Greener Eggs and Ham

The Benefits of Pasture-Raised Swine, Poultry, and Egg Production

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CONTENTS

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EXECUTIVE SUMMARY

Greener Eggs and Ham reviews alternative swine and chicken production and marketing, complementing our earlier report *Greener Pastures* that examined the multiple benefits of grass-fed beef and dairy cattle. Unlike ruminants such as cattle that have several stomachs and symbiotic microbes that break down the plant fiber component cellulose, hogs and chickens cannot survive on diets that contain only grass and other forages. Because of this, some of the benefits of pasture production are not the same for non-ruminants compared to ruminants. For example, the levels of beneficial omega-3 fatty acids are generally not different in pasture-raised versus conventionally raised pork and poultry.

Pork, poultry and eggs are a significant part of U.S. food production and consumption, and most food animals are raised in large confinement systems (CAFOs) and fed only grains and legumes along with antibiotics that hasten weight gain. This poses many problems for the environment, farmers, farm workers, and animal and public health.

To address these problems, innovative swine and poultry producers and researchers who take a holistic view of animal production, and who enjoy the challenge of working with nature rather than trying to control it, are developing production systems that give animals access to the outdoors and the opportunity to gain some nutrition from forage. Deep bedding that keeps pigs warm in open pens, and easily moved structures that allow chickens to live on pasture are just two of many new elements they have devised. A variety of labels has been applied to the products coming out of these systems including organic, natural, free range, pasture-raised and others. As demand for pasture raised products has increased, so has the need for clearer labels and stronger standards.

In contrast to CAFOs, which produce far greater quantities of manure than can be used on nearby fields, the objective in alternative systems is to spread the manure produced by animals on pasture over as large as space as possible. This lessens the contamination of groundwater with nitrates, pesticides, heavy metals, and antibiotics, and decreases the eutrophication of waterways that causes fish and plant die-off. The air in pastured animal areas is cleaner than in CAFO areas. Pasture systems also require less grain production, mitigating problems like soil erosion, pesticide residues in food and water, and nitrogen runoff. In fact, well-managed pastures can improve soil quality.

The benefits to producers who raise hogs and poultry on pasture include lower costs, lower capital needs, the ability to produce in season, less exposure to airborne hazards, and fewer objections from neighbors regarding odors and pollution. Consumers benefit from less exposure to antibiotic-resistant microbes, better tasting products (mainly due to the use of heritage breeds of hogs and chickens), and the knowledge that less environmental damage occurred in the production of the food.

UCS has a strong interest in supporting alternative systems that are good for humans, animals and the environment alike. We recommend that more attention be paid to research and policy needs in order to spur further adoption of these important alternative production models.

INTRODUCTION

As consumers learn more about the downside of conventional animal food production, they are becoming increasingly interested in alternatives. The Union of Concerned Scientists (UCS) applauds that interest and encourages modes of animal agriculture that are good for humans, animals, and the environment alike. To that end we released a report in March 2006, *Greener Pastures: How Grass-Fed Beef and Milk Contribute to Healthy Eating*, that described the multiple benefits of raising beef and dairy cattle on pasture, including the nutrition benefits of the fats found in pasture-raised meat and milk.

In this report, we turn to alternatives to conventional pork, chicken, and egg production. Again we focus on systems that raise animals largely outdoors and allow the animals to obtain some part of their diet by foraging in managed pastures. As in *Greener Pastures*, we address the multiple benefits associated with such systems.

Unlike cattle, however, pigs and poultry cannot survive on diets that contain only grass or other forages. They are monogastric (possessing a single stomach) and not well adapted to breaking down fibrous plant material into digestible compounds. Ruminant animals such as cows, on the other hand, have four stomachs and symbiotic microbes that break down cellulose, an important component of plant fiber. Whether outdoors or in, poultry and pigs must be fed diets containing grains, oilseeds, and in some cases animal by-products. In only a few cases is the pasture component of these diets high enough to result in substantial increases in the grass-derived beneficial fatty acids found in cows' milk and beef. This means that the benefits of pasture-produced pork, chicken, and eggs are primarily environmental. It is possible, however, to produce higher levels of beneficial fatty acids by adjusting the feed given to pigs and poultry.

Poultry and swine in the United States are raised in confinement systems organized around shortsighted views of efficiency and economies of scale. These systems pose many problems for the environment, farmers, farm workers, animal and public health, and ironically, the economic health of the producers. UCS has a strong interest in alternative production systems, especially those that can solve multiple problems caused by large confinement facilities. Among the most promising alternatives are systems that incorporate outdoor production and pasture feeding. Recent research shows that 25 percent of consumers would be willing to pay a 40 percent premium for a pork product raised on pasture without antibiotics, growth promotants, and animal by-products. In fact, demand currently exceeds supplies of all pasture-raised products (NichePork 2005). The commercial appeal of such products has led many producers to switch from conventional confinement production to pasture systems—a switch that leads costs to fall while profits rise.

This report presents a brief overview of the production, marketing, and benefits of pastured pork, chicken, and eggs, including:

- Background facts on the consumption of pork, chicken, and eggs in the United States
- Definitions, standards, and labels used to describe the alternatively produced products on the market
- Descriptions of conventional and alternative production methods
- Advantages of pasture production

- Environmental, animal, and human health problems with conventional production methods
- Environmental, animal, and human health benefits from pasture production, including differences in the levels of beneficial fatty acids between conventional and pasture-raised products
- Challenges facing alternative producers
- Research and policy needs
- Our conclusions

Background on U.S. Pork, Chicken, and Egg Production

Pork, chicken, and eggs are a significant part of food production and consumption in the United States. In fact, Americans have been consuming more pork and chicken over the last few decades and less beef; pork now accounts for about 25 percent of domestic meat consumption (ERS 2006a). In 2000 the annual per capita consumption of pork (not adjusted for cooking and other losses) was about 50 pounds, a modest increase from 1970. Chicken consumption was 53 pounds per capita (32 billion pounds total)—an astonishing increase of almost 90 percent from 1970 (Buzby and Farah 2006). Broiler chickens (those that produce meat) comprise 40 percent of all commercial meat production.

Egg and egg product consumption has declined over the past 30 years to about 260 eggs per capita per year (ERS 2006b). Nevertheless, the United States is still the second largest egg producer in the world (ERS 2004) at about 100 billion eggs per year, three-fourths of which are produced for human consumption and the remainder for hatching (ERS 2006b).

DEFINITIONS, STANDARDS, AND LABEL CLAIMS

In general, producers using pasture systems raise animals outdoors on forages of grass or mixed pasture for a substantial part of their lives. These systems provide animals with exposure to fresh air and the opportunity to move around and obtain some of their nutrition from grazing (the proportion depending on the species and the type of pasture provided).

