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Is There a Place for Meat on the Menu? — Challenges in Interpreting the Research
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Questions regarding the healthfulness of meat—more specifically, beef—draw from a wide range of disciplines, including philosophy, ecology, medicine, and public health. For many different reasons, consumers and even health care professionals increasingly debate the merits of a plant-based diet vs one featuring more animal protein and fat.

Dietitians widely support diets rich in whole plant foods, mostly because plant-based diets fulfill a wide variety of nutritional requirements. Rich in vitamins, minerals, antioxidants, and fiber, plant foods earn their place in a healthful diet. And multiple studies support the role of vegetarian and vegan diets in promoting health and reducing disease risk.[1-3]

As seen in Image 1, the rising popularity of farmers markets and school gardens place a greater emphasis on a plant-based diet. Meatless Monday and other popular efforts to reduce meat consumption appeal to consumers concerned about the purported health and environmental consequences of eating meat. Consequently, eating meat and other animal products has become far more controversial.

Image 1: Mar Vista Farmers' Market, April 2013.

A quick perusal of the Internet illustrates the dilemma for most consumers. For example, on August 22, 2013, ***The Medical Daily*** blog posted the article "How Red Meat Affects Your Health: 7 Reasons to Avoid Beef." ***Authority Nutrition*** countered with "7 Evidence-Based Health Reasons to Eat Meat." It's no wonder opinions regarding meat consumption have become more polarized and confrontational.

This continuing education course reviews questions regarding the healthfulness of meat—more specifically, beef—that stem from philosophical, environmental, medical, and public health concerns.

The Dietary Guidelines

The US Department of Health and Human Services Dietary Guidelines for Americans, 2010 recommend eating a plant-based diet, even though the guidelines also state that there's no single correct dietary pattern.[4] In addition, the guidelines encourage consumers to eat less fat and cholesterol.[4]

The science behind these recommendations falls under increasing scrutiny in the scientific literature, especially because the stakes are so high. Poor metabolic health coupled with an aging population points to an increased risk of chronic disease and associated financial costs.[5]

Recommendations that shape food-related policy for decades to come should be based on strong evidence. However, summary conclusions from the 2010 Dietary Guidelines regarding meat and other animal products appear relatively weak, such as the following:

• Limited evidence from prospective cohort studies do not consistently associate intake of animal protein products with cardiovascular disease.
• Moderate evidence shows no clear association between the intake of animal protein and blood pressure.
• Limited and inconsistent evidence from prospective cohort studies suggests that intake of animal protein products—mainly processed meats—may have a link with type 2 diabetes.[6]
• Limited evidence from cohort studies shows there's no association between protein intake and breast cancer.
• Limited evidence shows that animal products are associated with prostate cancer.

The 2010 Dietary Guidelines recommendation that consumers eat a plant-based diet often is interpreted as a recommendation to eat a vegan or vegetarian diet, or at least to eat less red meat. Current recommendations from the Scientific Report of the 2015 Dietary Guidelines Advisory Committee (DGAC) go a step further and definitively recommend a diet lower in red and processed red meat.[7]

A closer look at the research and the reasoning behind these recommendations is warranted and is the specific aim of this continuing education course.

A Closer Look at the Evidence

Researchers have suggested a link between red meat consumption and cardiovascular disease for more than 50 years. Since 1978, the Dietary Guidelines have advised consumers to eat less saturated fat and cholesterol, yet the guidelines' current dietary recommendations contain little direct evidence from randomly controlled trials.[8] The evidence is primarily derived from population

studies. Epidemiological studies also link meat consumption to an increased risk of cancer, diabetes, and obesity.

To make matters more complicated, meat consumption often is defined as a moral issue, filtered through the lens of social, environmental, animal welfare, and peace and contentment issues.[9] Personal values can influence beliefs and distort public perception regarding meat's healthfulness.

Following is a review of evidence that links meat with the following five areas of concern: all- cause -mortality, cardiovascular disease, diabetes, cancer, and obesity as well as a discussion of related concerns, including the impact of eating meat on the environment and the production of feed crops.

Meat Consumption and All-Cause Mortality

Many cohort studies link red meat consumption and all-cause mortality. In 2009, ***JAMA*** published a prospective study by Sinha linking the highest red meat consumption with a modest increase of all-cause mortality, cancer, and cardiovascular disease. The National Institutes of Health-American Association of Retired Persons cohort reported positive associations of both red and processed meat with the risk of all-cause mortality.[10] In the Nurses' Health Study (NHS) and Health Professionals' Follow-up Study (HPFS), high red meat intake was linked to higher all-cause mortality.[10]

Several studies link vegan and/or vegetarian diets to a reduced risk of all-cause mortality as well as a reduced risk of cardiovascular disease, stroke, type 2 diabetes, certain cancers, and obesity.[1-3] However, in the European Prospective Investigation into Cancer and Nutrition (EPIC), the researchers didn't find increased all-cause mortality among nonvegetarians compared with vegetarians.[10]

