An Analysis of Pork Production in Virginia: Production vs. Protection

Philip Agee, Benjamin Cabbell Barrow, Rollo Knight, Louis Nottingham, Dustin Zedaker.

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Literature Review

Americans have grown to crave the taste of pork products and other commercially-processed meats. At the same time American society has reached a certain level of affluence and started to develop an appetite for environmental quality – demanding cleaner air and water. Recently the American public's demands for pork and environmental quality have met in a showdown that establishes Smithfield Foods in one corner and environmentalists in the other. There are several externalities – both positive and negative – associated with pork production that have been well documented in research literature. Some examples include, Smithfield Foods produces more of a social cost than provides a social benefit, pork production positively influences local, state, and the federal economies, hog farming in Virginia is moving from traditional family farms to large-scale contract operations, etc. (Tietz, 2006; Smithfield Foods, 2007; Durrenburger & Thu, 2004). In the present paper, the role that Smithfield Foods' hog production and processing has on Virginia environmental quality and economy is investigated. It is hypothesized that the public's growing desire for environmental quality and distaste for large-scale, point-srouce polluters will cause Smithfield Foods to close its Virginia operation and explore opportunities overseas where environmental regulatory policies are less developed. The following five literature reviews attempt to demonstrate and support this hypothesis.

This debate between production and protection was initiated by a recent *Rolling Stone* magazine article. According to an article by Tietz (2006), a primary question was addressed for guiding the investigation in to Smithfield Foods. What are the environmental problems associated with Smithfield Foods' pork production and

processing? The focus of the investigation was on the scale of production and environmental degradation that was caused by hog production and processing. It was found that Smithfield Foods is the largest, most profitable pork processor in the world. Further investigation found that 27 million pigs were killed and processed last year with an estimated total sale of $11.4 billion. In this article it is hypothesized that Smithfield Foods is totally devoted to turning a profit and as a result disregards all environmental regulations. It was estimated that Smithfield's total annual waste discharge reached 26 million tons a year. According to Tietz (2006), in Virginia during 1997 Smithfield was fined $12.6 million for 6,900 violations of the Clean Water Act – this was the third-largest civil penalty ever levied under the act by the EPA, yet it amounted to only .035 percent of Smithfield's annual sales. All of Tietz findings support the hypothesis that Smithfield Foods is a large, commercial polluter (Tietz, 2006). One major limitation to this study is that it is not a peer-reviewed, scientific paper. Instead it is an article from a popular magazine that is meant to bring attention to the environmental downfalls of Smithfield Foods.

The next review represents Smithfield Foods rebuttal to *Rolling Stone's* article by Jeff Tietz. According to an article by Smithfield Foods (2007), two questions were addressed. First, did pre-disposed bias affect *Rolling Stone's* "Boss Hog" article? Second, what kind of an environmental record does Smithfield Foods possess? It was found that *Rolling Stone's* "Boss Hog" article was full of false accusations that could be attributed to irresponsible journalism. After further investigation, it was found that Smithfield agreed to be interviewed for *Rolling Stone's* "Boss Hog" article in an attempt to clear up numerous misconceptions about hog production and processing. Next, it was found that

Smithfield Foods had been praised and awarded for its business model and/or environmental stewardship by FORTUNE magazine, the London-based FTSE Group, the Environmental Protection Agency, the American Meat Institute (AMI), and the Virginia Governor's Environmental Excellence. The major limitation to this article is that it is a response to a provoking article written by Jeff Tietz of *Rolling Stone* magazine. The next three literature reviews represent three peer-reviewed scientific papers that shed light on the story of Smithfield Foods and their effect of the environment and the economy.

Next the topic of the industrialization of hog production is investigated. In a research article by Durrenberger & Thu (2004), a primary question was addressed. What effect does the industrialization of swine production have in the United States? The authors found that there is a growing trend of small-scale family farms with relatively small numbers of hogs are being replaced with large-scale contract farms. This change in production style can be attributed to the efficiency of large-scale production operations that have formal relationships with processors like Smithfield Foods. As a result, there are fewer hog farms, yet an increasing number of hogs. The authors also found that the industrialization of hog production in the United States had the effect of less profit accumulating in local economies, since fewer farm operators controlled production profits. This article supports the present paper's hypothesis by addressing the effects that fewer, family-owned operations have on local economies.

The next review considers the environmental problems associated with hog production and processing. In an article written by Welsh & Hubbell (1999), a primary question was investigated. Is large-scale contract farming better for the environment compared to small-scale family owned operations? It was found that large-scale

operations were more likely to implement new environmental technologies and thus emit less waste compared to their small-scale, independent producers, since it was profitable for them to do so and because the processor was likely to cover the costs of implementing such technologies. It was also found that higher-profits from contract-farms enabled companies like Smithfield Foods to invest more money into research in order to help curb the effects of hog production on the environment (Welsh & Hubbell, 1999). Another way the primary question was addressed was by looking at contract farms as point-source polluters. Point-sources polluters produce large volumes of waste – in this case fecal matter – but they are more easily identified and thus more easily regulated and if necessary fined. The authors concluded their study by noting that the key to understanding whether or not industrialized hog farming was more environmentally sound required understanding the interaction of structural forces with pollution processes, technology and innovation, and environmental regulation.

The final review investigates the benefits of different production strategies for hog farming. In an article published by Gentry et al. (2004), a primary question was addressed. What is the most effective approach – in regard to the pig's health – of raising hogs? The authors compared the overall health of hogs raised inside in close-quarter contract farms to hogs raised outdoors in smaller-scale free range operations. The authors concluded that both production approaches yielded pigs that were suitable for consumers, but hogs that were raised outdoors in free-range environments tended to score higher in health evaluations prior to processing. Both approaches reported similar growth rates and comparable loin qualities, but it was found that free-ranging outdoor pork

production did give rise to more desirable meat coloration and should be considered as a legitimate alternative to close-quarter, large-scale contract methods.

Together, the results reviewed indicate that Smithfield Foods is a large contributor to the environmental degradation of Virginia's ecosystems, yet they provide numerous jobs and generate millions of dollars of economic activity in the state. The development of contract farms similar to those under Smithfield Foods have led to a change in the identity of Virginia's agribusiness (Durrenberger & Thu, 2004; Gentry et al., 2004; Smithfield Foods, 2007; Tietz, 2007; Welsh & Hubbell, 1999). Further research is necessary in order to gain insight into the implications of imposing stricter environment regulations on Smithfield Foods by investigating the environmental and economic consequence that such decisions would have on the Commonwealth of Virginia.