Producers and researchers define these systems in various ways, emphasizing either the availability of pasture or the components of the animals' diets. The American Pastured Poultry Producers Association, for example, defines pastured poultry as "a production system that employs raising chickens (or other poultry) directly on pasture" (APPPA 2006), and the Minnesota Institute for Sustainable Agriculture states that pasture production is a system in which animals "get a portion of their diet from grasses and other pasture plants" (MISA 2006).

Two U.S. Department of Agriculture (USDA) agencies are responsible for developing most of the regulatory standards related to meat and poultry products and approving labels for those products:

- The Agricultural Marketing Service (AMS) develops and regulates voluntary claims and standards, and offers two types of services to help producers enhance their marketing efforts. One is third-party certification of product standards; the other is audited verification of specific processes (called the Process Verified Program).

- The Food Safety and Inspection Service (FSIS) is responsible for reviewing applications for meat and poultry product labels and pre-approving labels to ensure they do not contain misleading or inaccurate information (Benkstein and Telford 2003). When a producer proposes to make a label claim, FSIS requires documentation of the producer's protocols as well as testimonials and affidavits that the claims are accurate. In the last decade or so, production claims have become much more popular and prevalent on labels, and FSIS has approved many claims such as "raised without added hormones," "raised without antibiotics," and "free-range."

Recognizing this surge in popularity, AMS is currently developing common definitions for certain claims—including the three mentioned—to avoid confusion in the market. In 2002 AMS proposed a claim of "pasture-raised"/"free-range" for swine that requires continuous access to pasture for at least 80 percent of the production cycle. The agency requested further comments on this proposal the following year, but it had not been acted upon by fall 2006.[1]

A number of other labels and claims found on poultry or pork products relate to pasture production. Two backed by formal USDA standards, "organic" and "natural," are often used in conjunction with or instead of the claim "pasture-raised." Producers have developed a number of other informal claims, discussed below.

CERTIFIED ORGANIC. The USDA allows producers to apply this label if their production practices and inputs meet a comprehensive set of standards. The label is available for animals used for meat, milk, eggs, and other animal products certified by third parties as meeting production standards that require animals to have access to the outdoors—though only ruminants must have access to pasture (NOP 2002).

NATURAL. The USDA standard for this term requires only that products be minimally processed and contain no artificial ingredients. In essence, all fresh meat products meet this standard, so individual companies and marketing groups have established more stringent informal guidelines for their products. Many company guidelines for "natural" pork production include a ban on the use of antibiotics and other chemical growth promotants; some also ban the use of animal by-products in feeds. They may also include increased space allowances for animals and the use of other production practices thought to enhance animal welfare.

[1] In May 2006 AMS released a revised proposal for a grass-fed meat (beef, bison, lamb) label claim under its Process Verified Program (*http://www.ams.usda.gov/lsg/stand/ls0509.txt*).

OTHER TERMS. Producers of alternative or "niche" pork are trying to distinguish their products from conventionally produced pork. In addition to qualifying as organic and natural, these products include pork with one or more of the following attributes (NichePork 2005):

- Raised without antibiotics
- Raised without growth promotants
- Raised without animal by-products in the feed
- Certified to use a specific breed (for example, Berkshire)

Along with "organic" and "natural," "free-range" and "free-roaming" are among the terms most commonly found on poultry labels (FSIS 2003), although there are no regulatory definitions for the latter claims which imply that the animal had unrestrained access to the outside. FSIS does permit these claims for poultry after producers provide a written description of housing conditions ensuring that their birds have continuous free access to the outdoors for more than 51 percent of their lives (Myrick 2006). In general, however, these terms only guarantee that the animal has had some *opportunity* to go outdoors each day—through a door left open at some point, for example—with no requirement that it actually goes outside.

Eggs produced in ways perceived to be healthier or laid by chickens that are more humanely raised are called "specialty" eggs and may be marketed using claims that refer to the way the chickens were raised or the way the eggs were modified. Terms used to describe such eggs, some of which are regulated by USDA or the Food and Drug Administration (FDA), include:

- Designer eggs. This term describes eggs whose content has been modified to differ from the standard egg; examples include changes in vitamin, cholesterol, or fatty acid content (Jacob and Miles 2000).

- Free-range eggs. The FDA, which regulates the egg market, has set no standard for the use of this term.

- Cage-free eggs. This term, which is also unregulated, generally means that the chickens are uncaged inside warehouses. The term does not mean that the chickens have access to the outdoors, and there is no third-party auditing required, although several private groups offer audits (HSUS 2006).

CONVENTIONAL PRODUCTION SYSTEMS

Animal production in the United States has changed markedly over the past 40 years. Currently, most conventional production of swine, poultry, and eggs in this country is done in large confined operations in which animals are fed grain-based diets, given no access to pasture, and fed antibiotics to prevent disease and accelerate growth. These confined or concentrated animal feeding operations (CAFOs) pose environmental, animal health, and public health hazards due to the enormous quantities of manure they produce and the large number of animals raised in close quarters.

Swine

After China and the European Union, the United States is the world's third largest producer and consumer of pork (FAS 2006), at a farm value of $15 billion in 2005. The total size of the U.S. hog herd is currently about 60 million animals, with 70 percent in the midwestern Corn Belt and another 20 percent in the Southeast, especially North Carolina.

The number of farms producing hogs in the United States has declined steadily and dramatically since 1964, when more than 800,000 farms contributed to the national herd (Drabenstott 1998). Between 1994 and 2001 alone the number of hog farms fell by more than 50 percent to just over 80,000, even though the number of hogs produced remained about the same over this period (McBride and Key 2003). The result is that in the early 2000s about 80 percent of U.S. hogs were raised on farms that produced at least 5,000 pigs per year (Meredith 2003). The structure of swine production has changed simultaneously; most pork producers no longer sell in an open market but enter into production contracts with entities called integrators.[2]

The hog production cycle begins with breeding and an approximate 115-day pregnancy. In confinement operations most piglets are born (or farrowed) in crates that severely restrict the sow's movement (sows can lie down but cannot turn around) and partially separate the piglets from the sow. Piglets are weaned when they are two to three weeks old, placed in a nursery on slotted floors for four to seven weeks, then placed in pens with about eight square feet per pig until they reach the typical market weight of 250 to 275 pounds. Pigs are fed ground corn for energy and soybean meal for protein along with vitamin and mineral supplements.

Pigs experience stress of various kinds, particularly in barns housing a large number of animals of different ages. This facilitates the spread of disease, resulting in the use of significant amounts of antibiotics to control disease. They also must be kept cool through use of fans and outside vents because they produce a lot of body heat. However, many swine are now raised in systems where the pigs are all the same age, have more space per animal, and are only moved once during their lifetimes (EPA 2006a).