In the EPIC cohort, the lowest relative risk of all-cause mortality was observed with low-to-moderate meat eaters, and the authors suggested the possibility that other lifestyle factors influence disease risk. They noted that men and women who ate the most red or processed meat intake generally consumed fewer fruits and vegetables and were more likely to be former or current smokers and less likely to have a college degree.[10]

Studies also often link processed meat with a higher risk of all-cause mortality. The authors of the EPIC study investigated subgroups of their cohort to take a closer look at this relationship. A greater risk of all-cause mortality was found in current and previous smokers who consumed processed meats, but no association was found in people who had never smoked.[10]

Red and processed meat intake has been positively associated with cardiovascular disease, type 2 diabetes, and certain cancers in epidemiological studies. However, individuals in the highest quintile of meat intake were also more likely to have higher BMIs, increased smoking rates, and sedentary lifestyles, among other unhealthful lifestyle behaviors.[2]

Cardiovascular Disease

Research has long suggested a link between the risk of cardiovascular disease and excessive intake of saturated fat and cholesterol, though a recent meta-analysis suggests that this link may be less straightforward than originally thought.[11] McEvoy and colleagues state, "It is unclear

whether established health benefits for vegetarians are attributable to the absence of meat in the diet, the increased consumption of particular food components, the pattern of foods eaten within the vegetarian diet, or other healthy lifestyle components often associated with vegetarianism."[2]

A review by Micha and colleagues noted that this group found no randomly controlled trials that evaluated the effects of red, processed, or total meat consumption on cardiovascular disease or diabetes. The meta-analysis of observational studies found no significant association between red meat intake and cardiovascular disease, but processed meat consumption was associated with a 42% higher risk.[12]

The authors noted that red and processed meat consumption was "positively associated with less physical activity; multivitamin use; prevalence of high cholesterol; glycemic load; and intake of carbohydrate, fiber, and magnesium." The authors also noted that in this study, data regarding red meat consumption occasionally included comingled data from red and processed meat consumption, making it difficult to separate the role of red meat compared with that of more processed meats.[12]

Mente and coauthors also conducted a systematic search of prospective cohort studies or randomized clinical trials investigating diet and the risk of cardiovascular disease, finding that only the Mediterranean dietary pattern has been studied in a randomized controlled trial. Researchers found that using Bradford Hill criteria for causation provided a logical structure for assessing the relative strength of evidence and determining causality for an observed association. With that basis, strong evidence of causal relationship was found for protective factors, including intake of vegetables, nuts, and monounsaturated fatty acids; as well as for harmful factors, such as intake of trans fats, foods with high glycemic values, and dietary consumption identified as a Western dietary pattern. However, evidence of a positive association between cardiovascular disease and saturated fatty acid, polyunsaturated fatty acids, total fat, alpha-linolenic acid, meat, egg, and milk intake was considered modest or weak.[8]

Advice to eat less red meat typically stems from dietary recommendations to consume less total and saturated fat. Huth and Park present evidence that substituting carbohydrate with saturated fat increases both total and LDL cholesterol, but they noted that greater saturated fat intake also lowers triglycerides and increases HDL cholesterol.[11] The authors argue that the net total cholesterol to HDL ratio is a better overall predictor of coronary heart disease risk than either total or LDL cholesterol. It remains unchanged with additional saturated fat.

A meta-analysis by Siri-Taurino and colleagues found no significant evidence that dietary saturated fat is associated with an increased risk of coronary heart or cardiovascular disease.[13] Additionally, the authors suggested publication bias regarding the links between saturated fat and the risk of coronary heart disease, as studies with positive associations are received more favorably.

The 2015 DGAC report proposes eliminating cholesterol as a "nutrient of concern for overconsumption," but maintains recommendations to limit saturated fat.[7] In their comments to the DGAC, the Academy of Nutrition and Dietetics (the Academy) agrees with the action regarding cholesterol, but also recommends "deemphasizing" saturated fat as a nutrient of concern.[14]

The Academy states that most research linking saturated fat and risk of cardiovascular disease points to the impact of saturated fat on serum lipid values, but notes that "while the body of research linking saturated fat intake to the modulation of LDL and other circulating lipoprotein concentrations is significant, this evidence is essentially irrelevant to the question of the relationship between diet and risk for cardiovascular disease."[14]

Diabetes Risk

The literature on diabetes establishes an emphasis on lower-fat diets, with most advice complementing the 2010 Dietary Guidelines and American Heart Association recommendations. Death rates for adults with diabetes are two to four times higher than those for adults without diabetes, and the expanding study of cardio-metabolic disease underscores a common genesis for diabetes and cardiovascular disease.[15] The American Diabetes Association states, "A healthy diet is a way of eating that reduces risk for complications such as heart disease and stroke."[15] The typical low-fat diet recommends moderate lean protein intake close to 12% to 15% of total calories. Vegetarian diets are linked to reduced risk of diabetes as well.[1-3]

