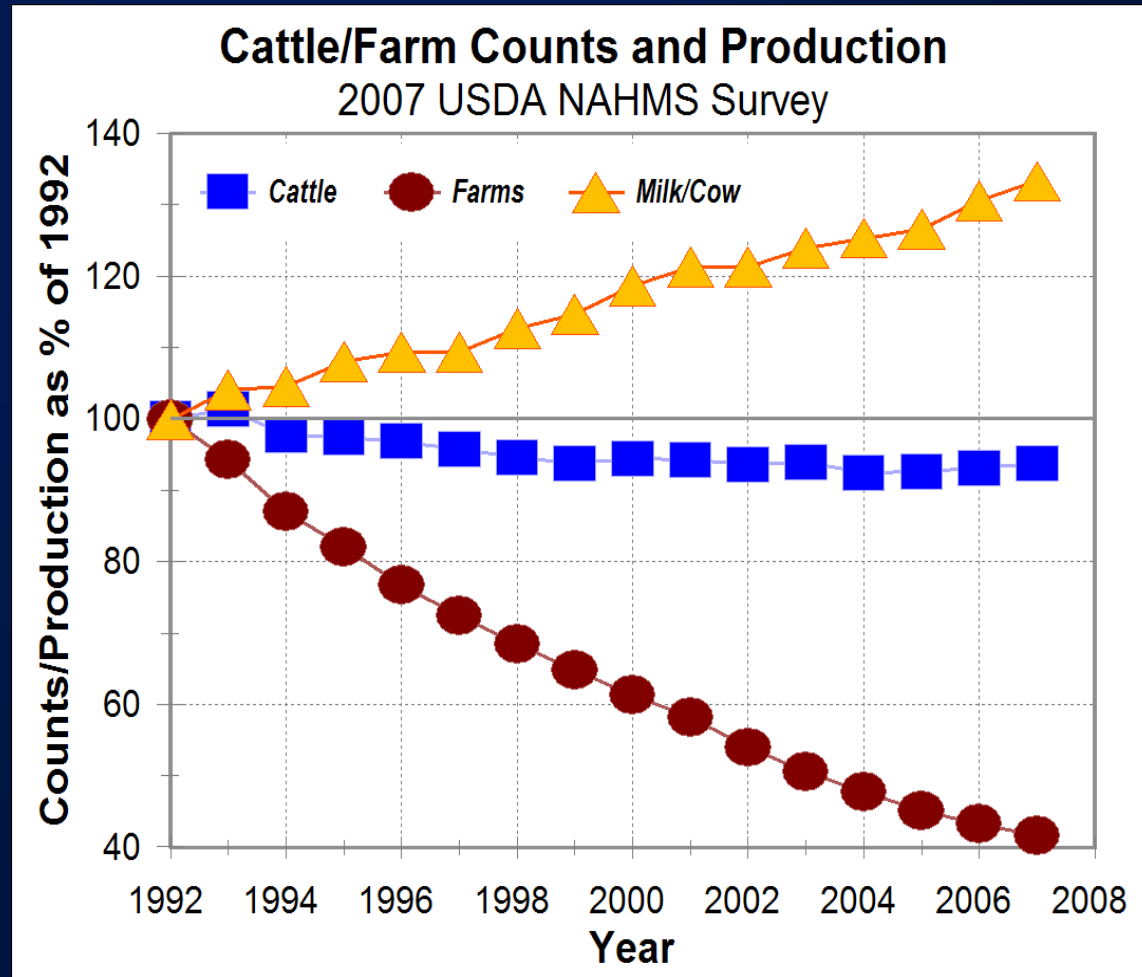
Where Dairy Cows are, w/ Changes

- Dairy losing in historic areas of NE and upper midwest
- Gaining in sporadic parts of West



Industry Changes: Dairy Numbers

- **Production per cow up by over 2% per yr (~50% since 1985)**
 - ◆ Genetic gain
 - ◆ Nutrition
 - ◆ Management
- **Cow numbers drop by <1%/yr**
 - ◆ Leveling out
- **Farm numbers drop by <4%/yr**
- **Total milk prod'n up nearly 25%**



Dairy Herd Size Changes

- **Larger Herds growing in number, but were only ~4% of all herds in 2006**

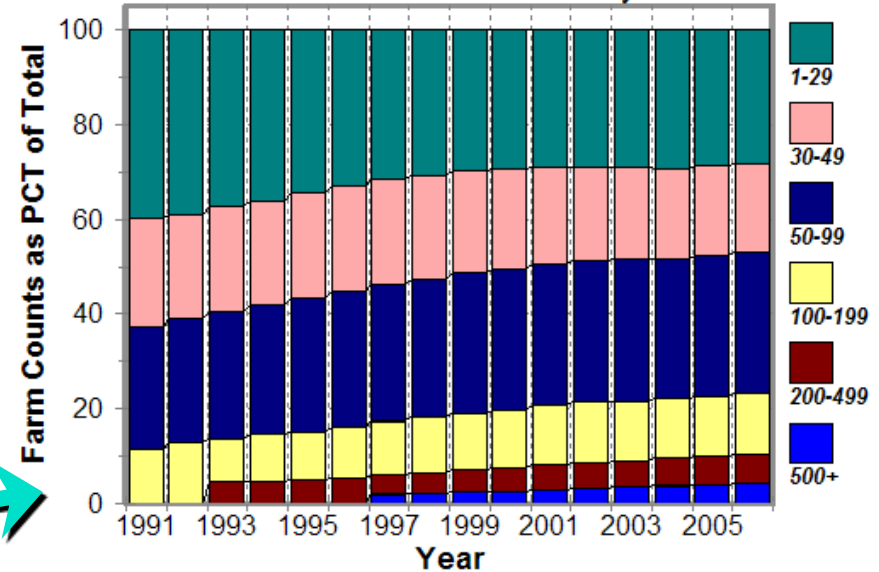
- ◆ *Nearly 80% of farms had less than 100 cows*

- **But Big Herds held ~47% of the dairy cows in 2006**

- ◆ *Big herds get 15% more milk per cow, therefore they produce ~54% of the US' milk*

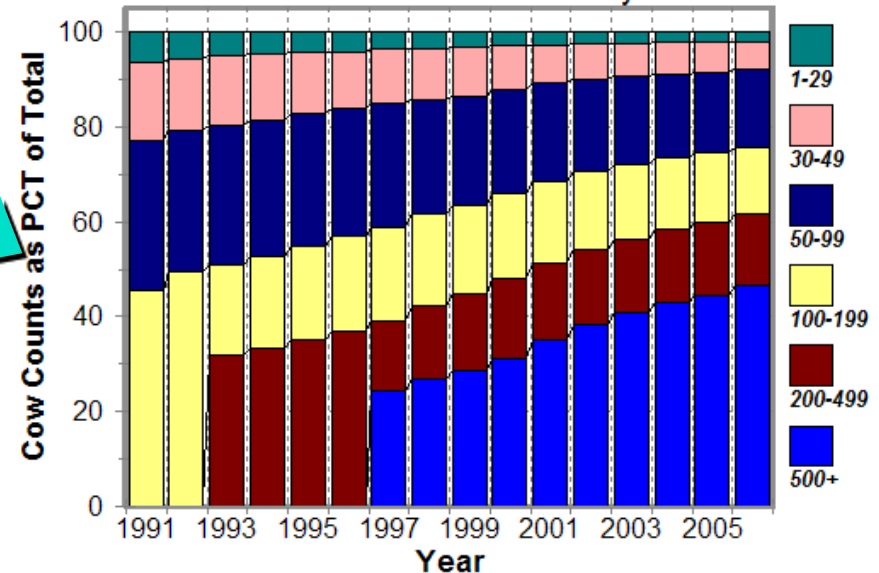
Farm Numbers, by Size Category

2007 USDA NAHMS Survey



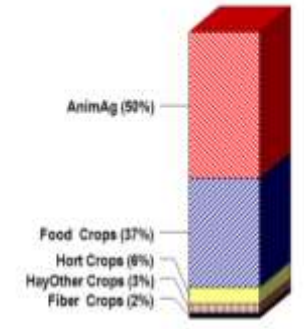
Cow Numbers, by Size Category

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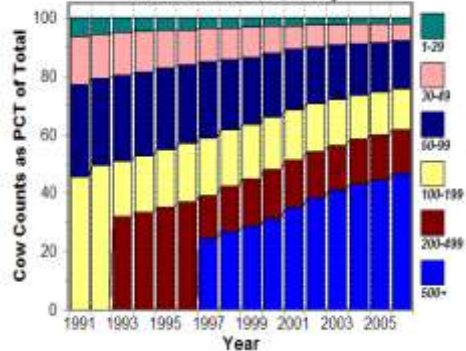