The History of Hog Production in the Commonwealth

Hog production is not new to the Commonwealth of Virginia. The National Pork Board (2007) credits Sir Walter Raleigh for introducing sows to the Jamestown Colony in 1607, yet these pigs were semi-domesticated and tended to be herded in small groups with the typical farmer owning 4-5 pigs. Personal production provided salt-pork and bacon for families, with excess meat being barreled for later consumption. As the colony's human population grew so did its appetite for pork. By the mid-1600's we still see the majority of pork being produced on a small scale for individual consumption, but by this time a market for pork had undoubtedly emerged. Following the Revolutionary War, people began moving west and they took their pigs with them. As much as Smithfield Hams would love to be accredited with being the first to commercially process pigs, credit must be given to the western expansion of the 1800's. As western

populations grew – both human and pork – farmers took advantage of their seemingly endless supply of grain by producing more and more hogs. Shortly there after, the exponential growth of pork production, along with the inefficient practice of small–scale slaughtering operations, led to the first commercial pork processing plant in Cincinnati, Ohio (NPB, 2007).

Hog farming in Virginia would continue to grow overtime – both in the number of hogs and the number of farms. The Commonwealth's hog industry would continue to be dominated by small to moderate sized family operations that relied on local and regional slaughter-houses for processing. Small-scale processing would become obsolete in 1936 when according to Smithfield Foods (2007), W. Luter, Sr. and his son, Joseph W. Luter, Jr., opened the Smithfield Packing plant in Smithfield, Virginia. Since Smithfield Foods has emerged it has changed the face of agribusiness in Virginia. With their ability to commercially process hogs, they have virtually eliminated the ability for small family farms to subsist – in a profitable manner – in turn for a shift towards large scale contract farming.

According to Welsh and Hubbel (1999), the 1980's and 1990's brought substantial changes in U.S. pork industry. Since the 1980's the pork industry has seen a shift from a relatively large number farms and farm-operators that participated in open-market exchange, towards a decrease in the overall number of farms/farmer-operators with an increase in the overall number of hogs being raised annually. Contract farms are essentially large-scale operations that establish a relationship with a major processor – in our case Smithfield Foods – in an attempt to make farming a profitable venture. The farmer benefits because he or she under their contract with the processor is guaranteed a

specific price for their product, whereas non-contract farmers are at the mercy of often unpredictable markets.

The shift in hog production from small, owner-operator farms toward large-scale contract farms is representative of what has been occurring in Halifax County over the past decade and a half. According to Garcia (1999), in 1992 there were 70 hog operations in the county with approximately 3,725 hogs. Compare those numbers to that of 1997 – 35 hog operations with approximately 10,300 hogs and you can see the general trend that reflects Virginia's hog industry today. What does the emergence of this shift towards contract farms mean for agribusiness in Virginia? Essentially the message is "get big or get out."

Today, many of Virginia's farmers are being forced to decide whether or not to continue to farm on a small scale and be subjected to lower market prices for their product, increased land value/taxes due to development, and increased cost of production or get out of the business all together. Other farmers are deciding to avoid getting out of the business by getting bigger. In order to get bigger – i.e. become a contract farmer – you must apply for a permit with the Virginia Department of Agriculture and Consumer Services. The VDACS requires a permit to operate any farm that has 750 hogs. According the Natural Resources Defense Council (2007), there are currently 52 farms that have acquired permits for large-scale contract farming.

Fifty-two contract farms distributed throughout the state should not cause that much of a public uproar, right? Interestingly enough, there is not an even distribution of these operations across the state. These large-scale operations are concentrated in what is considered to be "southside" Virginia – an area that includes south-central Virginia,

down towards the North Carolina border and reaches east toward the Tidewater area. According to NRDC (2007) “this is a rural, economically depressed area, making it vulnerable to the lure of jobs and tax dollars presented by factory-scale farms seeking as little regulation as possible.” Since the emergence of large-scale contract hog farms in the 1980’s and 1990’s there has been an increase in public debate on the pork industry’s effect on the environment. This has prompted many localities to revise their zoning laws in attempt to keep hog farms out of their back yards.

Like any controversial topic, there are two sides to the story that must be taken into account. From the contract farmer’s perspective he or she is merely trying to make a living, but by doing so they are potentially jeopardizing the health of their neighbors and causing harm to the environment. From the non-farmer’s perspective we recognize that our society has reached a certain level of affluence and by doing so we expect/demand a certain level of environmental quality – all while enjoying our delicious pork products of course. Simply put, we cannot have our pie and eat it to, or can we? It is vital that we find a balance between production and protection. If we do not reach a balance or some kind of compromise soon we can expect to see the recent trend of more of Virginia’s landscape being converted from numerous small-family farms to fewer contract farms with higher rates of production and more acute environmental problems. Agriculture is not merely another industry in Virginia; it is what this state was founded on 400 years ago. In order for Virginia to obtain the highest level environmental quality policy makers will have to impose stricter regulatory policies on contract farmers and companies like Smithfield Foods, but this will inevitably force the hog processing giant to relocate overseas where environmental regulation is less developed. This would mark a

triumphant victory for environmentalists, but at the price of losing some of Virginia's most important heritage.

Hog Farming Regulations

Over the last decade the face of the livestock industry, especially hog farming, has evolved from numerous mom-and-pop farming operations to gigantic centralized meat producing factories. The change has created much controversy due to the fact that now all of the animals are all located in one area and the waste pollution from those animals goes into one centralized water source, instead of many different farms contributing to runoff pollution in dispersed areas. Furthermore, the Bush administration has been drawing attention from environmental groups due to their loosening of agricultural pollution regulation standards.

As farmers realized that they could incur lower production costs through the utilization of advanced technology and increased numbers of livestock the amount of manure greatly increased, as did the amount of waste each farm was forced to handle. These new and improved concentrated animal feeding operations were faced with the problem of what to do with such large amounts of waste material. The quantities became too great to spread onto the fields of these farms. Furthermore, the total acreage of the farms decreased as the need for on-site grown crops decreased due to the new systems' use of genetically engineered feed that is produced offsite. Thus, the amount of manure increased and the area in which the farmers had to spread it decreased. This created great problems, in that farmers began applying all of the manure over a space that simply could not handle it. As crops become inundated with excess nutrients from manure, the nutrients build up and eventually run off into nearby water sources. "An estimated 51

percent of nitrogen and 64 percent of phosphorous-both potentially harmful to water quality-in manure from confined hog operations nationwide exceeds onsite crop needs" (Ribaudo 2003).