Results from the Diabetes Prevention Program (DPP) validate a role for lifestyle intervention in arresting the development of diabetes.[16] The dietary arm of the study specifies calorie and low-fat goals (fewer than 30% of total calories), and the lifestyle group achieved, on average, a 450-kcal reduction and a 6.6% decrease in percentage of calories from fat. Coaches employed for the study encouraged participants to adopt an individualized approach to support weight loss, meaning that as long as a participant continued to lose weight, there was no specific encouragement to reach designated dietary goals.[16]

The individualized nature of counseling in this study made it challenging to characterize the range of dietary protein, carbohydrate, and fat content despite the fact that the core curriculum used the Food Guide Pyramid to instruct participants on healthful eating. The lifestyle group achieved a 58% decrease in reduced incidence of diabetes despite the fact that only about 50% of participants reached weight-loss goals and 38% reached activity goals.[16]

"A Prospective Study of Red Meat Consumption and Type 2 Diabetes in Middle-Aged and Elderly Women" looked at data from the Women's Health Study. The abstract states that "our data indicate that higher consumption of total red meat, especially processed meats, may increase risk of developing type 2 diabetes in women." The authors state that their results are consistent with those of Health Professionals Follow-Up Study of male health professionals and the Nurses' Health Study II. However, concluding remarks clarify that "processed meat appeared entirely responsible for the elevated diabetes risk associated with total red meat in these two large cohort studies."[17]

The authors also noted that red meat consumers exhibited "higher BMI scores and were more likely to have a history of hypertension and family history of diabetes. Furthermore, total red meat intake was positively associated with greater intake of fatty acids [including trans fat], cholesterol, and protein but inversely associated with dietary carbohydrate, fiber, magnesium intakes, and glycemic load." In the statistical analysis, the authors adjusted for age, total calorie intake, BMI, smoking, alcohol intake, physical activity, and family history of diabetes.[17]

Gannon and colleagues challenged conventional dietary approaches in treating diabetes in two small studies by exploring the relative ratio of carbohydrate, protein, and fat in the diet and their effects on diabetic biomarkers. The first study, published in 2003, offered a carbohydrate/protein/fat ratio of 40:30:30, while the second study, published in 2004, investigated a 20:30:50 mix compared with a control diet following American Heart Association guidelines for the general public.[18,19]

The first study resulted in a moderate decrease in glycohemoglobin, primarily as a result of reduced postprandial glycemia.[18] In the second study, the more restricted carbohydrate protocol dramatically reduced the percentage of glycohemoglobin in people with type 2 diabetes without a significant change in serum lipids, except for a significant decrease in triglyceride concentration.[19]

These two studies don't detail which foods contributed to the higher protein content, but the authors noted that saturated fat was maintained at less than 10% of total calories. Participants returned to the study site every two to three days to pick up food and meet with a dietitian. A total of eight participants completed both the control and low-carbohydrate arms of the second trial. The authors suggested that the studies be considered a proof of concept effort since only men were studied over a short period of time (five weeks).[18,19]

In the meta-analysis by Micha and colleagues, the consumption of unprocessed red meat wasn't significantly associated with incident diabetes, but one serving per day of processed meat was associated with a 27% higher risk of diabetes.[12] The authors noted a 53% higher risk if looking only at studies conducted in the United States. However, more than one author suggested publication bias regarding studies that address the role of processed meat and saturated fat for both diabetes and cardiovascular disease.[8,13] In another paper, Micha and colleagues explained that publication bias would more likely identify harmful associations and would be unlikely to contribute to null associations.[12]

Cancer Risk

Several epidemiological studies associate red and processed meat intake with an increased incidence of colon cancer.[20] Typical areas of study included the type of meat consumed (red or processed), cooking method, quantity consumed, and individuals' genetic risk. In 2007, the World Cancer Research Fund reported on evidence linking red and processed meat consumption to the risk of colorectal cancer.[20] Red meat is also hypothesized to increase breast cancer risk.[21] In 2015, the International Agency for Research on Cancer (IARC), an arm of the World Health Organization responsible for identifying and evaluating the cause of cancer in humans, categorized processed meats as carcinogenic and red meat as probably carcinogenic.[22]

However, in a review of vegetarian diets, McEvoy and colleagues concluded there's limited and mixed evidence of a beneficial effect of vegetarianism in reducing the risk of cancer.[2] The authors reported vegetarians experiencing a significantly lower risk of breast cancer in the United Kingdom Women's Cohort study, while an Adventist study there showed no difference in breast cancer incidence between vegetarians and nonvegetarians.[2]

Among other researchers' statements regarding conflicting and inconsistent evidence,[3,5] McAfee and colleagues specifically claim that the elimination of red meat is "unlikely to be sufficient to reduce risk unless the overall balance of the diet is addressed."[20] Rohrmann and colleagues

stated that there was no statistically significant association between red meat consumption and cancer risk for participants and suggested that decreased mortality in vegetarians may have more to do with the sum total of healthful behaviors rather than the absence of meat in the diet.[10]

McAfee and coauthors noted additional inconsistencies in research linking red-meat consumption and colon cancer. For example, meat consumption decreased in the United Kingdom during the last 20 years, while the incidence of colon cancer increased significantly. They added that additional research linking red meat consumption with cancers of the prostate, lung, bladder, esophagus, and pancreas is limited and not thought to be convincing.[20]