Summary of Modern Animal Ag

U.S. Ag Sales, Top Ten
2007 Census of Agriculture

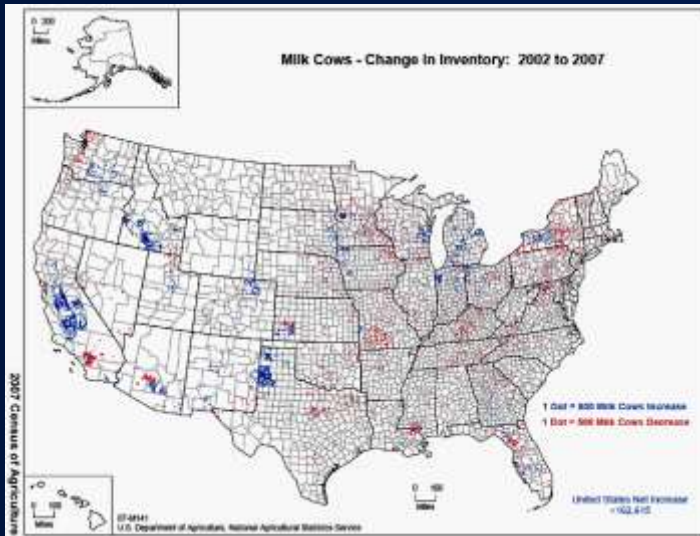


Cow Numbers, by Size Category
2007 USDA NAHMS Survey



- **IMPORTANCE:** Major part of all ag econ activity
- **LARGE SCALE:** Bigger and more dense farms
- **PRODUCTION CENTERS:** Geographically concentrated
- **TRANSPORTATION DEPENDENT:** Production, processing, distribution

These trends will continue



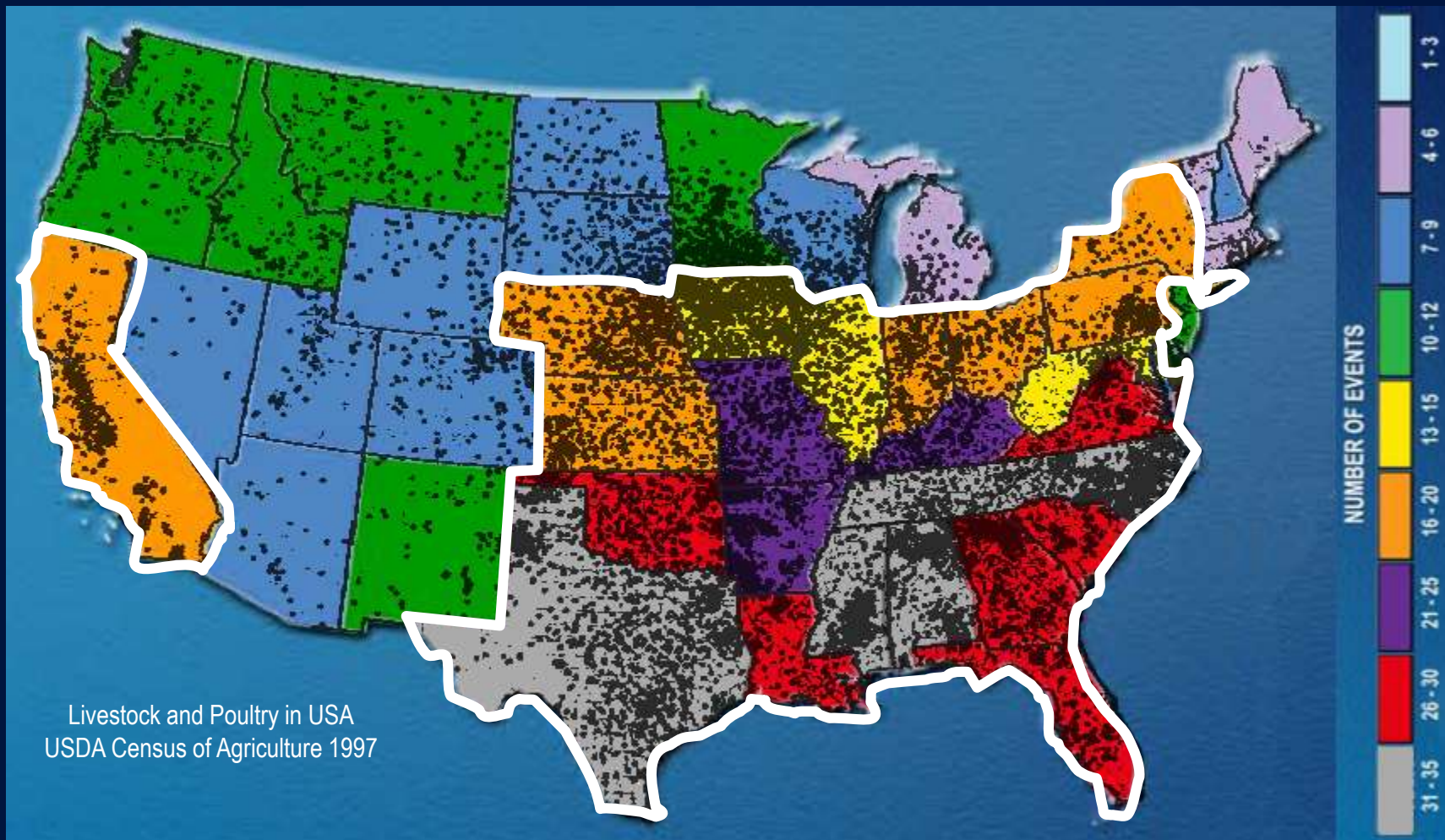
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Billion Dollar Weather Disasters 1980 - 2009



Agroterror or Accidental FADs – Is Ag at more risk now?

- **Agriculture trends making it a 'better' target**
 - ◆ *More human, animal, product movement (intra/interstate)*
 - Depends on 'just-in-time' animal, product, and resource mobility
 - ◆ *Larger, more densely populated farms*
 - ◆ *Increasing concentration -*
 - Genetic
 - Ownership
 - Geographic