The Clean Water Act of 1972 established that livestock feeding operations that contain at least 2,500 hogs, 1,000 beef cattle, 700 dairy cows, or 100,000 chickens were to be considered concentrated animal feeding operations (CAFOs), and were to be regulated by the National Pollutant Discharge Elimination System (NPDES). The NPDES is a permit program through which each farmer received permits that specified permissible pollutant treatment levels at the source. However, the major failure of the NPDES was that it only regulated the treatment of the manure at the area of excretion, presupposing that farmers would not over apply waste to containment areas or application fields. The result was excessive dispersal of treated waste to cropland and containment ponds; this often resulted in runoff into nearby creeks and rivers.

Remedial measures were implemented for this problem through the Unified National Strategy for Animal Feeding Operations which was developed by the EPA and USDA. "This strategy is based on a national performance expectation that each animal feeding operation should develop and implement a technically sound, economically feasible, and site specific…nutrient management plan[s]" (Ribaudo, 2003). This plan applies to both on and off-farm manure dispersal and treatment operations. The crux of the Unified National Strategy for animal Feeding Operations is that waste management plans be adopted by CAOFs specific to each organization's needs and crop manure-handling capacities. If the CAOFs could not spread the manure over their own lands in a manner that would not promote excess nutrient build up and runoff, they would be forced

to either transport their manure to other land owners willing to accept the excess waste, or eliminate waste through alternative use technologies. The farmers would be forced to internalize any extra costs incurred by these alternatives.

The Bush administration is only compounding the pollution problems by voiding many of the measures taken by President Clinton in his attempts to control agricultural pollution. The Clinton administration imposed measures to reduce point source water pollution, however "the Bush administration stripped them from the final rule after agribusiness complained" (Lazaroff, 2002). The Bush policy, implemented in 2002, allows for farmers to dispose of waste only after they obtain permits, a plan that is said will do very little to control runoff and water pollution. This new regulation simply serves to modify land application regulation, but will provide no exemptions for CAFOs who were previously allowed to discharge waste into waterways during flood periods.

Furthermore, President Bush implemented more lenient policies dealing with air pollution originating from agricultural operations. This legislation will grant CAFOs immunity from federal air pollution regulation in exchange for the monitoring of air pollution by the federal government. The plan is designed to allow the EPA to study these organizations in order to develop the best environmental regulatory plans in the future. Ammonia, Hydrogen Sulfide, feed dust and manure dust will be monitored so that they will be more effectively regulated in the future. Around 4,000 hog and chicken farms will be exempt from the current federal regulations, but only about thirty are scheduled for monitoring (Environmental News Service, 2005).

The Virginia Pollution Abatement (VPA) General Permit Regulation established the guidelines for the former nutrient management plans. The VPA was imposed on

farms that exceeded 200 dairy cows, 300 feeder and slaughter cattle, 150 horses, 700 pigs weighing 55 pounds or more, 2,000 sheep, 16,500 turkeys, or 30,000 chickens. Under the VPA, each farm was required to implement a nutrient management plan (NMP) which monitored the specific area of waste confinement and the land to which the waste was dispersed. Each farmer was required to apply for these permits and must go through a rigorous evaluation in order to make sure that the proposed NMP is environmentally sound. When assessing the CAFOs the state examined maps of the waste confinement facilities, the land used for waste distribution, soil samples, water and waste samples, calculations of dispersal rates, and application schedules. The waste containment specifications disallowed organizations from building containment ponds in 100 year floodplains, and required that they were built to prevent any type of point-source pollution discharge except, due to any weather system greater than the average 25 year 24 hour storm. Furthermore, the ponds had to be above the seasonal high water table (SHWT), if they were in excess of one foot of the SHWT groundwater monitoring wells had be installed. These ponds were required to be laden with a synthetic ground covering of at least twenty millimeters, or a one foot compacted soil liner. All requirements had to be professionally inspected and certified. The soil, waste, and water in these areas is closely monitored for excesses of numerous different nutrients and minerals. Lastly the NPA set limitations on CAFO's operation proximity with respect to occupied dwellings, water supply wells, surface water courses, as well as rock outcroppings. Each permit is good for 10 years (Kenyon, 1996). A new set of requirements was implemented in 1998; some of the proximity regulations were excluded from the improved system, yet the structural quality control of the holding ponds remains largely the same .

Virginia Department of Environmental Control (DEQ) enforces these environmental regulations on contract farms in the state, but historically Virginia has had fairly relaxed regulatory policies on contract farms. Up until 1993, the DEQ only required site-specific permits for hog farms, such as the ones described above. This was a lengthy process that typically required 12-18 months to acquire a permit. This prompted the agricultural interest groups to successfully lobby the Virginia General Assembly during the 1998 session for a more lenient, general permit system (NRDC, 2007). The new permit system made it easier to obtain a permit, but it did establish a mandate forcing farmers to develop nutrient management plans (NMP's) similar to the ones described above. The new policy has other trade-offs. For example, under the policy farmers are not required to maintain a buffer zone between their waste lagoon and adjoining neighbors, groundwater, streams and rivers, but they are required to have their lagoon design and construction certified by a professional engineer (NRDC, 2007).

Hog Farming & Pork Processing in VA

Hog farming has been a staple of Virginia Agriculture for generations. However, as time has progressed hog farming in Virginia has moved from small mom and pop farming operations to large scale contract farming operations. While there are still many small farms raising hogs throughout the state, the vast majority of the hogs are being raised on only a small number of massive hog feedlot operations. In these contract operations the hogs are owned not by the farmer, but by large pork processing companies such as Smithfield Inc. located in Isle of Wight county in Southern VA.

While conducting our research, it was found that hog farming in Virginia is on a steady decline. Using statistics from the National Agricultural Statistics Service and the

US Department of Agriculture it was estimated that as of Dec. 1, 2005 there were 490,000 hogs in the state. This number includes both the contract and locally owned hog farms from all counties in the state. The decline mentioned above can be seen in a comparison of the 2005 data versus the data from Dec. 2006. In only one year the number of hogs and pigs was drastically reduced by 130,000, bringing the statewide total for 2006 to an estimated 360,000 hogs.