Lastly, there is some evidence of publication bias. An abstract from the Proceedings of the American Association of Cancer Research in 2004 found that "Greater intake of either red meat (excluding processed meat) or processed meat was not related to colorectal cancer risk."[23] According to the principal author's list of publications, the paper was never published. In 2008, Smith-Warner's group did publish a paper that found no increased risk of renal cancer linked with fat, protein and meat consumption.[24]

The 2015 IARC monograph regarding meat and risk of cancer is of particular interest because "epidemiological studies suggesting that small increases in the risk of several cancers may be associated with high consumption of red meat or processed meat." Despite the admittedly small increase in risk for individuals, the task force suggested a public health benefit. Additionally, the IARC clarifies that their work determines hazard but not relative risk, and they state that the distinction is important.[25]

The lifetime risk of developing colorectal cancer is estimated to be 5%.[26] In 2012, Pan and colleagues found an increased risk of cancer mortality and consumption of red meat and processed meat, with the highest quintile of meat and processed meat consumption ranging between 2.6 and 3.1 servings per day compared with .22 and .53 servings per day in the lowest quintile and is thought to increase the relative risk by 13% and 20%, respectively.[27] A simple calculation suggests that the lifetime risk of developing colorectal cancer increases from 5% to between 5.65% and 6% when eating 8 to 10 oz of meat per day, suggesting a relatively small increase in risk for individuals.

Obesity Risk

Researchers often note higher BMIs among meat eaters. Vegetarians, particularly, vegans, exhibit lower body weight than the general population, as well as a lower incidence of obesity.[2] Elevated weight typically is considered a negative outcome in obesity research, but there's no evidence that increased body weight in people eating a mixed diet is linked to increased fat mass and, more specifically, to increased central body fat.

In a study looking at the relationship between animal protein intake and muscle mass in healthy women, animal protein was the independent predictor of an increased muscle mass index, even when the subjects consumed the same amount of plant protein as animal protein.[28] McAfee and colleagues asserted that omnivores' higher BMIs are likely linked to greater lean muscle mass.[20]

Greater protein intake (specifically animal protein) may also positively influence weight management and/or weight-loss efforts for some individuals. McAfee and colleagues noted that fat

slows digestion, while protein is known to contribute to a greater sense of satiety.[20] Gardner and colleagues also found that higher protein and fat intake contributed to greater satiety in insulin-resistant subjects and resulted in greater fat loss in insulin-resistant individuals, compared with more insulin-sensitive subjects.[29]

Insulin resistance is associated with a greater risk of increased visceral fat stores and inflammation, as well as a higher risk of cardiovascular disease, diabetes, and certain cancers. Diets with more fat and protein have been shown to lower the glycemic response and improve biomarkers linked to cardiovascular disease, diabetes, and obesity in people with diabetes.[18,19]

Limits of Epidemiological Research

The largest and most significant nutrition studies published today tend to be epidemiological in nature, with no capacity to determine cause or effect despite efforts to control for confounding variables. The current controversy regarding the role of red meat in the diet is understandable. Food-based nutrition research is notoriously expensive and difficult to conduct. Too few resources are available to study food intake in tightly controlled metabolic units, and free living conditions introduce a wide range of challenging variables.

On an anecdotal basis, most dietitians know the inherent challenges in collecting reliable data when asking people to report what they eat, how much they eat, or how to characterize what they eat. Researchers also struggle to reliably collect and interpret food and nutrition data.

Epidemiological studies and randomly controlled trials use a variety of tools, such as food-frequency questionnaires, five-day and 24-hour recalls, and diet histories, to determine food intake. However, critics charge these methods are rife with inaccuracies. In December 2005, researchers from the Fred Hutchinson Cancer Research Center in Seattle penned an editorial that questioned the use of food-frequency questionnaires, stating “much of the inconsistency and some of the null results in studies of diet and cancer are due to poor dietary assessment.”[30]

Researchers are also tasked with the challenge of discerning exactly what the data say, even when study designs intend to measure the effect of dietary changes. In the DPP, for example, participants were provided with specific calorie and fat gram targets, but if a participant was losing weight, the coach didn’t continue to counsel the participant to reach the designated targets.[16] Despite defining the dietary effort as calorie controlled and low fat, the researchers couldn’t determine what was working for any one participant.

Incomplete data also may be a factor contributing to the lack of reliable findings. In a recent study by Pan and colleagues, the researchers disallowed data only when more than 70 of 131 answers were missing on a food-frequency questionnaire.[6] The arbitrary cut point means data were counted when more than one-half of values were missing. In the discussion, the authors stated that they inserted average values to complete the questionnaires with missing data.

Interestingly, the epidemiological research regarding meat and the risk of cancer may be interpreted to have one implication for individuals—a very small risk—and another for public health. Gary Taubes, a science writer, discusses the limits of epidemiology in a ***New York Times*** article, "Do We Really Know What Makes Us Healthy?"[31] In summary, he suggests the following:

1. If the association appears consistently in study after study, population after population, but is small—in the range of tens of percent—then doubt it.