Industry Concentration

2001: 3 exporters had 81% of corn market

2001: 4 grocery chains fill 31% of food sales

2002: 4 meat packers met 81% of market

2003: 3 processors filled 65% of soy market

2004: 40 pig farms have 90% of market

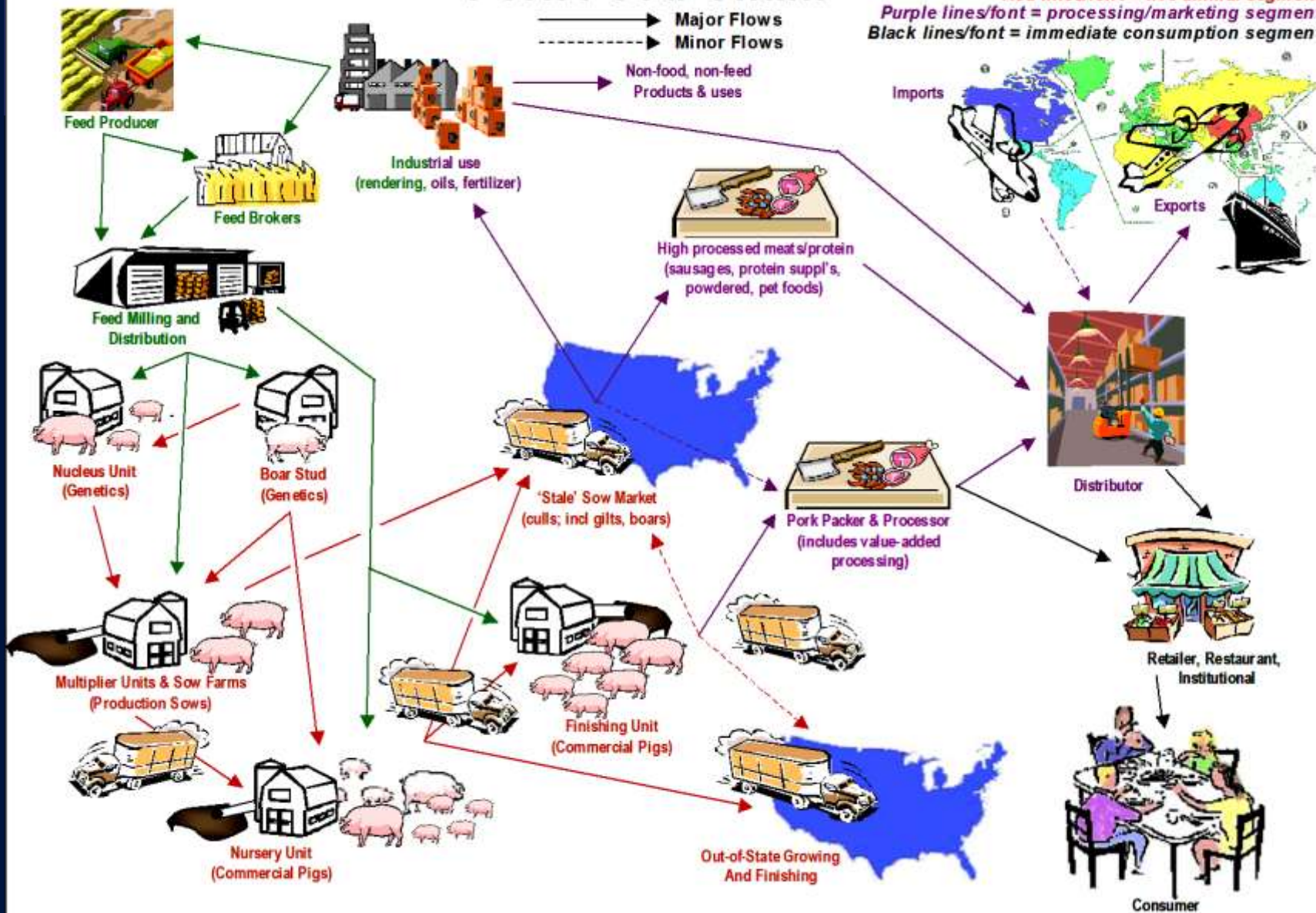
2006: 4% of dairies ship over 50% of US milk

2010: 30 feedlots will cover 50% of market



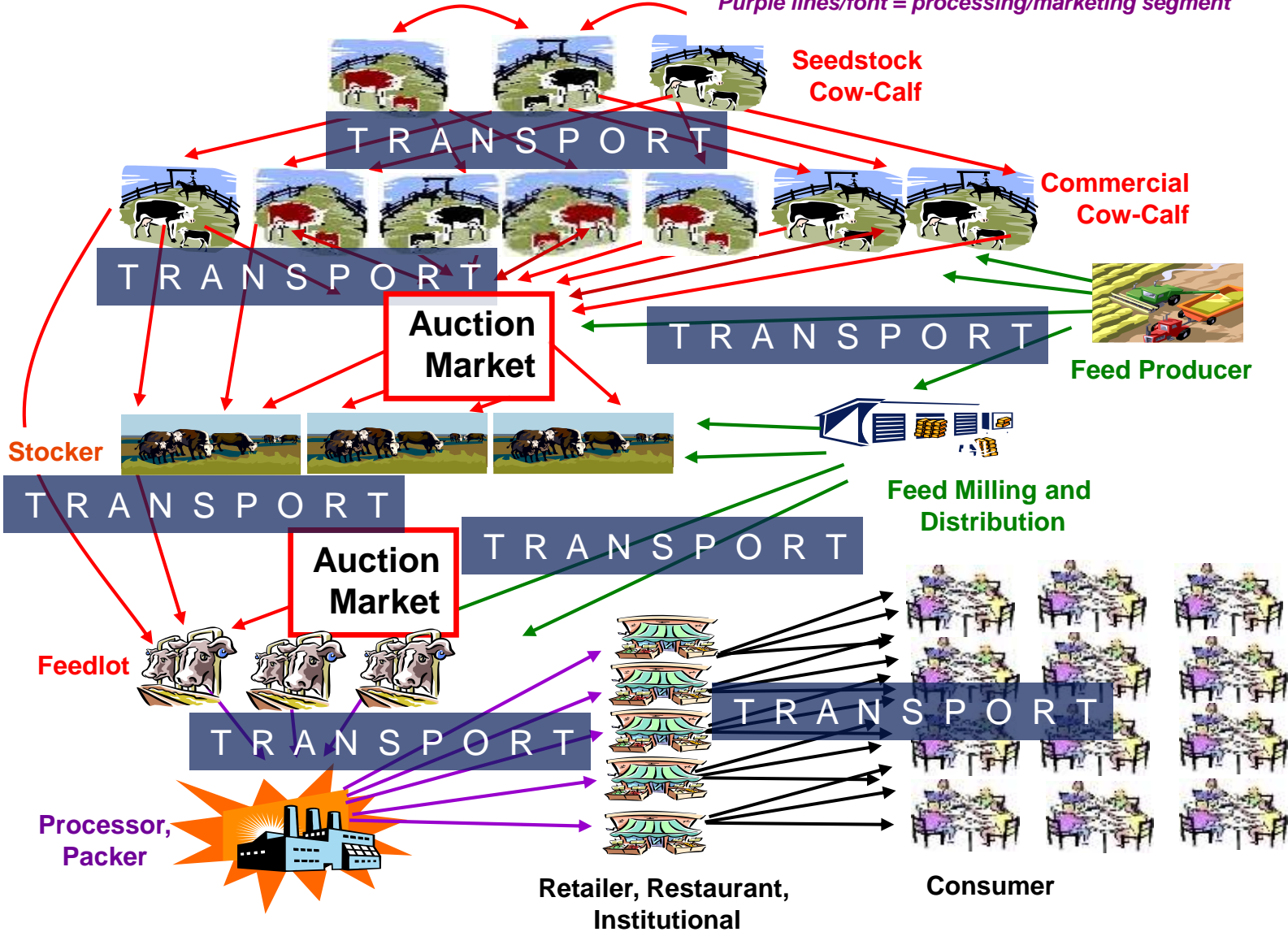
Pork Food-Chain

Green lines/font = feed segment
 Red lines/font = live animal segment
 Purple lines/font = processing/marketing segment
 Black lines/font = immediate consumption segment