The concentration of hogs in large facilities creates a huge volume of manure that must be stored and eliminated. The manure, mainly handled as a liquid, falls into a pit underneath the animals and is stored either in an enclosed storage tank or an open lagoon (which allows bacteria to digest the organic material and lessens odor). Since the manure is heavy and expensive to transport, producers dispose of it by spraying it onto nearby fields or injecting it into the soil.

Chickens

The United States is the world's largest producer of poultry meat, and more than 70 percent of broiler chickens are produced in just five states: Georgia, Arkansas, Alabama, Mississippi, and North Carolina (in descending order of production) (ERS 2004). Since 1960, most U.S. broiler production has been done by growers under contract with broiler processors (also called integrators); in 2003, 87 percent of poultry and egg production was done under contract with integrators. The grower normally supplies all the necessary housing, heating, cooling, feeding,

[2] An integrator is a type of contractor characterized as a large conglomerate or corporation that contracts with many growers to produce animals. In 2003, 50 percent of hog production was done under contracts with integrators.

and watering systems as well as the labor for raising the birds; the integrator owns the live birds and supplies the chicks, feed, veterinary medicines, and growth promotants.

Chicken houses may hold more than 30,000 birds, and large broiler operations have 200,000 birds at a time. The manure accumulated on the floor of these poultry houses is not routinely cleaned out between flocks and in many cases is removed only once every two years or so (Stringham et al. 2005). Ventilation is needed to dissipate the ammonia and other gases given off by the accumulated layers of manure. As with swine, these large enclosed operations can facilitate the spread of disease and necessitate the constant feeding of antibiotics to control disease.

Chickens in confined facilities are fed a grain/sorghum mix. New knowledge of nutrition and use of faster-growing breeds allows producers to raise a 3.5-pound bird in eight weeks, compared with 16 weeks 50 years ago (EPA 2006b).

Eggs

More than 280 million laying hens produced 80 billion eggs for human consumption in the United States in 2004. Two hundred and sixty companies produced 95 percent of those chickens, compared with 2,500 such operations in 1987. This consolidation in the industry means that the total number of hens in each operation is very large—the 11 largest operations raise more than five million laying chickens a year (Iowa Egg Council 2005). Producers of confined laying hens often withhold feed in order to induce molting (the shedding and regrowth of feathers), which increases laying rate and improves shell quality, but raises concerns about animal welfare.

The conditions in laying hen houses are extremely crowded; in many cases there are multiple tiers of cages with five or six birds in each cage and fully automated feeding and egg-gathering systems. There may be 100,000 birds in a single house and one to two million birds in a single operation (Madison and Harvey 1997). A laying hen's feed is mainly sorghum or corn mixed with soybean meal or cottonseed meal and supplements.

ALTERNATIVE PRODUCTION SYSTEMS

Innovative swine and poultry producers in the United States, who often take a more holistic view of animal production cycles and enjoy the challenge of working with nature rather than trying to control it, are developing alternative systems that give animals access to the outdoors and the opportunity to obtain some nutrition from forage.

Swine

Hogs are omnivores that eat a wide variety of foods. Piglets' ability to digest fibrous material such as grass increases as they mature, so they are mainly fed grain until they are about seven months old. Some producers raise all their pigs on pasture (after the piglets are old enough); some raise only pregnant sows on pasture (SAN 2003). In most pasture systems the pigs are provided straw bedding deep enough to maintain warmth and prevent excess nitrogen from urine and manure from harming the pasture. Sows give birth and wean in huts that are also outfitted with deep bedding.

Pasture generally takes the form of open pens in which hogs feed on legumes, grasses, and vegetables including kale and turnips. Another option is to let pigs forage in fields of unharvested corn, rye, or oats; when this is done farmers enjoy the benefits of lower harvesting costs and fertilizing the land with pig manure (Gegner 2004). Grain is necessary for weight gain, so about two pounds are provided per day for sows, and more for females that have not been pregnant (gilts). Forage can provide more than half of a pig's food intake, but in most pasture-based swine systems the amount is 10 to 30 percent (Gegner 2004).

Chickens

The most successful pasture production of poultry occurs on diversified farms where chicken production is a component of an integrated system (CIAS 2003, 2001). There are several pasture production options available (Fanatico 2002; MISA 2005; SAN 2006); one common approach puts 75 to 100 three- to four-week-old chickens in movable pens that are repositioned each day during the warm-weather growing season to provide fresh pasture. Another system uses portable fencing around a chicken house to form multiple pastures/yards. Houses can also be moved regularly (but not daily) to fresh sites. Up to 1,000 broilers per acre can be produced this way.

Other systems include those in which birds are free to roam outside confined areas but are shut in at night for protection from predators and weather. Chickens on pasture will forage for plants and insects to obtain up to 20 percent of their total food intake; the rest is a grain/soybean mix.

Eggs

Chickens that produce eggs ("layers") can be handled in the same way as broilers. Joel Salatin, a Virginia farmer whose diversified operation integrates the production of many animal and vegetable crops, has popularized the "eggmobile" in which a layer house is mounted on a trailer hitch. The house is moved every day through a pasture of at least 50 acres following grazing cattle, and the chickens eat the grubs and other insects in the cow manure. The birds are kept in the house only at night (Salatin 1996).

Another system suitable for mild climates is "colony" production, in which many small houses share a common nest house and feed area. The houses are designed to remain open at night; bird feeders and waterers located outside the house encourage the birds to forage (Fanatico 2002; SAN 2006). The feed for layers is similar to that for broilers: a mix of corn, oats, and soybeans, with vitamin and mineral supplements. Layers will forage more than broilers and can consume up to 30 percent of their diet from grasses, legumes, and insects (Salatin 1996).

FEASIBILITY OF PASTURE PRODUCTION

Pasture production is a small but growing sector of American agriculture. In general, farmers can earn more on a per-animal basis from pasture-raised foods than conventional production because of lower feed costs, use of family labor, and premium pricing. Animals tend to be healthier on pasture systems because they are not crowded and can engage in natural behaviors.

Research has shown that outdoor hog operations have 30 to 40 percent lower fixed costs and an overall 5 to 10 percent lower cost of production than confinement systems. In addition, farmers can realize more income from marginal land by using it for pasture production of pigs rather than crop production. Niche pork products of all kinds, including pasture-raised, are in high demand at premium prices. Enticed by these multiple benefits, many pork producers are raising hogs for the Niman Ranch Pork Company, which provides a set of production standards and pays a premium to pasture producers so their net return per animal is guaranteed to be higher than that of conventional producers.

Pig manure on pasture is easier to manage than in conventional systems because the herds are smaller and manure is dispersed over a large geographic area. Also, pasture production greatly decreases odor compared with CAFOs, so the neighbors' health and quality of life are not disturbed.