It is not only the number of hogs that is falling; the entire pork industry has seen a recent decline. There used to be twelve contract farms throughout the state; now there are now only four large-scale operations up and running. It should also be noted that we were told by an employee at VA Agricultural Dept. of Statistics that soon there will be only 3 large-scale operations in the state because one of them is scheduled to shut down by the end of the year. This shut down will reduce the number of hogs in the state even further. Even-though the Smithfield Processing Plant, which is the largest producer of pork products in the world, is still up and running, the pigs are often coming from other areas. This is most likely due to the fact that Virginia has strict state water quality standards.

These standards mean that the hog farmers of the state must have expensive equipment to contain the massive amounts of pollutants that are emitted by such large scale hog farming operations. The decrease in the number of farms and hogs in general in the state shows that the large pork processing companies, such as Smithfield Inc., would rather simply pack up their operations and move to areas with less stringent regulations than to pay for the clean-up that would be necessary for continued contract farming in the state of Virginia. However, this could prove to be problematic because Virginia state law

only allows hams that have been dry-cured in salt, smoked over hickory and oak fires and then hung to air-sure for at least six months to be called “Smithfield Hams.”

Industrial Hog Farming Pollution Factors and Possible Solutions

All activities that occur on Earth, both naturally and human induced, produce some kind of byproduct. Some of these byproducts are useful to ecosystems and can be quickly recycled by the environment, while others are more harmful and are not as easily neutralized by environmental processes, USDA (2006). These harmful byproducts are known as pollutants. Pollutants come from two general forms defined by the source(s) of their emission: *point source* pollution and *nonpoint source* pollution. David A. Anderson (2006) defines nonpoint source pollution as certain pollutants found in the environment (rivers, streams lakes, air, ground, etc.) originated from a wide range of unidentifiable sources. On the other hand, point-source pollution occurs when pollutants are released into the environment from one, specific site, such as a factory or an industrial farming unit, in which that single source admits enough pollutants to have detrimental effects on the ecosystem(s) they enter. Ecosystems have the natural ability to recover from byproduct pollutants, according to the USDA (2006), when they are released in smaller, decentralized concentration; however, when large, concentrated amounts of toxic substances enter an ecosystem at a specific site, the ecosystem may become so greatly disturbed that the environment cannot naturally recover itself, USDA (2006).

According to Jeff Tietz’s 2006 article in Rolling Stone magazine, Smithfield Foods, grew to become the nation’s largest pork producer with the past two decades. Smithfield has hog subsidiaries all over the United States, ranging from small farming

units to industrial farms, containing up to 550,000 hogs. Hogs produce a large amount of waste; one hog produces around three times as much waste as a human, all of which has to go somewhere. Waste treatment is not easy, and more importantly, it is not cheap. If Smithfield were to treat the 27 million tons of fecal matter its hogs produce each year in the same way human waste get treated, it would cost them far more than they are willing to spend, Tietz (2006). So what does Smithfield due with all this waste? The practice that has been used for many years uses a holding pond and spray removal process. A holding pond is giant hole in the ground, up to thirty feet deep that is lined with polyethylene to prevent waste from seeping into the earth, though it can be punctured by rocks and bones. There can be several hundred holding ponds surrounding one Smithfield plant (Tietz, 2006; NCSU-CALS, 2004).

The waste that ends up in these ponds is not just hog excrement however; it is a mixture of anything and everything that can fall through the cage-like floors of the hog stalls. A mixture of afterbirths, old batteries, antibiotic syringes, stillborn pigs, urine and fecal matter mix together in these holding ponds to form a extremely toxic, pink liquid (Tietz, 2006). This concoction contains chemicals such as ammonia, methane, hydrogen sulfide, carbon monoxide, cyanide, phosphorous, nitrates and heavy metals, as well as pathogens such as salmonella, cryptosporidium, streptocolli, girardia and other fecal coliform bacteria (USDA, 2006; Sustainable Table, 2007). The waste substance is so toxic that it is immediately fatal if a human were to fall in a holding pond. The smell alone is enough to kill any organism directly exposed to a holding pond for even a very short period of time (Tietz, 2006).

It is obvious that this method is not efficient enough to prevent this toxic, liquid waste from escaping into this surrounding environment. Tietz's (2006) states If the lining of the holding tanks gets punctured in some way, it is unlikely that it would be difficult to notice, and even more difficult (and more importantly unprofitable) to repair. The fluid would then be able to seep into the ground and eventually end up in a local watershed (USDA, 2006; Tietz, 2006). The fact that this waste mixture can accidentally escape into a water source seems pretty scary; the only thing scarier is that this waste actually gets released on purpose as well (Tietz, 2006). When the holding tanks become full, the waste is often sprayed onto surrounding fields as fertilizer, allowing the substance to be readily washed into the nearest watershed (USDA, 2006). An average rain shower can cause these ponds to overflow, so a flood can cause nearly an entire tank to empty: a disastrous situation for a nearby town (Tietz, 2006).

Air admissions from hog waste makes up a large portion of the issue (EPA, 2006). Holding tanks are often located directly next to animal confinement facilities, so harmful gases are continuously present in hog's living facilities (Sustainable Table, 2007). They also pollute the surronding air when stored gases are vented out of barns or manure slurry is sprayed onto fields as fertilizer. Hydrogen sulfide, methane, ammonia, and carbon dioxide are the four main hazardous gases produced by decomposing manure, and they all cause a range of health and environmental problems (EPA, 2005; USDA, 2006). The Environmental Protection Agency (2006) concludes that methane emissions from manure in the United States increased by nearly 26% between 1990 and 2004, due, almost entirely, to the increase in industrialized dairy cow and hog farms.

Producing crops for animal feed also contributes to farm-generated air pollution. The EPA (2006) stated that soil management techniques by industrial farms (with Smithfield being the largest), mainly the use of fertilizers, are the top contributor to nitrous oxide emissions, which accounted for 68% of all nitrous oxide released into the air in 2004, due to poor waste treatment strategies.