2. For individuals, such small associations, even if real, will have only minor effects or no effect on overall health or risk of disease.

3. Even when public-health implications are apparent, they should be treated with suspicion until a clinical trial demonstrates their validity.[31]

Additional Considerations

Traditionally, most discussions regarding the role of meat in the diet focus on nutrient composition and disease risk. However, heightened awareness of the food supply, farming practices, and impact of feed animals on the environment drives an increasingly charged debate in scientific, political, and social domains.[32] In 2006 one Danish professor of consumer relations in the food sector noted at least some consumers have concerns regarding meat production, animal welfare, animal feed, use of antibiotics, hormones, and the environmental impact of raising animals for food.33 During the last decade concerns regarding the environmental impact of raising animals for food have gained significant traction.

These issues are rarely addressed within the usual scope of medical and nutrition research, despite their impact on environmental health, metabolic health, and sustainability. Proponents of a plant-based diet often lean on this data to reinforce their position.[32,34,35] However, meat remains an important food source for many.

A full discussion of environmental food impact issues is beyond the scope of this continuing education course, but dietitians will increasingly be expected to consider the food supply and how it's produced in the course of their work. The Academy's comments to the 2015 DGAC recommendations recognize a growing body of evidence regarding sustainable practices in agriculture.[14] Because dietitians will be asked to speak to the environmental and health consequences of what's grown and what consumers purchase in the marketplace, a brief discussion of the issues follows.

Image 2: Confined agricultural feeding operation located off Interstate 5 in California.

Impact of Animal Feed

We know little about the impact of eating meat and animal products from grass-fed and grass-finished animals compared with conventionally raised animals.[36] Most influential studies addressing meat's role in the diet fail to consider the effects of animal feed on meat's nutritional profile. Beef produced before the 1940s would be categorized as grass fed or grass finished today.[36]

During the 1950s, industry capitalized on more efficient beef production by feeding animals energy-dense grain, with animals confined in a small land area to maximize growth, as seen in Image 2. Most studies addressing the health risks of eating red meat were conducted during the same time period that ruminants were fed corn and soy and, more recently, refined carbohydrate waste.[36]

The USDA sanctions a limited amount of recycled waste to enter animals' food chain supply, including stale bakery products and candy, and other plant waste.[37] Historically, grain-based snacks and bakery products have been the primary source of industrially hydrogenated trans fats in the food supply of the United States, a substance the advisory committee for the 2010 Dietary Guidelines suggests is best to avoid.[4] The 2015 DGAC scientific report states trans fat from partially hydrogenated oils should be minimized in the diet.7 Little is known about the effects of these foodstuffs on the nutritional quality of meat from conventionally raised cattle.

Image 3: Grass-fed cows from Rocky Canyon Farms in California.

Grass-fed beef tends to be lower in overall fat content because the animals are free to move as they graze on their natural and less energy-dense diet, as seen in Image 3. The beef from these animals can exhibit a host of other nutritional advantages.[36] Grass-finished meat yields higher levels of vitamins A and E precursors and more antioxidants. Grass-finished beef yields a more desirable saturated fat profile and greater amounts of conjugated linoleic acid, transvaccenic acid, and omega-3 fatty acid on a gram-by-gram basis than does beef from grain-fed animals.[36] Transvaccenic acid is the major trans fat found in ruminant fats.

Omega-3 fatty acid is often found wanting in the standard American diet, and the 2010 Dietary Guidelines encourage two or more servings of seafood per week to enhance omega-3 fatty acid consumption.[4] Yet there's evidence that grass-fed and grass-finished dairy products and animal meat also could significantly contribute to omega-3 fatty acid intake.

In Australia, most ruminants are pasture fed, and their meat yields higher omega-3 fatty acid content—specifically docosapentaenoic acid (DPA). Australian adults consume six times as much meat, poultry, and game as fish and seafood, and the omega-3 content of animal products contributes 43% of long-chain omega-3 polyunsaturated fatty acid content in the Australian diet. Twenty-eight percent comes from beef and lamb, 14% from pork and chicken, and an additional 4% from foods containing meat. The researchers state that DPA typically isn't included in nutrition analysis data, so epidemiological studies considering DPA content are limited.[38]

Animal Feeding Practices

The shift from pasture-finished animals to the predominant use of concentrated agricultural feeding operations (CAFOs) since the 1950s drives many animal welfare and environmental concerns today. Feeding animals in CAFOs, often known as feed lots, affects carbon imprint, water usage and contamination, pesticide exposure, fertilizer runoff from animal feed crops, methane production, and bioaccumulation of endocrine disruptors.[39-43] Each of these factors complicates the health and environmental implications of meat consumption.