Similarly, consumers' willingness to pay more for pastured poultry makes this type of operation feasible for poultry farmers. Farmers experience a better cash flow from producing and selling pastured birds, and if farms are certified organic they can also earn a good return by selling their layers as roasting hens. Most pastured poultry is produced on diversified farms where poultry and eggs account for about one-third of the farm's income. Production of fewer than 5,000 birds on pasture will produce only supplementary income; many producers raise only 1,000 birds per year because of the time and inspection requirements. However, some fairly large pastured poultry operations produce up to 25,000 chickens per year. Farmers raising between 10,000 and 25,000 birds use more hired labor, but their net returns were similar to smaller operations after deducting the costs of feed, chicks, buildings, and hired labor (CIAS 2003).

Demand is so strong for pastured chicken and pork in part because consumers perceive the taste to be better. Taste panels show that breed differences are responsible for the taste of pastured poultry, not how the chickens are fed; professional taste tests of pork samples have had variable results, with meat from pigs raised outdoors tasting the same or more intense than meat from confined pigs (Gentry and McGlone 2003). One of the reasons for this potential difference in pork taste is that alternative producers use swine breeds that yield more marbling (that is, higher fat content). Many of the good-tasting breeds are heritage breeds that were dwindling in number because they do not do well in confinement, but pasture production is helping these breeds make a comeback. As pastured pork producers increase the fat content of their meat, it will tend to have more flavor than the conventionally raised lean pork found in the market.

PROBLEMS WITH CONVENTIONAL PRODUCTION

As described earlier, most production of hogs, chickens, and eggs in the United States is accomplished in systems that confine large numbers of animals and feed them a mixture of grains and legumes (primarily corn and soybeans). These systems offer producers the advantages of economies of scale (lower fixed costs), increased feed efficiency (weight gain per unit of feed), and the ability to raise animals year-round.[3] However, the costs of these systems to society include water and air pollution, soil contamination, health problems and safety hazards for farm workers, health problems for animals, health risks for the communities in which confinement facilities are located, and health problems for consumers.

Problems from Manure

Most of the environmental and public and animal health damage resulting from conventional animal production is due to manure. In 1997 livestock and poultry production generated an estimated 1.1 billion tons of manure—six times the waste generated by humans in the United States (EPA 2002). What's worse, the siting of CAFOs has concentrated enormous quantities of waste in particular geographic regions and states.

Manure must be stored and used in acceptable ways. It can be safely applied to fields as fertilizer if treated appropriately and applied in amounts the soil can absorb, but the amounts applied often surpass the absorptive capacity of the land surrounding the confinement houses, especially in the Southeast, and the manure ends up in surface and groundwater (Ribaudo 2003). Leaks or overflows of manure lagoons into waterways and groundwater can contaminate:

- wells (with nitrates)
- water supplies (with pathogens such as *Cryptosporidium* and *Salmonella* that can cause health problems in humans and animals)
- fields (with heavy metals, pathogens, and antibiotics)
- waterways (with nutrients such as nitrogen, phosphorus, and potassium that cause eutrophication—the death of plant material due to a loss of oxygen—and the impairment of aquatic ecosystems, leading to decreased recreational use by swimmers, boaters, and anglers)

Huge amounts of hog or chicken manure also cause significant air pollution, as emissions are spread by the exhaust fans and vents in large confinement houses. Poultry houses are a bigger source of emissions than hog houses, especially the human toxin ammonia that causes nose and eye irritation and respiratory problems. The levels of this gas inside poultry houses and in nearby communities regularly exceed safety thresholds, thereby affecting the health of farm workers and residents. Volatilized ammonia is also deposited in bodies of water, causing eutrophication.[4]

Hydrogen sulfide, another gas produced during the decomposition of manure, causes nausea and flu-like symptoms and can affect oxygen uptake in animals and humans. Hog and poultry workers, especially the former, are exposed to both ammonia and hydrogen sulfide inside confinement houses, along with dust composed of dander, dried manure, insects, bacteria, and other hazardous compounds. Hog facility workers have been shown to suffer from decreased lung capacity and asthma, bronchitis, and other acute and chronic respiratory conditions (Halverson 2000).

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[3] Although CAFOs have increased economic efficiency, inflation-adjusted retail prices have remained the same for pork and declined for chicken (Ward 2006).
[4] Volatilized ammonia takes the form of fine particles that can travel up to 250 miles (Sustainable Table 2004).

Problems from Grain Production

In 2004 the hog industry alone fed more than one billion bushels of corn to swine. Growing this corn causes environmental problems including soil erosion, pesticide contamination of both water and air, and nitrogen runoff from fertilizers used on fields.

As described in our earlier report, *Greener Pastures*, corn production requires very high amounts of fertilizers and herbicides (Clancy 2006). Excess fertilizer runs into waterways, herbicides enter groundwater and become a health hazard, and irrigation water depletes aquifers. Soybean production is less destructive than corn because it requires less fertilizer, but because soybeans are susceptible to a variety of pests and diseases (including newly arrived pests that have the potential to dramatically reduce yields), soybean production does routinely require the heavy use of pesticides.

Animal Welfare Problems

Because hogs raised in confinement are permanently confined, denied bedding, and often crowded, they are prone to tail biting, foot pad lesions, leg problems, and respiratory diseases. Sows spend 15 weeks confined in narrow gestation crates unable to even turn around. Chickens are also crowded and never see natural light. Feed is withheld from layer hens to trigger molting.

Problems for Nearby Communities

Most of the early research on human exposure to animal production hazards focused on CAFO workers and producers. With the growth in very large CAFOs, people living in communities near these facilities are also exposed to airborne and waterborne risks. Although it is difficult to prove cause and effect, research conducted over the last decade provides evidence that people living close to swine CAFOs in different parts of the country experience more diarrheal and respiratory disease than the general populace. People living near CAFOs also report more negative moods resulting from exposure to odors—enough that public health experts have expressed concern for the long-term mental health of people in these communities.

Furthermore, people living near CAFOs can also be affected financially. By discouraging many people from opening their windows or spending time outside, CAFO pollution reduces the value of land and homes, and precludes economic development (Cole, Todd, and Wing 2000).

Problems from Substances Given to Animals

To compensate for the stress of crowded conditions and shorten the time to market, CAFO operators feed hogs and chickens substances including arsenic-based compounds and antibiotics that promote growth and prevent infection.