Beef Food-Chain

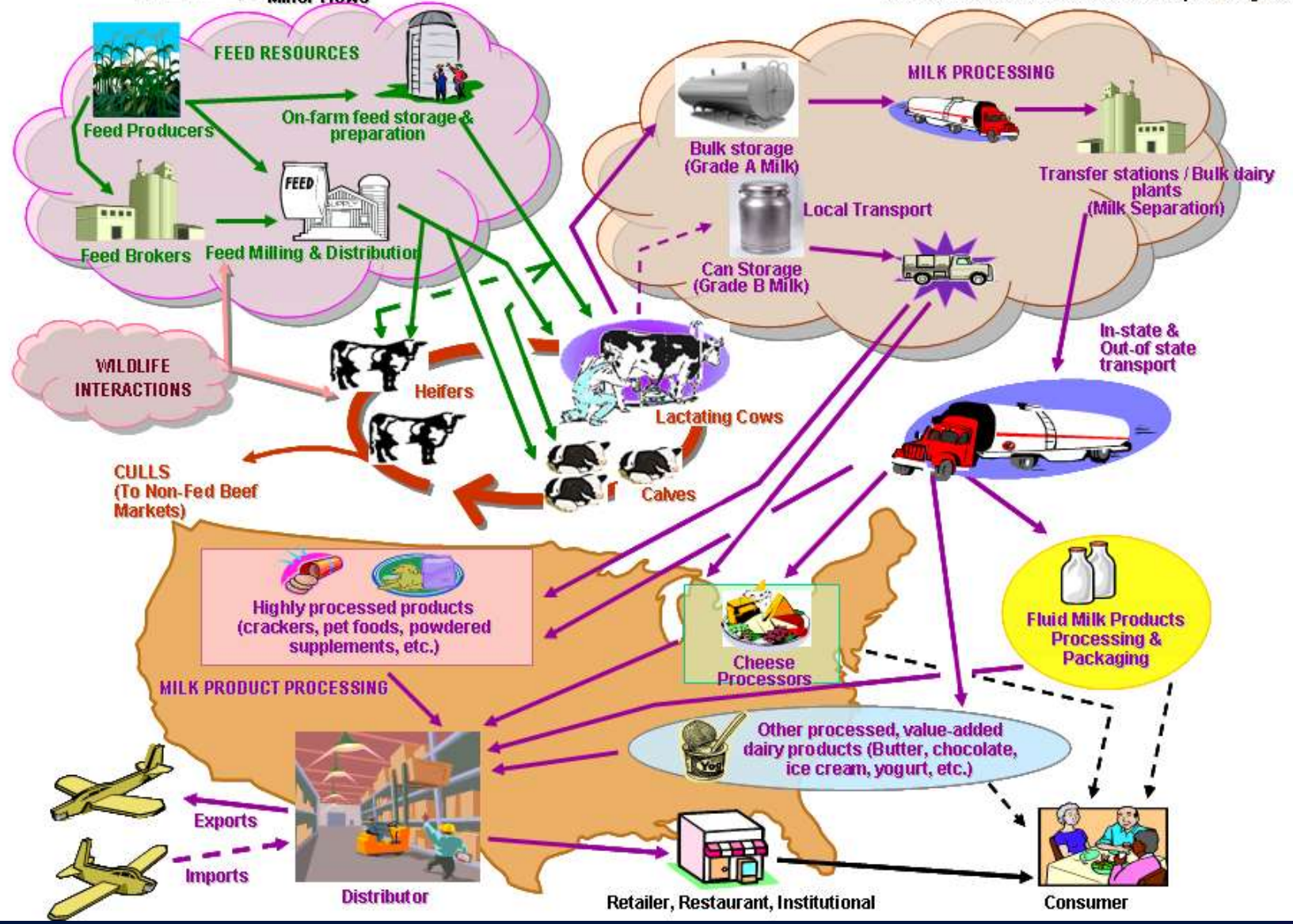
Green lines/font = feed segment
 Red lines/font = live animal segment
 Purple lines/font = processing/marketing segment



Dairy Food-Chain

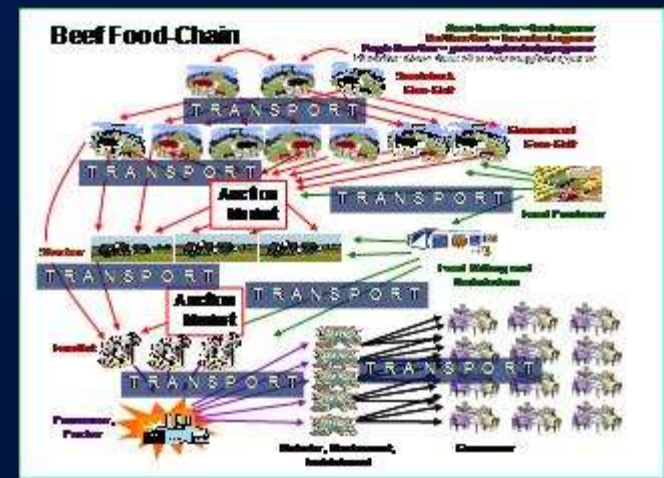
————— Major Flows
 - - - - - Minor Flows

Green lines/font = feed segment
 Red lines/font = live animal segment
 Purple lines/font = processing/marketing segment
 Black lines/font = immediate consumption segment



Summary of Ag's Vulnerabilities

- **GEOGRAPHY: Concentrated in hi weather risk areas**
- **OWNERSHIP: Few entities control majority**
- **EFFICIENCY: Brittle to changes**
- **TRANSPORTATION: (i.e., Energy) Cross supply chain dependencies**
- **MARKETS: Structure (e.g., Sale Barns, lack of ID) hinders monitoring/control**



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Lessons Learned...

UK 2001

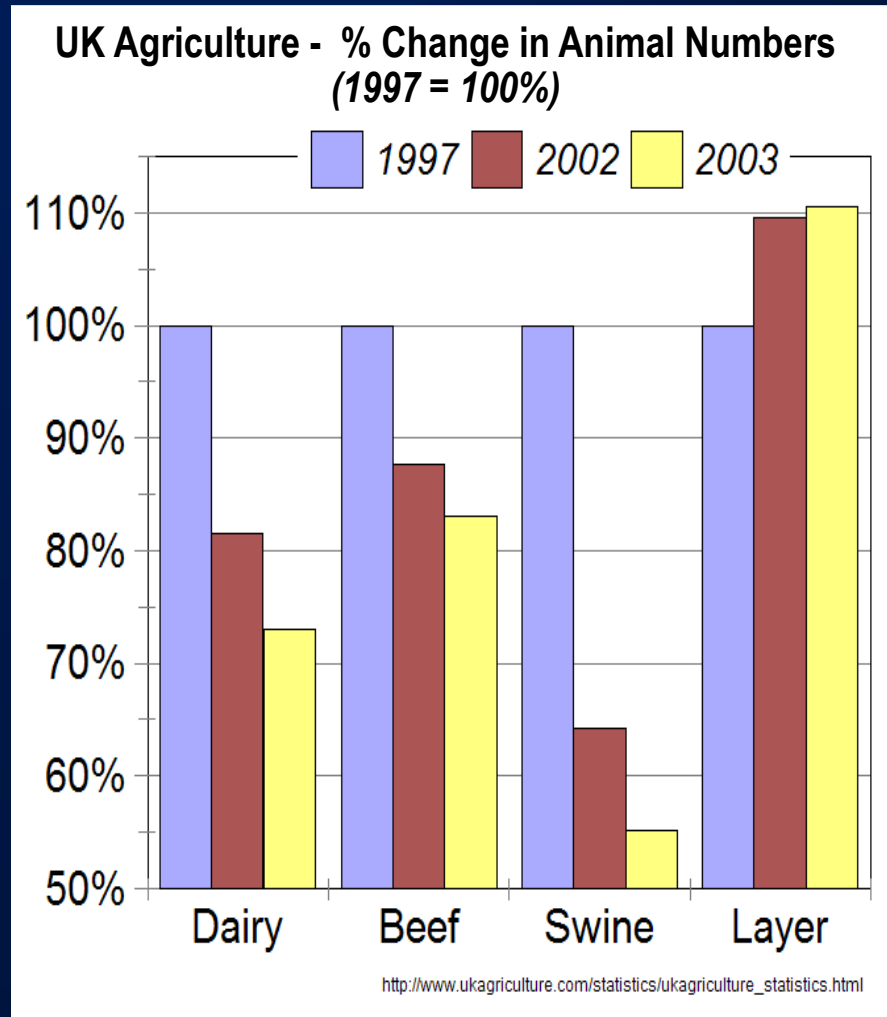
- **7 mo's; 70% of all cases in 1st 8 wk**
 - ◆ *Costs ~ £ 6 B (~1/2 to tourism)*
 - ◆ *Societal costs ~4.5X Ag costs*
- **Stamping Out w/o Vacc'n policy**
 - ◆ *Hindered by-*
 - *Prior cuts in surveillance ability*
 - *Too few trained responders*
 - *Slow initial response*
 - *Public revulsion at the waste*



Lessons Learned...

FMD's Longterm Impact on UK

- **2001 FMD outbreak has taken a toll on UK animal ag**
- **In six years (97-03) -**
 - ◆ **BEEF** (↓ 17%),
 - ◆ **DAIRY** (↓ 27%),
 - ◆ **SWINE** (↓ 45%),
 - ◆ **POULTRY** bucked the trend (↑ 11%).



Lessons Learned... Netherlands 2001

Imported via Ireland calves staged thru France with UK sheep in Feb.