Factory farms emit multiple kinds of pollutants into the air, soil, and water, each of which can cause a number of problems for both human health and the environment (USDA, 2006; EPA, 2005). Tietz (2006) reported that there have been many accounts of people falling ill, whether they worked at the animal farming plant or not, due to the fact that they lived in the same county or a nearby county of a subsidiary. Because of the size of these hog operations, and the lack of sophisticated waste treatment technologies, it is inevitable that the general health of humans living nearby treatment techniques, as well as the stability of ecosystems, will suffer from toxic emission factors (EPA, 2006; Tietz, 2006).

The most significant of the manure-borne pathogens are the protozoan parasites *Cryptosporidium parvum* and *Giardia duodenalis*, and the bacterial pathogens *Salmonella*, *Campylobacter*, *Escherichia coli*, and *Listeria monocytogenes* (USDA, 2006). Large amounts of pharmaceutically active compounds such as hormones and antibiotics also may be present in animal wastes emitted into the environment. Pathogenic microorganisms in both livestock and poultry can become resistant to antimicrobial agents, making it difficult to eliminate or prevent their growth or their spread to humans and other organisms (USDA, 2006; Sustainable Table, 2007).

Hydrogen sulfide, a gas that limits the ability of cells to use oxygen, is generally associated with hog production facilities, EPA (2006). Exposure to hydrogen sulfide in high levels can have a variety of acute affects, such as eye and respiratory irritation, neurological and cardiac problems, seizures, comas, and death (Sustainable Table, 2007; ATSDR, 2006). However, according to the Agency for Toxic Substances and Disease Registry (2006), even at low concentration levels, humans may experience low blood pressure, headache, chronic coughs, and psychological disorders. Though these things may not be fatal, they are still an unnecessary and unfair externality of living near an industrial animal farm.

Ammonia is mostly associated with hog and poultry farming. It is released into the air as a gas, or it can be washed into a nearby water source (USDA, 2006). Irritation of the eyes, skin, and respiratory tract are the result of breathing, ingesting, or simply being exposed to a significant concentration of ammonia (Sustainable Table, 2007).

Particulate matter is a high concentration of tiny solid particles carried by air from a pollution source to another area. These particles become a problem when they are blown, in the form of dust, off hog and other large scale farms into nearby water sources, residential areas, or any other ecosystem. Particulate matter can cause a variety of health problems for humans and other organisms in close association with the source. Humans that live or work in locations that are regularly exposed to particulate matter are more likely to repertory problems like experience bronchitis and asthma, as well as cardiac conditions such as arrhythmias and heart attacks (Sustainable Table, 2007).

Endotoxins, the main form being Lipopolysaccharides (LPS), are produced when the cell walls of Gram-negative bacteria (a form of bacteria that is usually pathogenic,

and is characterized by the presence of LPS in their cell walls) degenerate or “lyse”, and are often measured in high concentrations in industrial farming plants (Bacteriology, 2002). These air pollutants can cause respiratory problems even in extremely low concentrations. Injection of a small amount of endotoxins in human volunteers produced fever, a lowering of the blood pressure, and activation of inflammation and coagulation (Sustainable Table, 2007).

The Farm Safety Associations describes methane gas as an asphyxiate at extremely high concentrations, but is not particularly toxic. It is, however, highly flammable and poses a risk of explosion if manure storage facilities are poorly ventilated. Though methane production is most commonly associated with cows, which produce it naturally during digestion, it is a byproduct of most manure that is stored in oxygen-depleted holding ponds according to the FSA (2002).

Pollution factors affecting Virginia’s water systems are probably the most notorious of the environmental hazards caused by Smithfield Foods. The U.S. Geological Survey (2007) describes how the Chesapeake Bay watershed is a unique attribute of Virginia’s geography, however, it is especially vulnerable to water pollution according to The Chesapeake Bay Program (2005). Because of the size, shape and direction of the Eastern Shore (the peninsula that causes the Chesapeake Bay to only have one, relatively small opening to the Atlantic Ocean), the water in the bay gets rotated out into the Atlantic very slowly, so when pollution travels down Virginia’s rivers that lead into the Chesapeake, those pollutants get trapped in the bay causing the ecosystems within it to suffer much more than a large, open body of water like the Atlantic Ocean (USGS, 2007; CBP, 2005).

The bay suffers mainly from nutrient and sediment runoff from the rivers that feed into it. Sediment runoff is caused by the lack of vegetation surrounding rivers, lost to development, which hold soil back from washing into the water. Sediment causes excess saltine solutions and silt to cover the vegetation and animals at the bottom watersheds and rivers, potentially harming these ecosystems if it occurs in excess (CBP, 2005).

Nutrient pollution comes from adding unnatural amounts of organic waste matter into a water source according to the USDA (2006). Nutrients, mainly phosphorous and nitrogen found in feces, cause great increases in the population densities of phytoplankton (CBP, 2005; CBF, 2003). These populations, when allowed to grow to very high densities, coat the surface of a body of water, preventing sunlight and oxygen from entering water. Plants under the surface do not receive enough carbon dioxide and sunlight, preventing them from being able to respire, so they die. Also, these phytoplankton, which die and reproduce rapidly, sink to the bottom once dead where they are decomposed by bacteria. The decomposers use dissolved oxygen at the bottom of the water, causing fish and all other organisms to die (CBP, 2005; CBF, 2003).

This is a giant conflict for Virginia, because the Chesapeake Bay is a very important resource for fish and shellfish. In the last twenty years, populations of oysters and striper bass, two highly sought after animals in the Chesapeake Bay, have been gradually decreasing due to reduced due to the results of habitat loss and nutrient pollution (CBP, 2005). However, this is not all the fault of one industry, like Smithfield. In fact, Smithfield seems to be less responsible than some other factors, for the decreased health state of the Chesapeake Bay. The Chesapeake Bay Program (2005) argues that the

majority of the problem stems from habitat destruction and urbanization, which have been taking place since Europeans colonized America. Forests and wetlands have been replaced with buildings and farms as the human population in this country has continued to grow exponentially. Forests and especially wetlands act as filters for excess nutrients and sediments that wash into the Chesapeake from rivers and streams. We have also caused runoff and flood levels to increase by cutting down forests. Trees use to absorb groundwater, preventing it from flowing into rivers when heavy rains occurred. Now that forests have been removed to allow for houses, farms and cities, rain water can flow straight from the ground into the nearest river or stream (CBP, 2005). This explains why water levels on medium and large rivers rise so quickly, even when rainfall is not that intense.