ARSENIC. Arsenic-containing feed supplements are routinely given to broiler chickens[5] to promote growth and prevent parasitic infections. Although these supplements use the organic[6] form of arsenic, which is not a health hazard, data indicate that it is converted into inorganic arsenic within the bird. Inorganic forms of arsenic are human carcinogens and have also been

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[5] Arsenic is prohibited in the feed of layer chickens.
[6] "Organic" refers to the combination of arsenic with carbon molecules.

associated with increased risk of heart disease and neurological effects. As a result, the FDA sets tolerance limits for arsenic residues in food.[7]

Ninety percent of the arsenic ingested by chickens is excreted in manure, much of it in inorganic form. When poultry litter and manure are used by organic or conventional producers as fertilizer, the arsenic, which is an element and cannot be destroyed, can accumulate in soils, damaging plants when the levels become too high. When arsenic is not bound to the soil and litter piles are not protected from rain, arsenic dissolves and ends up in ground and surface water (Bellows 2005). The levels on fields can be high enough that if animal wastes were classified by the Environmental Protection Agency (EPA) as hazardous under the Resource Conservation and Recovery Act, land disposal of chicken litter would be prohibited based solely on the leachable arsenic concentration that exceeds the standard (Nachman et al. 2005).

Several recent reports suggest that 10 to 25 percent of the arsenic fed to chickens ends up in chicken meat (Bellows 2005; Wallinga 2006). Using research conducted by a producer of arsenic compounds, Lasky et al. (2004) translated the amounts of organic and inorganic arsenic in chicken livers (as recorded by the USDA National Residue Program) into the amounts likely to be in chicken muscle meat. The study determined that people eating an average amount of chicken would ingest approximately one to five micrograms of inorganic arsenic per day; at the high end of chicken consumption, people would ingest 21 to 31 micrograms of inorganic arsenic per day—what the authors call "a sizeable proportion of the tolerable daily intake" (two micrograms per kilogram of body weight per day).

In 2005 *Consumer Reports* analyzed 116 samples of conventional and organic chicken sold in U.S. stores and found no detectable arsenic in muscle samples (Consumer Reports 2005). In April 2006 the Institute for Agriculture and Trade Policy (IATP) reported that 55 percent of a small sample of uncooked chicken products in Minnesota and California supermarkets contained arsenic (Wallinga 2006). Although all samples of some of the poultry brands had no detectable arsenic, IATP also tested chicken nuggets and other products served at fast-food outlets, and found detectable levels of arsenic in every sample. Although all the levels detected in these studies were acceptable according to federal standards for arsenic residues in food, the authors of both studies questioned the continued use of arsenic, stating that it does not appear to be necessary to produce competitively priced meat products.

ANTIBIOTICS. Antibiotics are fed to pigs, chickens, cattle, and fish to promote growth and prevent disease that can occur when animals are crowded together in small spaces (Durham 2005). The constant feeding of antibiotics to animals eventually leads to the development of antibiotic-resistant bacteria that can be spread to humans through food, water, and animal contact. Once in a person's gastrointestinal tract, these bacteria can proliferate if the person is given antibiotics to which the bacteria are resistant.

UCS estimated that in the late 1990s about 10 million pounds of antibiotic drugs were fed to hogs for purposes other than the treatment of disease, and about two million pounds to poultry. Almost all of these drugs fed to swine are considered vital tools in the treatment of human

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[7] The Environmental Protection Agency (EPA) regulates arsenic levels in drinking water, and the USDA monitors arsenic levels in food animals.

diseases; about 25 percent of the antibiotics used in poultry production are also used to treat human diseases (Mellon, Benbrook, and Benbrook 2001).

BENEFITS OF PASTURE PRODUCTION

Environmental Benefits

Raising more hogs, chickens, and eggs on pasture rather than in CAFOs would reduce the adverse environmental effects of food animal production. Waterways and fields would be less polluted, fish and other aquatic organisms would face fewer hazards, and air emissions would decrease.

In addition, animals in well-managed pasture systems could actually have positive effects on the environment. Pasture systems for swine, chickens, and eggs are often integrated with other operations on farms that produce both crops and livestock. Such diversified farms support a greater range of plants, soil microbes, and wildlife, reduce the external inputs needed (for example, fertilizer, water, feed), and save money, energy, and other environmental resources through the re-use of their own products (for example, feeding vegetable trimmings to chickens, using bedding as compost).

Well-managed pasture can greatly improve soil quality, which in turn improves the quality of pasture, reduces water runoff, and increases yields. For example, in the system used by pork producers who contract with Niman Ranch Pork Company (see p. 13), animals must be raised on pasture, liquid waste management systems are prohibited, and manure is handled as a solid (either spread on fields or composted).

Animal Health Benefits

Pigs on pasture have the freedom to move around and engage in natural behaviors, and as a result show fewer indications of stress. They have many fewer respiratory diseases and foot and leg problems. Natural bedding such as straw keeps animals cleaner and warmer.

Pastured poultry growers must provide conditions that protect chickens from predators as well as wind, rain, and too much sun. If those conditions are met, the chickens have a low mortality rate and exhibit natural behaviors such as flocking. As mentioned above, chickens (and eggs) are often produced on diversified farms that raise other animals on pasture; these chickens serve as miniature manure spreaders and eat the insects that bother cattle (SAN 2006). It is important, however, that chicken houses be moved frequently so disease organisms do not build up in the soil.

Human Health Benefits

PUBLIC HEALTH. Pasture operations create much less pressure to use antibiotics and arsenic-based compounds for disease prevention and growth promotion. Reducing antibiotic use lessens antibiotic resistance and decreases the likelihood that human drugs will lose their efficacy. Eliminating arsenic in animal production reduces the burden of this toxic compound on the environment and the human body.

NUTRITION. As described in detail in *Greener Pastures*, the scientific community is quite interested in the health benefits of omega-3 fatty acids (Clancy 2006). The three such fatty acids that receive the greatest attention are **alpha-linolenic acid** (**ALA**), **eicosapentaenoic acid** (**EPA**), and **docosahexaenoic acid** (**DHA**).

Strong evidence from the scientific literature indicates that the fatty acids EPA and DHA, which are found in fish, have beneficial health effects. When consumed in adequate amounts, they appear to 1) reduce the risk of heart disease as well as the risk of sudden death related to coronary heart disease, 2) reduce triglyceride levels in patients with Type II diabetes, and 3) have beneficial effects on inflammatory and immune reactions. ALA, which must be provided by the diet because it cannot be synthesized by humans, reduces the risk of heart disease and the incidence of fatal heart attacks, but the effects are not as strong as with EPA/DHA.

Linoleic acid, an omega-6 fatty acid, helps prevent heart disease when consumed at appropriate levels in the diet, but at higher levels may have adverse effects on heart health and other functions. The current ratio of omega-6 to omega-3 fatty acids in the U.S. diet is high (10:1); nutritionists believe it should be closer to 1:1 or 2:1.