Grain-fed animals experience more infection, exhibit a more compromised immune system, and are treated with more antibiotics. Growth hormones and additional antibiotics are administered to some CAFO animals to maximize growth. Despite reports that the hormones and antibiotics administered to animals aren't detectable in food from the animals, both growth hormones and antibiotics as well as a host of other contaminants are detectable in wastewater and groundwater near CAFOs. "Manure and wastewater have the potential to contribute pollutants, such as nitrogen and phosphorus, organic matter, sediments, pathogens, heavy metals, hormones, and ammonia, to the environment."[39]

Efficiency drives the CAFO model, as proponents of conventional farming stress the need to feed a growing population with less land. Supporters of industrialized agriculture argue that growing animals faster inherently contributes less methane to a warming global climate, a smaller carbon imprint due to economy of scale, and lower food costs for the public at large.

Image 4: Turning waste into fertilizer: Pigs root for fermented corn seeded between layers of hay and manure at Polyface Farms in Virginia.

Biodynamic farming offers an alternative approach to farming and animal husbandry. Its advocates claim greater sustainability, better stewardship of natural resources, and increased animal welfare. In 2008,The Pew Charitable Trusts reported that meat and other products from animals fed their natural diet exhibit an improved nutritional profile, contribute to improve water utilization and storage, effectively recycle nutrients, and decrease pollution while contributing to greater soil ecology and biodiversity.[44] Additionally, less reliance on manufactured fertilizers and pesticides decreases the environmental impact of these agents. Image 4 shows how Joel Salatin of Polyface Farms in Virginia uses the rooting behavior of pigs to cultivate fertilizer. The pigs root for fermented corn layered between manure and hay accumulated over the winter, turning waste into a valuable resource for the next stage of biodynamic farming.

Some advocates of a plant-based diet argue that raising animals for food uses excessive resources and contributes more greenhouse gases to an already precarious environment. But in a

noted lecture, ecologist Allan Savory spoke to the importance of animals in the ecosystem.45 He provided evidence that animals are a critical factor in reversing desertification (the turning of fertile soil to desert), decreasing the damage from methane production, and addressing climate change via carbon sequestration. He maintained that animals are integral to soil health and fertility, regardless of whether humans eat them. Rather than assuming animals are to blame for ecological damage, the problem may be the CAFO model that requires separating animals from the efficiencies of an integrated farm environment.45

The proponents of biodynamic farming and other similar approaches argue for a more sustainable farming model that is equally, if not more, productive.[45,46] However, eating at the top of the food chain inherently increases health risks associated with an increasing body burden of endocrine disruptors. Persistent organic pollutants and other endocrine disruptors derived from plastics and pollution are lipophilic; they bioaccumulate at the top of the food chain regardless of farming or feeding practices.[47]

As the debate continues, it's clear that the question of meat's place at the table isn't merely an issue of nutrient density and dietitians increasingly will be asked to grapple with more than nutrient composition data when it comes to helping consumers decide what to eat.

Conclusion

Populations thrive across a wide range of food patterns, from a plant-based vegan diet to the meat-, milk-, and blood-based diet of the Masai in Africa. Despite calls by some for consumers to adopt a plant-based diet, meat remains a central dietary component for many, especially in the developed (Western) world. Additionally, with greater access to wealth, consumers in developing nations show an increasing preference for more animal protein.

Humans have evolved to eat an omnivorous diet, and meat contributes a strong source of biologically available protein and a significant number of key nutrients for all consumers. Higher protein and fat intake can contribute to a greater sense of satiety and improved metabolic health for some consumers.

The link between meat consumption and risk of disease is weaker than many believe. After 40 years of having been told to eat less meat, meat eaters tend to smoke more, drink more, exercise less, eat fewer fruits and vegetables, and engage in other lifestyle behaviors associated with poor health. The limits of epidemiological data leave open the possibility that meat eaters who ignore or resist health recommendations may be skewing the data.

In the increasingly charged climate of Paleo vs a vegan or vegetarian diet, dietitians are challenged to navigate the controversy. The dependence on epidemiological studies as opposed to randomly controlled trials regarding meat's role in the diet limits the strength of the data. Questions remain regarding the interpretation of nutrition studies and methods of collecting food intake data. In the world of evidence-based medicine, dietitians need to acknowledge where there's inadequate or no evidence. At this time, research has yet to establish that eating meat poses greater health risk for consumers who generally live a healthful lifestyle.

In terms of future research, critical questions remain: Is there an increased risk of disease and all-cause mortality for meat eaters who don't smoke, don't drink excessively, and are physically

active? What's the risk for meat eaters who consume adequate fruits and vegetables? What's the risk of eating red meat from animals that are fed their natural diet? Finally, what's the impact on the health of the entire ecosystem when the animal and what it's fed honors the biodynamic connection between animals and plants?

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[Sidebar]

HOW WE GROW OUR FOOD MATTERS

As the world grapples with a growing population, scientists and consumers recognize the increasing challenge of balancing limited resources with the need to grow more food. Some see answers in an increasingly industrialized food system, advocating for genetically modified seeds and the efficiency of mono-crop farming and large-scale concentrated agricultural feeding operations (CAFOs). Increasingly, scientists, farmers, and consumers seek alternative approaches. Polyface Farms and Marsden Farm, discussed below, provide examples of current efforts to address these challenges.