FMD + 21 Mar 2001; Last case 22 Apr

Control - Stamping Out/Stop Move; started w/ Emergency vacc; Area vacc later

Total affected farms = 26 infected

(180K animals, >1900 farms = vacc to kill)



BBC News 22 Mar 2001

	<u>Euro (M)</u>	<u>US\$ (M)</u>	<u>Pct</u>
Infected farm costs	320	291	36%
Post-Prod anim-ag chain	215	195	24%
Tourism/recreation	275	250	31%
Other	90	82	10%
Total Societal Costs	900	817	100%

Total Non-Ag costs vs Ag costs = 1.5 : 1.0

Ratio of VaccToKill to IPs = 1900:26 = 73 : 1.0

Backer JA, et al. Vaccination against Foot-and-Mouth Disease... CVI report 09/CVI0115. Wageningen UR, Wageningen. Aug 2009

College of Veterinary

Medicine

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POPULATION HEALTH AND PATHOBIOLOGY
ANIMAL BIOSECURITY RISK MANAGEMENT GROUP



Lessons Learned...

Taiwan + FMD 3 yrs out (2000-2002)

• Indemnity for Pigs destroyed	\$188 M	49.5%
• Cost of Vaccine	\$14 M	3.6%
• Carcass Disposal	\$25 M	6.5%
• Miscellaneous	\$28 M	7.4%
• Loss of Market Value	\$125 M	33.0%
• Total Direct Costs	\$ 380 M	
• Total Indirect Costs (jobs, tourism, etc)	\$3,650 M	

Total Non-Ag costs vs Ag costs = 9.6:1:0

- *Taiwan's GDP down ~2%, now a net IMPORTER of pork*

***FADs are SOCIETAL disasters striking thru agriculture.
So, solutions must be societal, not just agricultural.***

USDA/ERS 2000; U Minn Center for Inf Dis Res & Policy 2002;
Austral Nat'l Farmer Fed 2002

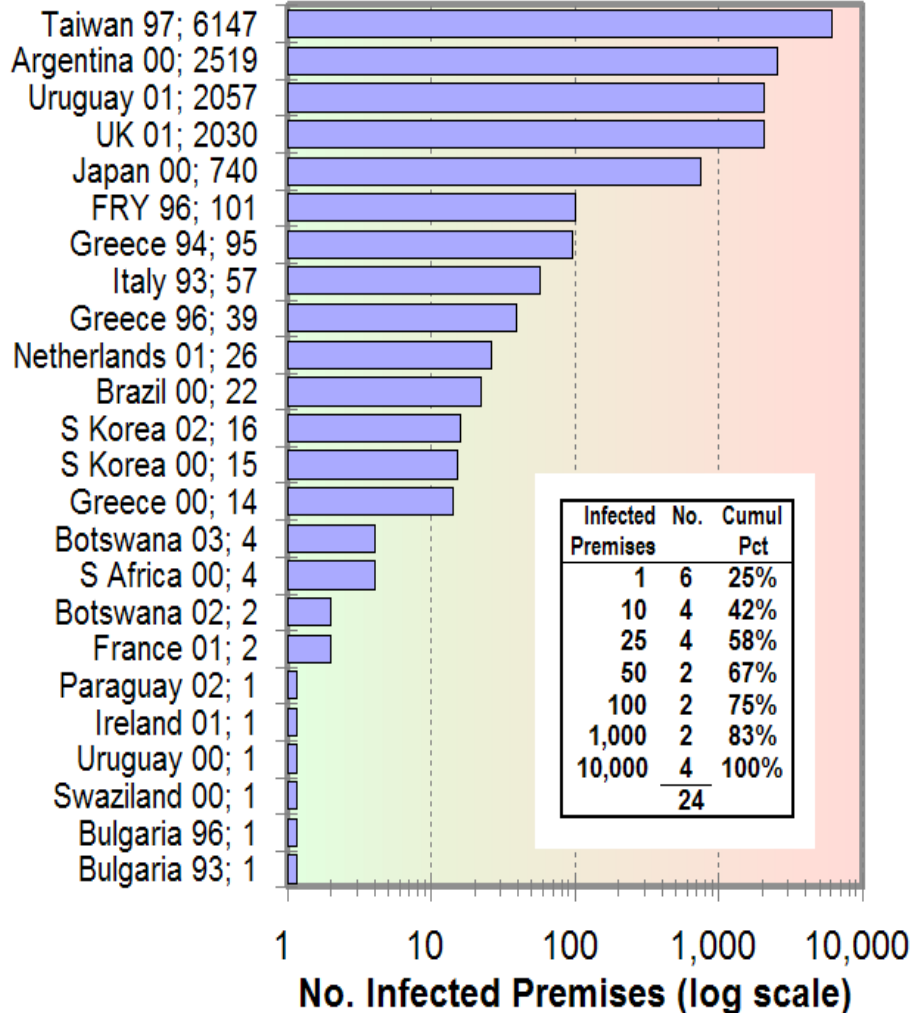


FMD Outbreak Size 1993-2003

- **Median outbreak = 15-16 inf premises**
 - ◆ *Range was big:*
 - 10/24 (42%) had fewer than 5 inf premises
 - 4/24 (17%) had over 2,000 inf premises
 - ◆ *Gap: only 1 outbreak between 101 and 2030*
- **No relation between time to detection and outbreak size**

FMD Outbreak Size - Infected Premises

Country Yr; Count

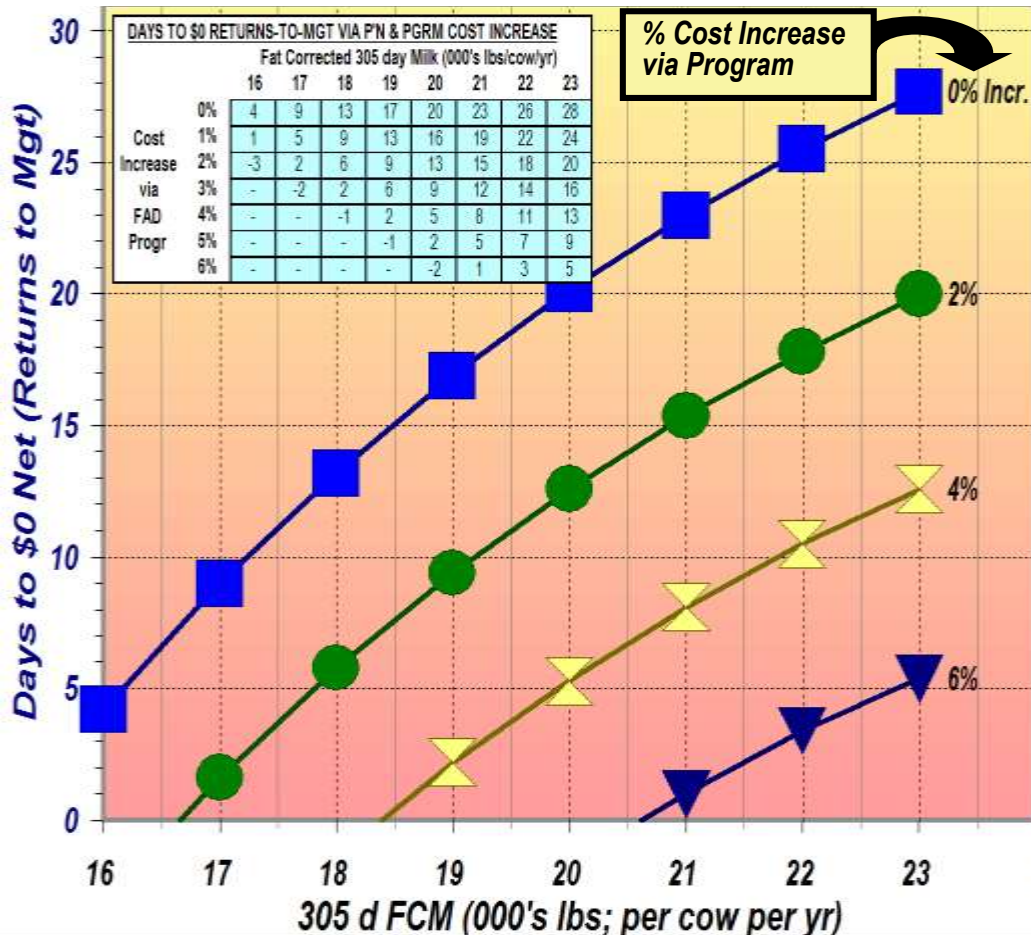


Adapted from: McLaws M, Ribble C. Can Vet J 2007;48:1051-1062.