Milk and meat from pasture-fed cows have higher levels of the omega-3 fatty acids compared with those fed conventionally, although the total amounts are relatively small (Clancy 2006). Cattle can obtain virtually all of their nutrients from pasture because they have four stomachs, one of which (the rumen) is populated with microbes that digest cellulose and metabolize the fats, carbohydrates, and proteins that grasses and legumes contain. As mentioned earlier, swine and poultry are monogastric (that is, have only one stomach) and can utilize forage in their diets but not subsist on it entirely. At most, adult swine can consume up to 50 percent of their diet as forage and roots; poultry diets may be composed of 20 to 30 percent pasture and insects. Because pigs and chickens cannot consume as much cellulosic material as cattle, scientists do not expect substantially higher levels of beneficial fatty acids in meat from pastured swine or poultry.

The meat and eggs of monogastric animals reflect the quality of the pasture they are offered. Pasture-raised poultry might be expected to have higher levels of ALA, as many grasses (Cava et al. 2000; Lopez-Bote 1998; Muriel et al. 2002) and greens, especially purslane (Simopoulos and Salem 1989), are rich in omega-3 fatty acids. In addition, chickens in the outdoors eat seeds, insects, and small animals, all of which provide some omega-3 fatty acids (Vives et al. 1979).

Importantly, the fatty acid composition of eggs and poultry meat can be easily influenced by manipulating the fats, particularly the unsaturated fats, in the non-pasture component of the diet (Cruickshank 1934). Adding fish meal or fish oil to chicken feed significantly increases EPA and DHA levels in egg yolks and breast meat (Hulan et al. 1989, 1988). Similarly, according to Wood et al. (1999), "the fatty acid composition of muscle and fat tissues in the pig can be greatly modified by incorporating the appropriate oil source in the feed, since dietary fatty acids are absorbed intact in the small intestine and then incorporated into tissue lipids."

Egg producers can also modify the fatty acid profile in eggs by adding various fat sources to the diets of layer hens, such as certain strains of algae that increase DHA levels. Several studies have shown that adding flaxseed, a rich source of ALA, to chicken feed increases the ALA in egg yolks (Van Elswyk 1997). Cherian and Sim (1991) also found an increase in DHA from flax-enriched feed.

Research on Fatty Acid Levels in Pasture-Raised Swine, Poultry, and Eggs

UCS and Garry Auld, professor of food science and human nutrition at Colorado State University, conducted an extensive review of the literature on pasture-raised or free-range pork, poultry, and eggs, and not surprisingly found only a few studies in which animals had been fed "on pasture" at a level high enough to affect fat composition. Those findings are summarized below; the appendix contains details about the research studies.

STUDIES COMPARING PASTURE-RAISED TO CONVENTIONAL PRODUCTION. One study found a significant difference in the DHA levels of eggs from pasture-raised and conventionally raised chickens, but more research is needed to confirm whether this is generally the case (Karsten et al. 2003).[8]

Research has shown that meat from pasture-raised chickens is generally a little leaner than that from conventionally produced animals, and has equal or slightly higher levels of ALA that translate into small amounts per serving. The amounts of EPA/DHA in pasture-raised chickens from three studies are similar or somewhat higher than the amounts in conventionally raised chickens if calculated on a per-serving basis. Using total fat values that seem reasonable for pasture-raised chicken breast meat (two percent), we calculated the amounts of EPA/DHA and found them to be fairly low—about five percent of the amount normally consumed by the U.S. population and only one to three percent of the amount various scientific bodies have suggested might be an adequate intake.

There have not been enough studies on U.S. pasture-produced swine to draw conclusions about nutrient levels.

MANIPULATION OF DIETS TO INCREASE LEVELS OF BENEFICIAL FATTY ACIDS. Producers are manipulating feed components to increase the levels of beneficial fatty acids in eggs, chicken, and pork. Feeding the appropriate amount of ALA-rich flaxseed can produce levels of omega-3 fatty acids twice as high (350 milligrams[9] per egg or higher) as eggs from ordinary layers, with no change in total fat or cholesterol (Canadian Egg Marketing Agency 2006). Omega-3-enhanced broiler chickens resulting from flaxseed feeding are under development.

Pork producers are also feeding flaxseed or other oilseeds such as canola to increase omega-3 levels. For example, a Canadian pork product from Prairie Orchard Farms has 400 milligrams of omega-3 fatty acids per serving as a result of feeding hogs a mix of flaxseed and vitamins. The company has received permission to label the pork as a source of omega-3s, both in Canada (Hisey 2006) and, as of June 2006, the United States (The Pig Site 2006). Of course, the highest

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[8] Although the actual amounts of ALA and DHA are similar in the eggs studied by Karsten and her colleagues, the amount of DHA is much higher than ALA compared with other sources of the fatty acid in the diet.

[9] Most is ALA; about 25 percent is DHA.

amounts of fatty acids will be found in the fattiest cuts, so bacon has five times more fatty acids than ham.

CHALLENGES FOR PASTURE-RAISED SWINE, CHICKEN, AND EGG PRODUCERS

Seasonality

As mentioned earlier, one of the many reasons confinement systems became standard practice is that pasture production is difficult in temperate regions during the winter months. Winter hog production can be done using hoop houses[10] but it is more costly than summer feeding (Hueth, Ibarburu, and Kliebenstein 2005). Laying chickens can also be kept in hoop houses with very deep bedding during cold weather. However, chickens are tropical animals and most pastured poultry operations do not produce in the winter; instead, producers market frozen products. On the other hand, some producers use seasonality as a positive attribute in their marketing.

Breeds

Pasture-raised hogs require traits such as hardiness in extreme climates, foraging ability, and good mothering skills (Kelsey 2003). Not surprisingly, the most common U.S. hog breeds, which have been bred for confinement, do not possess these traits. Work is being done to identify the traditional swine breeds best suited for pasture production in the United States and to set up breeding operations that will make these hogs available to farmers.

Cornish Cross chickens, the predominant breed produced in the United States, are favored for their rapid weight gain, excellent feed efficiency, and high meat quality under confinement conditions. But they are not good foragers, have weak legs, and suffer from health problems, so pasture producers are experimenting with other breeds including the Silver Cross, Cebe Red and Black, and Redbro. These breeds' slower growth compared with conventional chickens gives them a superior taste, but the longer feeding time requires more feed (Fanatico, Polson, and Born 2005), increasing the prices producers must charge.

Production without Antibiotics

Growing numbers of pastured poultry and swine are being produced without the use of antibiotics for routine disease prevention and growth promotion, but some precautions are needed when producers stop using antibiotics. Experts advise hog producers to keep herds closed (that is, free of animals brought in from the outside), which will minimize exposure to disease organisms. In addition, later weaning time will reduce stress and allow piglets to develop greater immunity. Various substances can be fed to improve growth (for example, enzymes, herbs, possibly probiotics), and research interest in natural growth promotants is high (Shurson et al. 2002).