Polyface Farms

In contrast to conventional CAFOs, biodynamic farming utilizes waste as a valuable resource. Fermented and composted waste is used to fertilize soil, which helps grow grass eaten by ruminants that deposit waste. The recycled efficiency isn't only cost-effective but also contributes to improved soil ecology and a reduced reliance on externally sourced fertilizers.

The benefits of this technique were visible and tangible during the author's early spring visit to Polyface Farms in Virginia in 2013. Biodynamic farmers typically describe themselves as grass growers, as biodynamic farming depends on grass to complete the cycle from waste to high-quality protein found in beef and other animal products. Image 5 illustrates the impact of vital soil ecology and the capacity to grow grass. Greater capacity to grow grass means that Polyface Farms relies on hay to feed the animals 40 days per year compared to 120 days required on more conventional farms in the neighborhood.

Image 5: Polyface Farms in Virginia. The green foreground is Polyface land; the hill behind the copse of trees is another farm employing conventional farming methods.

Marsden Farm

Researchers from Iowa State University claim that more environmentally sustainable agriculture can be achieved now without sacrificing food production or farmer livelihoods. An experiment conducted from 2003 to 2011 at Marsden Farm in Boone County, Iowa, resulted in a significant

reduction of environmental impact for both three- and four-year crop rotations compared to a standard two-year rotation. The researchers used traditional seed for the three- and four-year rotations and Bt corn GMO seed for the standard two-year rotation.[1]

Despite higher labor costs, the three- and-four-year crop rotations achieved slightly greater yields and produced the same profitability as two-year rotations using Bt corn GMO seed (see Figure 6). Also, the four-year model used less external inputs of fertilizer, pesticides, and fossil fuel (see Figure 7), resulting in a 200-times lower rate of freshwater toxicity.

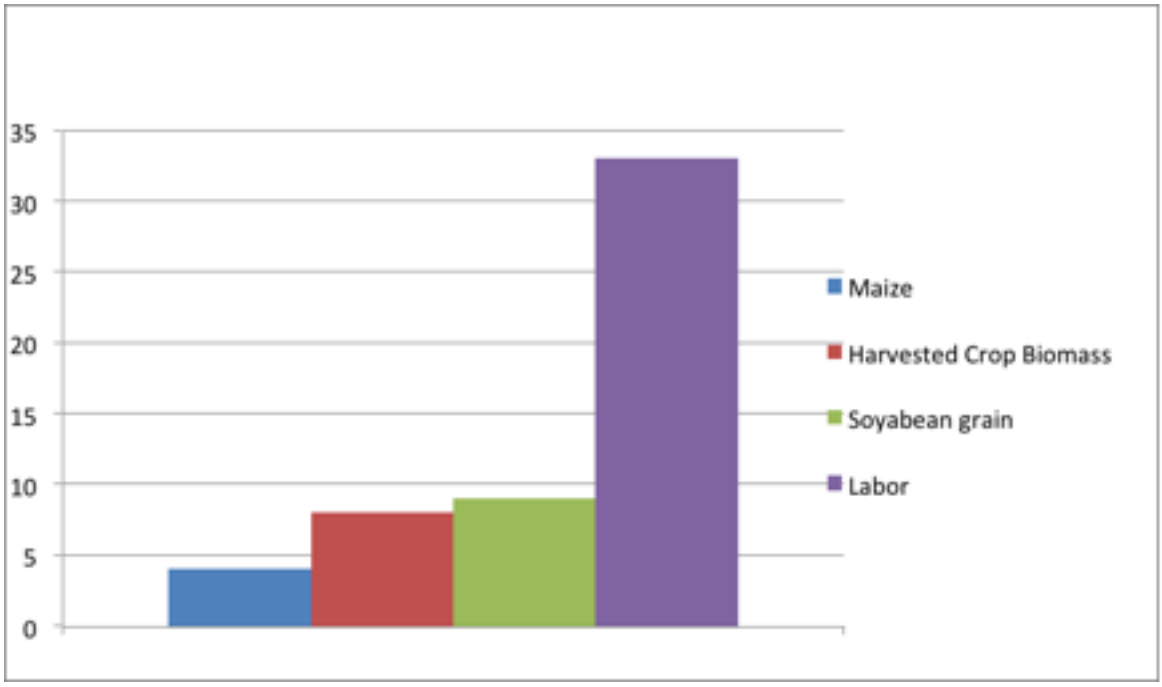

Image 6: Percentage of yield and labor cost differences between conventional two-year rotation of using Bt corn seed and three- to four-year rotations of traditional seed. Both systems delivered equal profitability.[37]