Dairy Industry Issues with Current Plans for FMD

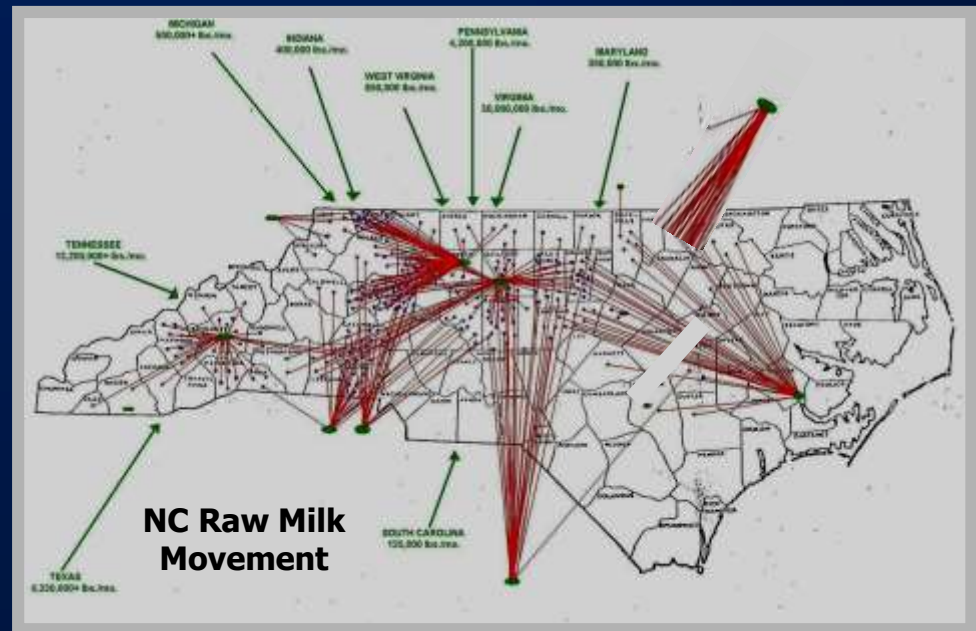
Days to \$0 Annual Returns-to-Management by Milk Production & Cost Increases



- **“Healthy farms” hurt by Stop Move Rules**
- **Typical NC Dairy (<18K 305 FCM) can survive <13 days, IF no added costs**
 - ♦ *If FAD program changes costs/income by 3%-4%, dairy has NO resilience*
- **Higher producers last longer; same trend**
 - ♦ *Program selects against an industry segment*
- **Losses of uninfected farms are not indemnified**

North Carolina's Dairy Industry and FMD – Even if NOT INFECTED

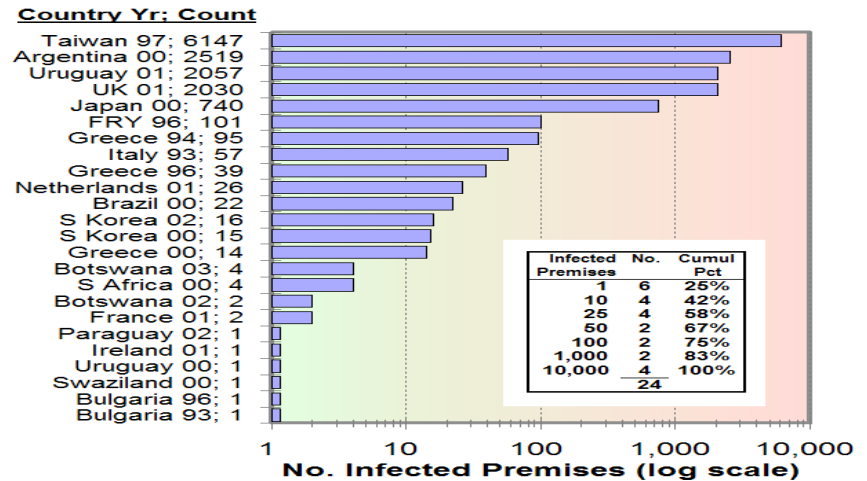
- **Half NC's milk processors are out of state**
 - ◆ *Stop movement hits us hard*
- **NC's in-state milk processors have 36-48 hr of capacity.**
 - ◆ *After that we dump milk*



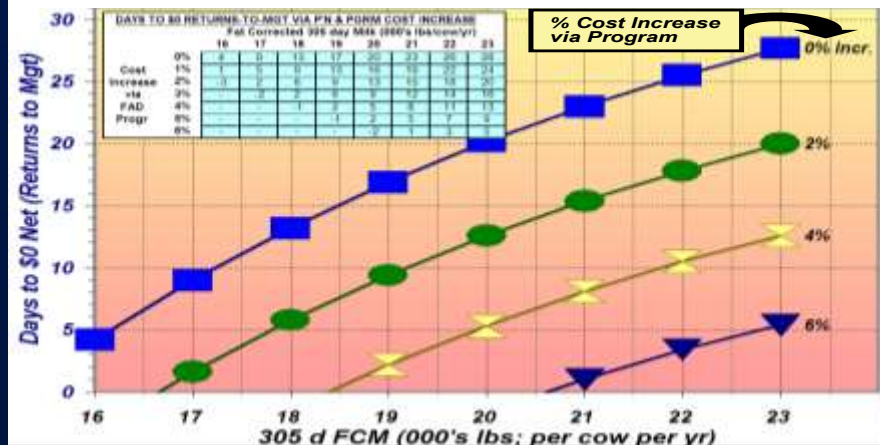
Summary of Lessons Learned

- **SCALE: When big, it is very, very big**
- **COSTS: Social costs ~1.5-10x Ag costs**
- **DAMAGE: Program can be worse than FMD**
 - ◆ Dependence on slaughter and vacc to kill
 - ◆ Stop moves/market shut-downs

FMD Outbreak Size - Infected Premises



Days to \$0 Annual Returns-to-Management by Milk Production & Cost Increases



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Studies Addressing FMD Costs and/or Impacts Since 2005

- **Studies**

1. 2006 Purdue market modeling FMD in USA
2. 2007 California State Fair FMD scenario
3. 2007 SW Kansas cattle FMD outbreak
4. 2008 USDA economic/epidemiologic simulation of FMD in USA
5. 2008 DHS economic/epidemiologic simulation of FMD lab accident in USA



2006 Market Effects of US FMD Outbreak *[C. Hurt, Purdue Univ]*

- **Used simple Input/Output model based on recognized S&D and Elasticities**
- **Assumptions**
 - ◆ *Widespread FMD outbreak in USA*
 - ◆ *No pork/beef exports for one year*
 - ◆ *No imports of either from FMD+ regions*
 - ◆ *Canada/Mexico do NOT break with FMD*
 - ◆ *Consumption changes =*
 - *Pork/Beef decrease 5% for one year*
 - *Poultry increases 3% for one year*
 - ◆ *Number of US animals destroyed in eradication program "relatively small"*



2006 Market Effects of US FMD Outbreak *[C. Hurt, Purdue Univ]*

- IMPACTS (Substitute products advantaged, Complementary products disadvantaged)**

CHANGE IN...	BEEF	PORK	POULTRY
SALES VOLUME	-14%	-11%	+4%
FARM REVENUE	-\$4 B	-\$2 B	+\$1 B
CORN USE	-3%	-3%	+1%
MEAL USE	-2%	-2%	+2%

Adapted from C Hurt. "Importance of US Animal Agriculture".
NIAA 2006, Louisville KY. Apr 2006. www.animalagriculture.org



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2007 FMD Outbreak at California State Fair

[Carpenter, et al. UC Davis]

- **5 day livestock exhibition period for the 2005 Calif State Fair**
 - ◆ Dairy cattle, dairy goats, pygmy goats
 - ◆ 921 K visitors; 195 exhibitors
 - ◆ 62% of responding exhibitors brought animals back to commercial livestock premises
- **Assumed exposure to FMDV on day 0, with 1-10 index cases on da 1**

No. Index Cases	Mean No. of animals (90% Conf Int; 1000 sims)			
	Latent <i>not infectious</i>	Subclin <i>infectious</i>	Clinical <i>infectious</i>	Susceptible <i>not infectious</i>
1	12 (1-20)	1 (0-4)	0 (0-1)	181 (167-194)
5	47 (5-80)	6 (0-10)	1 (0-5)	141 (105-190)
10	76 (10-117)	11 (0-19)	2 (0-10)	106 (57-185)

80% of simulations had 0 clinical cases by day 5



2007 FMD Outbreak at California State Fair

[Carpenter, et al. UC Davis]