[10] A hoop house is an inexpensive structure made of arched metal frames secured to posts and sidewalls, then covered with a tarp. The shelters have open ends and are used to house poultry or swine or store equipment (Gegner 2004).

Chicken producers keep flocks at low stocking densities to reduce stress, vaccinate for certain diseases, pay careful attention to breeding stock, and keep conditions as dry as possible (Watkins and Jones 2002). For both hogs and chickens, visitor access (including wild animals) should be restricted—sanitation remains a high priority especially for poultry, and balanced, high-quality diets are a must.

Attentiveness

Good management is essential to the success of pasture production. As the head of the Iowa-based Pork Niche Marketing Group says, “You’re basically substituting husbandry for technology” (Arnot and Gauldin 2006). For poultry producers in particular, housing animals on pasture calls for a great deal of attentiveness; they must be always on the alert that they are not unintentionally abusing or neglecting birds and be prepared for unexpected weather that can result in high mortality. Consequently, pastured poultry producers must stay close to home during the growing season. And all pasture producers must manage manure carefully to minimize disease, protect the grass from damage, and not overapply manure to fields.

Processing and Inspection

PORK. Because most slaughterhouses will not accept small numbers of hogs, producers of niche pork products often pool hogs to reach optimal numbers. Others form cooperatives to build new slaughtering plants; many producers seek multiple grants and loans to amass the substantial capital needed to pursue this strategy.

Small processors also face a challenge when it comes to inspection. All meat sold in the United States must be inspected by a state or federal inspector (except for animals slaughtered solely for the use of the producer and his/her family and guests). USDA-inspected meat can be sold in all states, but meat inspected by a state facility can only be sold in that state. Not surprisingly, the smaller plants willing to slaughter smaller numbers of hogs are less likely to be served by a USDA inspector. However, there are several legislative initiatives currently aimed at increasing the access of small and mid-sized producers to USDA-inspected plants, or allowing meat from state-inspected plants to be sold in other states.

CHICKENS. Chickens may be slaughtered either on or off the farm. On-farm processing saves producers transport time and the costs associated with paying an offsite processor. However, on-farm processing limits product quantities and sales because of labor needs (Wallace 2000).

Off-farm processing is more efficient for a larger number of birds, and bigger markets exist for birds slaughtered in larger facilities that are state- or USDA-inspected, but the costs are higher. In several regions of the country, mobile poultry-processing units that can be rented or co-owned save farmers significant amounts of money in processing smaller numbers of birds.

Small-scale poultry processors enjoy several exemptions from federal inspection requirements. For one, a producer who annually slaughters no more than 1,000 birds raised and sold on his/her farm, and does not distribute outside the state, is exempt from inspection. Federal inspection also does not apply to producers who raise and process 20,000 or fewer birds per year if they do not slaughter the birds at a facility used by any other person, and if the birds are “sound and healthy,” processed under sanitary conditions, labeled appropriately, and distributed only inside the state. About 25 states have poultry inspection programs that are required by federal law to be "at least as rigorous" as the federal inspection program, but state-inspected birds can only be sold in that state (Hipp 2001).

EGGS. The minimal regulations for producers selling eggs to consumers are mainly focused on cleanliness and quality. Selling to institutions requires producers to candle,[11] grade, and size eggs; purchase an egg stamp assuring compliance with regulations; and meet storage temperature requirements.

RESEARCH NEEDS

Economic Incentives

Despite the wealth of studies and anecdotes suggesting that the demand for pasture-raised animal products is currently higher than the supply, formal economic studies are needed to substantiate the claim. By predicting future demand for pasture-raised pork, chicken, and eggs, and assessing the number of animals and farms needed to meet that demand, such studies could give many producers the resolve to move from conventional to pasture production. Also, given the competing demands on land for animals, food crops, and energy crops, policy makers want to know how much land is needed to produce different percentages of the domestic meat supply on pasture.

Environmental, Human, and Animal Health

Research comparing confined systems with pastured systems in terms of environmental and health consequences and externalized costs would help focus the attention of consumers and policy makers on the toll of conventional animal production. Parameters that should be studied include disparities in surface and groundwater quality, air quality, manure disposal, soil fertility, animal health, worker health, and community health.

Production Methods

To assist producers considering an alternative system, more research is needed on:

- which breeds will produce the best meat or eggs in different climates
- ways to increase the number of animals produced on pasture without compromising the environment or animal health
- the best pasture production systems for different climates
- ways to produce pasture-raised animals without antibiotics
- safe compounds that can replace the current generation of growth promotants

POLICY NEEDS

Policy changes in key areas could encourage growth in the number of producers and consumers needed to expand the market for pastured animal products.

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[11] Candling means examining an egg for freshness by holding it before a bright light.

- Clearly worded product labels backed by strong standards are needed to help producers and consumers interested in innovative animal production find each other in the marketplace. Labels related to antibiotics and hormones, feeds, pasture requirements, and outdoor access requirements for hogs, chickens, and eggs are important to both the pastured pork and pastured poultry industries.

- USDA programs including Cooperative Extension and Appropriate Technology Transfer for Rural Areas should offer more technical assistance on production methods along with assistance in accessing markets and financial resources.

- Federal and state meat inspection issues should be resolved in collaboration with consumer groups concerned about the weakening of standards for small-scale slaughtering plants.

- Economic development agencies should recognize the strong demand for pastured products and provide more financing for production, slaughtering, and processing operations.

CONCLUSIONS

Pastured-raised swine and poultry operations offer environmental, economic, public health, and animal welfare benefits, as well as better-tasting products.

Most of the environmental benefits of pasture systems come from dispersing manure over wide areas. These benefits include less contamination of groundwater with nitrates, pathogens, heavy metals, and antibiotics, and less eutrophication of waterways that kills fish and plants. In addition, the air near pastured animal operations is cleaner than that near CAFOs. Pasture systems also require less grain production, reducing problems such as soil erosion, pesticide residues in food and water, and nitrogen runoff. In fact, soil quality can be improved with well-managed pastures.

Farmers benefit from lower costs, lower capital needs, the ability to produce in season, less exposure to airborne emissions, and few objections from neighbors regarding odors and pollution. The current strong demand for products from pastured animals supports premium pricing.

Communities near pasture production systems are not threatened by ammonia, hydrogen sulfide, fine manure particulates in the air, or obnoxious, stress-inducing odors. Public health is improved by slowing the spread of antibiotic-resistant bacteria (which arise partly due to the overuse of antibiotics in crowded animal facilities). And the animals themselves are healthier on pasture; they suffer less stress because they are able to engage in natural behaviors, and they experience fewer respiratory diseases and foot and leg problems.

Not unexpectedly, there are few demonstrated nutrition benefits because pigs and chickens cannot consume large amounts of grass and legumes. Eggs from chickens fed on legume/grass pastures may have fairly high amounts of one of the omega-3 fatty acids (DHA), but more research is needed to confirm this possibility. Research suggests that other differences between total fat levels or levels of beneficial fatty acids are minor.