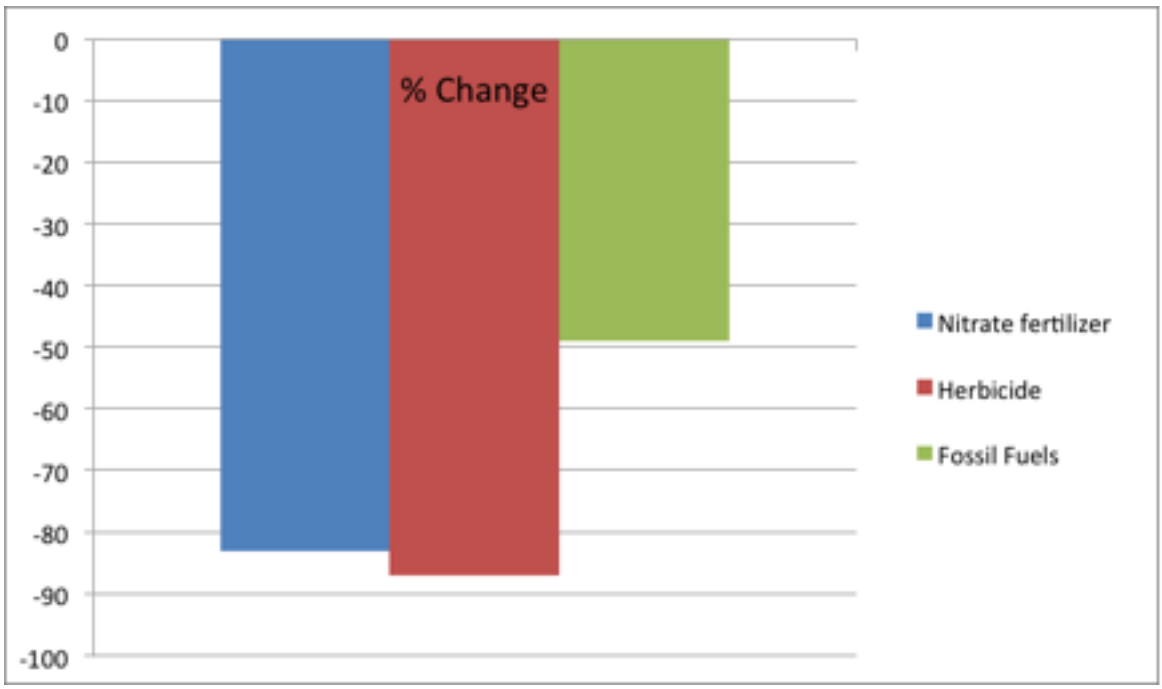

Image 7: Decreased use of external inputs between conventional two-year rotation and three- to four-year rotations.[37]

The authors of the study stated, "Reintegrating crop and livestock systems offers a promising strategy for reducing reliance on fossil fuels, minimizing the use of increasingly expensive fertilizers, and limiting water pollution by nutrients, pathogens, and antibiotics."[1]

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Additional Resources

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2. Ohlson K. ***The Soil Will Save Us: How Scientists, Farmers, and Foodies Are Healing the Soil to Save the Planet***. New York, NY: Rodale; 2014.

Examination

1. Based on the meta-analysis by Mente and colleagues, which of the following is a dietary factor strongly linked with an increased incidence of cardiovascular disease?
A. Milk
B. Trans fats
C. Eggs
D. Red meat

2. What was the primary outcome of the lower carbohydrate diets tested by Gannon et al in treating diabetes?
A. Decreased body weight
B. Increased plasma triglycerides
C. Increased plasma cholesterol
D. Reduced glycohemoglobin

3. In the EPIC trial, red meat consumption wasn't significantly associated with all cause-mortality, but consuming processed meat was associated with higher all cause-mortality in which of the following groups?
A. Previous and current smokers
B. Black Americans
C. Obese individuals
D. Previous and current dieters

4. Meat consumption has decreased in the United Kingdom during the last 20 years. How has the incidence of colon cancer changed during that time?
A. It has decreased significantly.
B. It has decreased slightly.
C. It has stayed the same.
D. It has increased significantly.

5. Polyface Farms in Virginia relies on hay to feed the animals ___ days a year compared with ___ days required on more conventional farms in the neighborhood.
A. 40, 120
B. 80, 120
C. 120, 40
D. 120, 80

6. What was the profitability of Marsden Farm when implementing a three- to four-year crop rotation and using less fertilizer and pesticide?
A. Less profitable than a two-year crop rotation
B. Equally as profitable as a two-year crop rotation
C. More profitable than a two-year crop rotation
D. Twice as profitable as a two-year rotation

7. Using a four-year crop rotation instead of a two-year crop rotation, the Marsden Farm experiment resulted in what change to the rate of freshwater toxicity?
A. a 200-percent increase
B. a 200-times increase
C. a 200-percent decrease
D. a 200-times decrease

8. Compared to grain-fed beef, pasture-fed ruminants yield a significantly higher content of what?
A. Fat
B. Partially hydrogenated fat
C. Omega-3 fatty acids
D. Omega-6 fatty acids

9. Vegetarians and vegans may exhibit lower BMIs than meat eaters even when they do which of the following?
A. Eat a greater number of calories than meat eaters.
B. Eat more plant protein.
C. Eat the same amount of plant protein.
D. Eat less plant protein.

10. Eating at the top of the food chain may cause greater health risk due to which of the following?
A. Consuming excessive amounts of saturated fat
B. Accumulating a greater body burden of endocrine disruptors
C. Consuming excessive amounts of protein
D. Consuming an excessive number of calories