- **Statewide Outcomes (Means)**

- ◆ *Outbreak days*
111-155
- ◆ *Count infected premises*
33-244
- ◆ *Probability at least 1 FMD+ leaves CA*
28%-99%

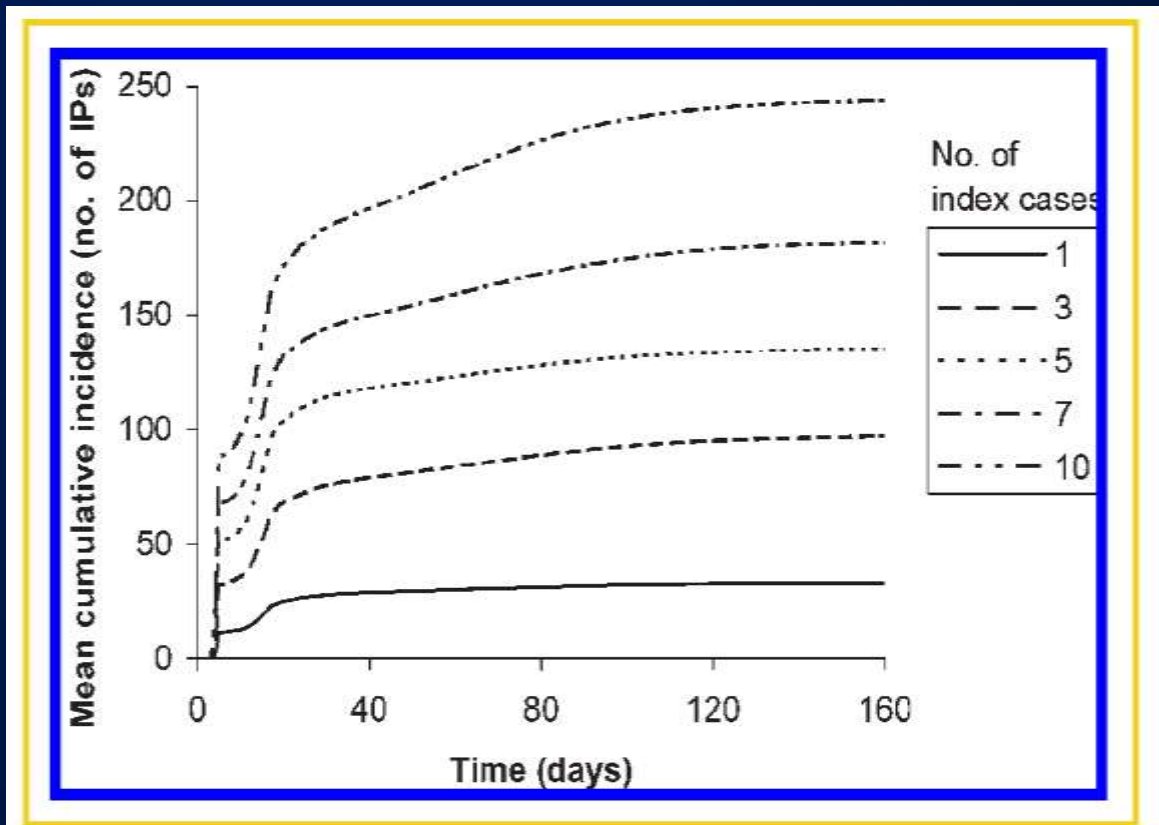


Figure 2—Mean cumulative number of infected premises (IPs) as a function of number of index cases during a simulated FMD outbreak beginning at the 2005 California State Fair.

Adapted from Carpenter TE, et al. JAVMA V231 No8. Oct 15 2007

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2007 FMD Outbreak in SW Kansas Beef Cattle *[Pendell, et al. CSU]*

- **Used Epi and Econ model**
- **Three Scenarios: Initial FMDV incursion at...**
 - ◆ *[1] Single cow-calf operation, [2] Single 10K-20K head feedlot, [3] Five >40K head feedlots at once*
 - Cases escaping KS ignored; no costs beyond KS considered
 - No disease response costs included

	Mean No. Head Destroyed (thousands)				Mean Durat (da)	Avg KS Industry Loss (millions)			Tot Impact* (millions)
	Feedlot	Swine	Other	Total		Beef	Swine	Poultry	
Single Cow Calf	93	26	2	119	29	\$43.2	(\$3.7)	(\$11.3)	\$51
One Medium Feedlot	292	92	6	384	39	\$166.5	(\$7.5)	(\$25.2)	\$284
Five Large Feedlots	1,200	387	26	1,587	89	\$728.5	(\$26.3)	(\$89.7)	\$1,343

* Includes other industries, government, and households

Pendell DI, et al. The economic impacts of a foot-and-mouth disease outbreak: A regional analysis. *J Ag and Applied Economics*. 39 (Oct 2007):19-33



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2008 FMD Response Strategies

[Paarlberg, et al. USDA]

- **Integrated Epi [USDA N Am Anim Disease-Spread] + Econs model**
 - ◆ *FMD outbreak starts in 4 small midwest hog farms feeding contaminated garbage*
 - ◆ *Fifty iterations per scenario*
 - ◆ *Baseline quantities, prices & elasticities from quarterly 2001-04 values*
- **Total losses to livestock were \$2.8B to \$4.1B**
 - ◆ *Large trade-related losses despite low animal destruction*
 - ◆ *Swine recover faster than cattle due to shorter production cycle*
 - ◆ *Export losses raise domestic supply & decrease price, benefiting consumers*
 - ◆ *Return to normal after 7 quarters*



2008 FMD Response Strategies

[Paarlberg, et al. USDA]



Three stamping out strategies reduced outbreak duration to less than one quarter:

- 1. Destroy only direct contact herds: Avg= 56 days**
- 2. Destroy direct-and-indirect-contact herds: Avg= 55 days**
 - ◆ *requires excellent tracing info*
- 3. Destroy all herds within 1 km of outbreak: Avg= 37 days.**
 - ◆ *larger rings did not effect duration*

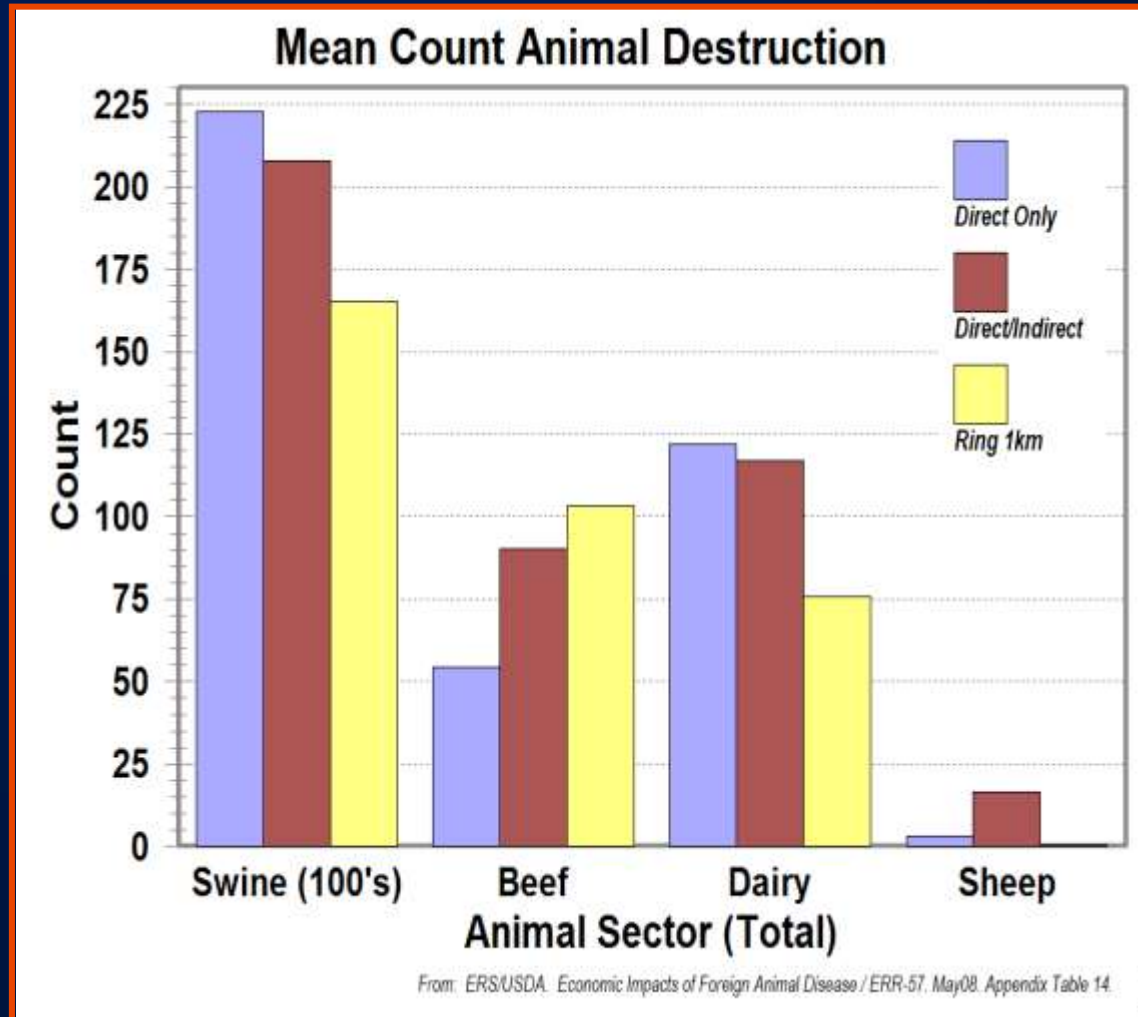
But various sectors did better under different scenarios...