Not only does vehicle use, agriculture, industrial operations, etc. take up land where trees and wetlands use to reside, they also contribute large amounts of nitrogen and phosphorous pollution that end up in the Chesapeake Bay (CBP, 2005). However, it according to the Chesapeake Bay Foundation (2003), hog subsidiaries probably deserve less blame for the demise of the Chesapeake than others. In fact, the Chesapeake Bay Foundation (2003) states that, in the Shenandoah and Potomac watersheds, large-scale poultry operations produce more waste than hog, cattle, or dairy farms and up to 150 percent more than the nutrient pollution generated by human waste in the same area. In addition, poultry waste creates four times more nitrogen and 24 times more phosphorous than hog waste in Virginia.

So is it worthwhile to make such a fuss over environmental issues associated with hog waste? Well, to the people who live in areas near hog farms, the answer is definitely

yes. Though the hog industry may not be the primary source of the nutrient loading into the Chesapeake Bay, it may still a good idea to push for more environmentally friendly management practices, especially in a day and age where our natural ecosystems are continuously under threat. Luckily, many people have taken notice to the other big polluters of the Chesapeake, and actions have been taken to force them to improve their waste-management methods. In Maryland, poultry producers being forced by the General Assembly to make some changes to their waste management tactics; perhaps the hog industry can incorporate some of these new methods into their own waste treatment strategies.

In the world of poultry production, the biggest names in chicken, Tyson Inc., Allen Family Foods and the Purdue Company, are being forced to clean up their acts in how they treat their animal waste. For the past two decades, the poultry industry has taken as much, or more, ridicule from environmental groups and state governments, as the hog industry. According to a Chesapeake Bay Journal (2001) article, after Virginia and Maryland experienced their first *pfiesteria* (dinoflagellate that causes the phenomenon known as red tide, that results in fish kills and temporary health problems) outbreak in 1997, the Maryland General Assembly issued legislation stating that the Maryland poultry industries (Purdue, Allen Family Foods, and Tyson Inc.) must all develop new methods for dealing with the nutrient wastes that their contracted farms produce, so that it is not being used as fertilizer that will eventually run into the Chesapeake Bay. The options these companies are looking at could possibly spark some similar treatment ideas for hog farming operations.

Unfortunately, it appears no one has managed to find a completely ideal method for tackling this issue. According to a more recent article in the Washington Post (2006), some projects are underway, but finding one that is effective and efficient has been more difficult than expected. The Purdue Company built a $12 million treatment plant that converts chicken litter (a 9 to 1 mixture of chicken feces and wood bedding) into pellets, allowing it to be shipped to other states to be sold as fertilizer, mainly to farms and golf courses. However, the consumer market for this fertilizer has not led Perdue to the profits that they initially had in mind. The company has made claims that it might try a new method in the future, such as converting chicken littler into electric power.

Tyson Inc. and Allen Family Foods sided with the electricity idea from the start, but this method is no yellow brick road either. Converting chicken waste into electricity is relatively popular among most environmentalists, because not only does it solve the problem of waste run-off, but offers an alternative to burning fossil fuels, Bay Journal (2001). Fibrowatt, a power company that already has owns three animal waste-run power plants in Great Britain, and has teamed up with Allen Family Foods, to hopefully get a large plant up and running in Maryland by 2008. About half of the energy produced would be used to power the chicken processing plant, while the other half would be sold to commercial power companies. Unfortunately, the process of converting animal waste to electric power is not as easy as burning fossil fuels, thus increasing consumer costs.

Because chicken litter comes in a variety of consistencies, from moist to dry, operations that have undertaken this experiment have struggled to convert the litter to electricity efficiently. The cost of electricity from burning chicken litter is approximately three to four times as expensive as electricity from coal-burning factories. Fibrowatt

hopes that the state of Maryland offer tax credits to companies creating jobs in depressed communities (Chesapeake Bay Journal, 2001).

Based on the ambiguity over whether a feasible, environmentally friendly waste treatment method will ever be discovered, it is hard to think that Smithfield Foods, or any other animal farming operations in Virginia, will ever stick around long enough to employ a mutually beneficial waste treatment option. However, Smithfield has demonstrated that they are willing to be a part of the search for cleaner waste management practices. According to the North Carolina State University's College of Agriculture and Life Sciences (2004), in 2000 Smithfield entered into an agreement with the Attorney General of North Carolina to provide a total of $17.1 million dollars to find environmentally superior technologies for treatment of hog waste (NCSU-CALS, 2004); is became known as the Smithfield Agreement.

The Smithfield Agreement states that the North Carolina State University College of Agriculture and Life Sciences will conduct research to create and test the effectiveness of technologies that are environmentally superior to the holding pond/spray method. The agreement defines environmentally superior technologies as : "any technology, or combination of technologies that (1) is permittable by the appropriate governmental authority; (2) is determined to be technically, operationally and economically feasible for an identified category or categories of farms as described in the agreements and (3) meets the following performance standards: 1. Eliminates the discharge of animal waste to surface waters and groundwater through direct discharge, seepage or runoff; 2. Substantially eliminates atmospheric emissions of ammonia; 3. Substantially eliminates the emission of odor that is detectable beyond the boundaries of the parcel or tract of land

on which the swine farm is located; 4. Substantially eliminates the release of disease-transmitting vectors and airborne pathogens; and 5. Substantially eliminates nutrient and heavy metal contamination of soil and groundwater."

There are 18 candidate systems that have been proposed by the researchers for managing waste. The key element of each technology is to separate solid waste from liquid waste, similar to what the Purdue Company was doing by making solid pellets. This allows the solid waste to be transported further, so it does not all have to be spread on nearby fields; thus preventing high concentrations of runoff from a single area (NCSU-CALS, 2004). Also, these new technologies that separate solid from liquid waste should greatly reduce the amount of odor and ammonia emissions. To accomplish this, candidate systems are designed to reduce the potential pollution hazards associated with hog waste by dealing mainly with issues stemming from the high concentrations of nitrogen and phosphorous in hog feces and urine (NCSU-CALS, 2004).