In the end, we believe that pasture production of animals—beef and dairy cattle as well as hogs and poultry—is the optimal way not only to satisfy consumers' desire for tasty, environmentally friendly food, but also to change the agricultural landscape in a positive way.

APPENDIX

Studies of Fatty Acid Levels in Pasture-Raised Swine, Poultry, and Eggs

One challenge in the literature concerning the nutrient levels of pasture-raised products is authors' tendency to use different definitions or understandings of the terms "free-range" and "pasture." In most studies, these terms are equated with being outdoors, that is, with activity and exposure to the elements, but not with any particular alteration of the normal diet of feed concentrate (Bee, Guex, and Herzog 2004; Gentry et al. 2002a, 2002b; Sather et al. 1997) or any actual consumption of pasture.

In addition, researchers do not typically report the net amount or proportion of pasture forage in the total diet or the specific types of grasses, nuts, grains, plants, and grubs/insects consumed. A number of studies describe (and often analyze) the nutrient composition of the pasture, but few assess the animals' actual intake. For example, "pasture" in studies we consulted could mean grain-based feed with access to additional forage of sown peas, oats, and barley (Nilzen et al. 2001); green forage beets and turnips (Dworshak et al. 1994); grass (Cava et al. 2002; Estevez, Morcuende, and Cava 2003); or unidentified plants (Olsson et al. 2003).

Other confounding variables are breed, gender, and muscle type. For example, the Yorkshire hog breed is leaner than the Duroc (Enfalt et al. 1996), but the Duroc breed has more saturated and monounsaturated fat and fewer polyunsaturated fatty acids (PUFA) than the Landrace (Cameron and Enser 1991). In general, at equal weights, males (boars) will be leaner than females (gilts), which are leaner than castrated males (barrows) (Enser 1991; Nurnberg, Wegner, and Ender 1998). Both the amount and type of fat varies; PUFA and linoleic acid are highest in boars and lowest in barrows. Older pigs tend to have greater proportions of saturated fat but less unsaturated fat (Nurnberg, Wegner, and Ender 1998). In studies of Iberian pigs raised either indoors or outdoors on pasture and acorns, different muscles yielded different fatty acid profiles (Muriel et al. 2002).

We surveyed about 25 studies in which researchers measured total fat (or leanness), the relative and actual amounts of omega-3 fatty acids (ALA, EPA, DHA), and the omega-6/omega-3 ratio in swine, chickens, and eggs. Most articles do not report on all of these variables, particularly the total amount of intramuscular fat in meat or the total fat in an egg. This makes it impossible to calculate the specific amounts of fat or fatty acids on a per-serving basis. For the few studies that did report total fat, we were able to calculate the amount per serving.

SWINE. A number of studies in Spain using Iberian pigs or Iberian crossbreeds compare free-range conditions (access to only acorns and pasture) with confined conditions (feed concentrate). Given the high fat and oleic acid (monounsaturated fat) content of acorns, it may not be possible to apply these results generally to more conventional grass or vegetable-based pastures. They do, however, demonstrate the influence of dietary changes. In general, the studies find that the ALA content in free-range pig meat is equal to or greater than that in swine raised indoors on feed. The omega-6/omega-3 ratio tended to be lower in the free-range Iberian pigs (Muriel et al. 2002; Rey, Lopez-Bote, and Arias 1997; Tejeda et al. 2002) but was still above 10:1.

In the few other studies reporting on pasture-raised pigs, the primary difference in growing conditions was not diet but activity and exposure to the elements. The same concentrate was fed both indoors and outdoors, but outdoor animals' diets were supplemented with some non-measured (and often non-identified) pasture forage. The findings in general show that free-range meats have lower omega-6/omega-3 ratios than conventionally fed hogs, although the ratio will still be around 10:1 at best—the same as the typical U.S. diet. Free-range meat has equal or higher levels of ALA than conventionally fed hogs; EPA and DHA were not reported frequently enough to draw conclusions. Actual levels of total fat were rarely reported. Free-range pigs, other than those fed on acorns or chestnuts, were generally a little leaner.

CHICKENS. Few studies have looked at the nutritional aspects of pasture-raised chicken. Chickens raised outdoors with at least some exposure to grass or green forage were leaner (Castellini, Mugnai, and Dal Bosco 2002; Latif et al. 1996) than conventionally raised chickens, but poultry meat is very lean in general (that is, most of the fat on chickens is located beneath the skin, not intramuscularly).

Breast meat from pasture-raised chickens does have higher ALA than conventionally raised chickens (Castellini, Mugnai, and Dal Bosco 2002; Latif et al. 1998; Polak et al. 2002; Zlender et al. 2000). EPA/DHA may be similar (Zlender et al. 2000) or higher in outdoor birds (Castellini, Mugnai, and Dal Bosco 2002; Polak et al. 2002). When comparing omega-6/omega-3 ratios, outdoor birds had ratios that were equal (Zlender et al. 2000), lower (Polak et al. 2002), or higher (Castellini, Mugnai, and Dal Bosco 2002).

EGGS. In studies where forage or insect consumption was not measured, exposure to pasture appears to enhance the amount of DHA in eggs (EPA does not change much), though the increases were not always statistically significant (Guardiola et al. 1994; Lopez-Bote et al. 1998; Simopoulos and Salem 1989). Similarly, the proportion of ALA in yolks was generally higher in eggs from pasture-raised birds than those from conventionally raised birds (Lopez-Bote et al. 1998; Simopoulos and Salem 1989), though Guardiola et al. (1994) found higher levels of ALA in eggs from birds with the least exposure to pasture (the type of pasture was not described).

An unpublished study conducted in the United States (Karsten et al. 2003) compared the content of omega-3 fatty acids (ALA, EPA, and DHA) in egg yolks from layer chickens raised on three different forages plus feed with those from chickens raised indoors on feed only. The study found higher omega-3 levels in the yolks of chickens fed legume pastures (clover or alfalfa plus grass) than in those of chickens fed only grass. This result is likely due to the fact that legume plants have over 30 percent more omega-3 fat than grasses. Fortunately, it was possible to calculate the milligrams per serving of these fatty acids because the total fat content of the eggs had been analyzed and the fat content of the yolks from all the eggs was the same (Karsten 2006). The average amount of ALA was 87 milligrams/yolk in the pastured eggs[12] versus 22 milligrams/yolk in the eggs from caged birds. The average amount of DHA in the eggs from pasture-fed chickens was 92 milligrams/yolk versus 43 milligrams/yolk in the eggs from caged chickens.

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[12] The amounts of ALA and DHA were averaged among the chickens raised on grass and grass plus alfalfa or clover at two different times.

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