2008 FMD Response Strategies & Sector Differences

[Paarlberg, et al. USDA]

- **Beef Sector had fewest losses in DIRECT ONLY control strategy**
- **Others had fewest losses in RING 1KM control strategy**
 - ◆ *Will depend on animal density, markets, locality, geography, etc.*



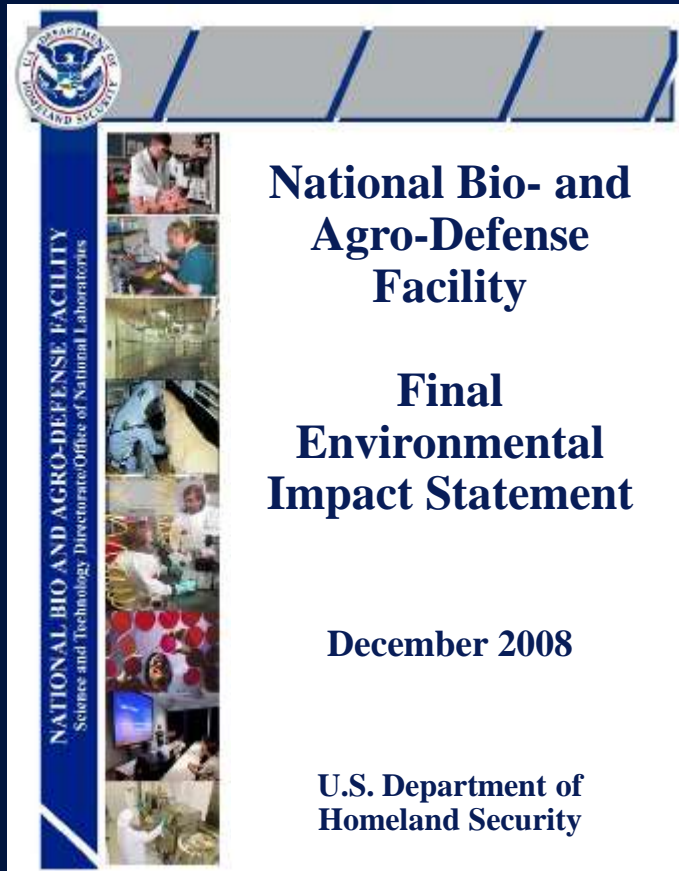
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2008 FMD and Lab Accident [DHS]



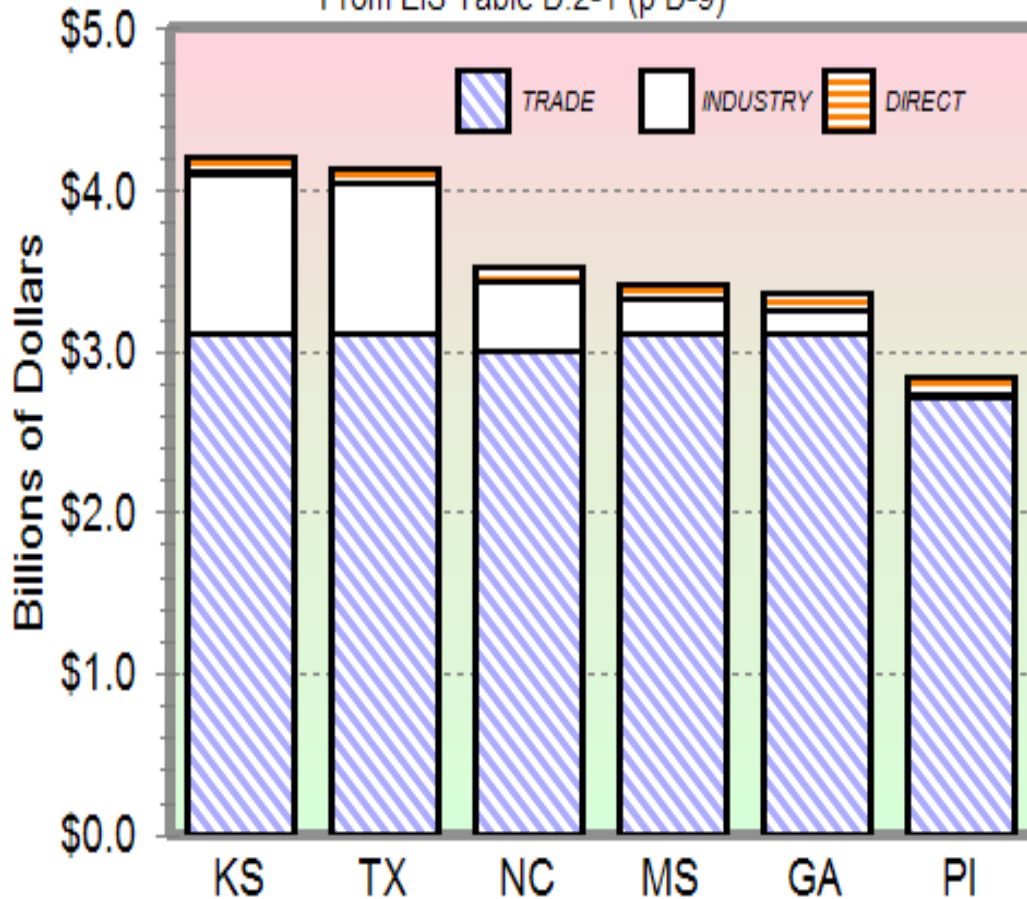
- **National Bio and AgroDefense Facility Draft Environmental Impact Statement; Part D2. FMD Risk Analysis**
 - ◆ *Worst plausible case single aerosol release of FMDV at each of six potential sites*
 - ◆ *Assumed all NBAF safety systems and procedures fail*
 - ◆ *Assumed control measures without resource constraints*
 - **Stop Movement, Stamping Out infected herds, but no pre-emptive slaughter and no vaccination**

2008 FMD and Lab Accident

[DHS]

POTENTIAL COSTS OF FMDV RELEASE

From EIS Table D.2-1 (p D-9)



- **Outbreaks ran ~1.5 - 2.0 months**
- **Trade bans ran ~6 months**
- **Total costs varied**
 - ♦ *\$2.8B @ NY to \$4.2B @ KS.*
- **National trade impact is major:**
 - ♦ *\$2.7B @ NY to \$3.1B for GA, KS, MS, and TX each.*
- **Industry costs varied widely**
 - ♦ *\$31M @ NY to >\$1B @ KS.*



Summary of Economic Impacts

- **FMD outbreak costs in USA estimates from \$3-\$6B, depending on model**
- **Societal vs agricultural impacts range from 1.5:1.0 to nearly 10:1.0**
- **Trade impacts are national and huge**
- **Different means of incursion for the event (markets, laboratories, fairs) lead to similar outcomes**
- **Commodity groups may prefer different response strategies**



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