Most of the systems that the technology researchers for the Smithfield Agreement have developed begin by separating solid from liquid waste; the separated solid waste can then go on to be sold as fertilizer, while the liquid waste goes to the next stage of treatment. Then a process called nitrification converts ammonia (a nitrogen hydrogen compound NH_3) into nitrate, by mixing the ammonia with bacteria or microbes in an oxygen rich environment. Then, the process of denitrification, in which nitrate is converted to the harmless nitrogen gas that makes up approximately 79% of our atmosphere, is conducted in an oxygen-free environment. The phosphorous is then removed as a compound, such as calcium phosphate, that can be sold as a solid fertilizer (NCSU-CALS, 2004). The differences in each of the technologies varies, some seem

rather similar, yet more sophisticated than the traditional holding pond technique. Others, such as the uses of black soldier fly larvae to decompose waste into a usable product, and the construction of artificial wetlands that filter nutrients, are a little more outgoing (NCSU-CALS, 2004).

Decline in Virginia Hog Farming

The U.S. Department of Agriculture and Consumer Services predicts that 70% of Virginia's farmland will change hands in the next 15 years because the average age of farmers is 56.4 years old (Garcia 2004). But more specifically, many shifts have already taken place in the demographics of Virginia hog farming over the last 40 years. Up until the mid 1990s Virginia hog farming was comprised mainly of small family run hog farms. In the late 1990s another shift was made: it was go big or get out. Farms producing hogs and pigs decreased dramatically between 1992 and 97.The number of farms fell from 1,596 farms in 1992, to only 823 remaining farms in 1997, representing a decline of 48 percent (Garcia 2004).

There became fewer hog farms, but they were much larger in size. The data from Halifax County taken from the agriculture census perfectly models what has happened to pig farming in Virginia. In 1992, Halifax had 70 hog farms with 3,725 pigs. In 1997, the number of farms fell to 35, but the number of animals nearly tripled to 10,359 (Garcia 2004). But now in Virginia, a recent increase in the cost of meeting environmental regulations and a decrease in hog prices has forced contract style farming to leave Virginia.

Why are they leaving?

Due to the fact that pigs have a hard time digesting the fiber found in pasture grasses, farmers have to find other methods for feeding pigs, these alternatives are typically more expensive. Corn is the best option for farmers because of its availability and protein content. The only problem with corn is that prices can be volatile. The volatility of corn and the high fixed cost associated with raising pigs forces hog farms to boost their bottom line by cutting costs in other crucial areas like pollution control. To add insult to injury, Virginia only produces 20-30 million bushels of corn, yet 70 million bushels are used a year by poultry, hog and dairy farmer (Purcell 2004). This places Virginia hog farmers and the entire pork processing sector in Virginia at an unavoidable disadvantage. How can they compete with other farmers who don't have to ship grain in from other states?

The final blow to hog farming though has been an increase in the price of land in rural and suburban Virginia. Because so many people are retiring from the northern states to rural Virginia the price of land has shot through the roof. It is tough to operate a profitable farm when farmland is worth 10,000 to 12,000 dollars per acre (Purcell 2004). Also, it is worth noting that ethanol production has increased and because pork prices are a function of corn prices, this may in turn increase the demand for corn in the U.S. which would directly affect pork prices, thus forcing hog farmers to change what they feed hogs or relocate where corn prices are lower (Leer 2005).

Where are they going?

Just recently, Smithfield Foods, which is the largest pork producer in Virginia, invested 150 million dollars into their hog farming operations in Poland (CEE 2004). This

suggests that they are looking to outsource their hog farming operations to Poland. Also, Smithfield plans to contribute to the establishment of some 250 micro-farms in Western Romania.

The representatives of Smithfield said that they were interested in the future acquisition of a significant share of grain from Arad County Romania, a move that will boost the activities of the local farmers. With respect to future farms, the company's representatives said that starting in 2006, they want to open one farm per week. An one of Smithfield's subsidiaries has announced investment plans totaling 800 million dollars, Bursa reports(CEE 2004).

Also the recent strengthening of the Canadian dollar has encouraged some producers to expand to Ontario and Manitoba. Because of this strong exchange rate and the loosening of trade regulations in the past 15 years, the Canadian hog exports to the U.S. have increased 800% (Haley 2004). Another major area of growth for hog farming is in Iowa, Indiana, Illinois, Missouri, and Ohio. Factory style hog farming has grown rapidly in these states because corn prices are low, labor is abundant and land prices remain stable (Hurst 2006).

Why are there More Contract Style Hog Farms?

It is very difficult to live solely off of the income of a small family-run hog farm. Rural Virginia is way behind the rest of the state's economy. Trying to estimate the price of corn, estimate the demand for pork, and finance the high fixed costs of farming hogs can be very difficult on the smaller operations. This is why more than 90% of Virginias farming families rely on off farm income (Garcia 2004). One reason farmers vie for hog contracts is to gain entry into a much more stable market where supply can be catered to

the individual pork processors needs. Instead of guessing how much pork will be purchased, farmers can sign contracts with large processing companies which will allow a perfect equilibrium to be reached and remove some of the financial strain from the farmer.

IMPLAN Input/Output System

The input-output model, which was pioneered by Wassily Leontief and Nicholas Georgescu-Roegen, describes how the economy may be thought of as having *n-industries* and an *open sector*, which exogenously determines the *final demand* for the product of each industry. The model also shows that the economy has a *primary input*, which is labor. The economy has an inter-industry matrix, each element of which shows the number of cents of output from industry, *j*, that goes into the manufacture of a dollar's worth of output from industry, *i*. Each column sum represents the partial input cost, not including the primary input, incurred in producing a dollar's worth of some commodity.

"The IMPLAN input-output model describes the commodity flows from producers to intermediate and final consumers. In the model, the total industry purchases of commodities, services, employment compensation, value added and imports are equal to the value of the commodities produced. The model is driven by purchases for final use, also known as final demand. Industries in the model produce goods and services to satisfy final demand, and by doing so, the industries purchase goods and services from other producers. These other producers are also buying goods and services. This buying of goods and services, known as indirect purchases, continues until leakages from the region stop the cycle from continuing.

These indirect and induced effects, the effects of household spending, can be mathematically calculated. This calculation is known as the Leontief inverse, and the resulting sets of multipliers describe the change of output for every regional industry caused by one-dollar change in final demand for any given industry. IMPLAN was developed as a cost-effective way to develop regional input-output models.

The IMPLAN model was designed to serve three functions: first, data retrieval, second, data reduction and model development, third, impact analysis. Detailed data coverage of the entire US by county, and the ability to incorporate user-supplied data at each stage of the model, allows for a high degree of flexibility in both geographic coverage and model formulation. MIG, Inc. IMPLAN database consist of two parts: first, a national-level technology matrix, and second, estimates of sectorial activity for final demand, final payments, industry output and employment for each county in the U.S. along with state and national totals.

The IMPLAN model allows users to do the following: develop multiplier tables; develop a complete set of Social Accounting Matrix (SAM) accounts; change any component of the system, production functions, trade flows or database; generate type I, II, or any true SAM multiplier internalizing household, government, and/or investment activities; create custom impact analysis by entering final demand changes; and obtain any report in the system to examine the model's assumptions and calculations. The IMPLAN system is composed of two components, the software and the database. The database provides all information to create regional IMPLAN models, and the software performs the calculations and provides an interface for the user to make final demand changes." (Lindall & Olson 1)

For this project, the students of Dr. Kenneth Townsend's Environmental Studies Seminar looked at the impact that both removing Smithfield LLC and contract hog farms from Virginia would have on the economy of Virginia. Dr. Townsend ran IMPLAN models for removing Smithfield LLC and the contract farms separately, and this paper will cover the economic impact of each industry being removed from the Virginia economy.

Before one can begin to cover the impact of the removal of these industries would have on the economy of Virginia, you must understand the sectors that will be discussed, which I will now review. The removal of Smithfield LLC will affect the following areas: employment, employment compensation, indirect business taxes, labor income, output, proprietor's income, total value added, and tax impact.

"Employment is the total wage and salary and self-employed jobs in a region. Employment databases are measured in total jobs, both full and part-time. Employee compensation is wage and salary payments as well as benefits including health and life insurance, retirement payments, and any other non-cash compensation. This provides a measure of income to workers who are paid by employers. Indirect business taxes consist primarily of excise and sales taxes paid by individuals to businesses. These taxes are collected during the normal operation of these businesses but do not include taxes on profit or income. Proprietor's income consists of payments received by self-employed individuals as income. This would be recorded on Federal Tax form 1040C. This includes income received by private business owners, doctors, lawyers and so forth. Any income a person receives for payment of self-employed work is counted here." (Lindall & Olson 10) The tax impact model shows the losses Federal and State/Local

governments would incur from the removal of the income coming from Smithfield LLC and contract farming. These losses in tax revenue would have an impact on all Federal, State and Local projects funded through the government.

Output, VA, Employment without the removal of Smithfield LLC and contract farms is $549,470,703,000 in Industry Output, $4,641,805,000 in Employment, $199,557,020,000 in Employee Compensation, $18,818,599,000 in Proprietor Income, $81,051,909,000 in Indirect Income, $22,908,881,000 in Total Business Tax, and total for the state was $5,513,611,969,000. While using the IMPLAN model, it was found that hog processing constitutes 0.14% of the total Virginia economic output, hog farming makes up 0.048% of the total Virginia economic output, and together the entire hog industry constitutes 0.18% of Virginia's economy. While, 0.18% may not seem like a large number, when considering the entire economic output for a state, it is rather substantial.

Now that I have covered the output levels of Virginia Economy and the size of hog farming and processing for the state, I will show what would happen to the economy if environmental regulations forced Smithfield LLC, contract farmers, or both out of the state.

First, I will examine the impact to the economy of Virginia if Smithfield LLC was removed. Employee Compensation would experience a direct loss of $95,781,017, an indirect loss of $131,675,781, an induced loss of $60,699,433 and a total loss of $288,156,277. Employment would experience a direct loss of $2,757.1, an indirect loss of $10,857.5, an induced loss of $1,847.4 and a total loss of $15,462.1. Indirect Business Taxes would experience a direct loss of $6,151,321, an indirect loss of $23,281,845, an

induced loss of $11,689,347 and a total loss of $41,122,513. Labor Income would experience a direct loss of $98,271,347, an indirect loss of $144,471,388, an induced loss of $66,643,878, and a total loss of $309,386,614. Output would suffer a direct loss of $1,046,891,968, an indirect loss of $754,014,277, an induced loss of $197,292,320, and a total loss of $1,998,198,569. Proprietor's Income would experience a direct loss of $2,490,330, an indirect loss of $12,795,607, an indirect loss of $5,944,444, and a total loss of $21,230,381. Total Value Added would suffer a direct loss of $125,575,498, an indirect loss of $251,077,208, an induced loss of 119,919,504, and a total loss of $496,572,201. The Tax Impact of removing Smithfield LLC would be a loss of $74,898,915 in Federal Government Nondefense Taxes, a loss of $48,843,189 in State/Local Government NonEducational Taxes, and a total tax loss of $123,093,315.

The removal of contract farmers from Virginia's economy includes the same as the removal of Smithfield LLC, but without Total Value Added, and including Other Property Type Income.

"Other property type income consists of payments from rent royalties and dividends. This includes payments to individuals in the form of rents received on property, royalties from contracts, and dividends paid by corporations. This also includes corporate profits earned by corporations." (Lindall & Olson 10)

The impact of the removal of contract farms from Virginia's economy will now be examined. In Employee Compensation, there would be a direct loss of $38,055,636, an indirect loss of $19,289,950, an induced loss of $15,184,809, and a total loss of $72,530,394. Employment would face a direct loss of $15,077.2, an indirect loss of $1,134, an induced loss of $460.7, and a total loss of $16,671.8. Indirect Business Taxes

would suffer a direct loss of $5,420,986, an indirect loss of $4,487,321, an induced loss of $2,912,353, and a total loss of $12,820,661. Labor Income would experience a direct loss of $36,449,672, an indirect loss of $23,975,121, an induced loss of $16,666,709, and a total loss of $77,091,502. Output would suffer a direct loss of $265,682,000, an indirect loss of $96,565,109, an induced loss of $49,222,154, and a total loss of $411,469,227. Proprietors Income would directly gain $1,605,996, indirectly loss $4,685,172, an induced loss of $1,481,899, and a total loss of $4,651,105. Other Property Type Income would directly gain $2,786,002, suffer an indirect loss of $22,979,359, an induced loss of $10,363,000, and a total loss of $30,556,358. The Tax Impact of removing contract farms from VA would be a loss of $18,702,758 in Federal Government NonDefense Taxes, a loss of $14,159,309 in State/Local Government NonEducation Taxes, and a total loss of $32,698,764 in taxes.

As you can see, removing Smithfield LLC and contract farms from the state of Virginia would have an extreme impact on the economy of Virginia and the tax revenue going to the Federal Government as well as State and Local Governments.

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