“Better” Chicken: Economic, Ethical, and Environmental Implications of the U.S. Industrial Broiler Debate

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1 Acknowledgments

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Finally, I want to thank my father. This thesis originated from a question my father asked me when I was 10 years old in the grocery store: “Would you rather they kill a happy chicken or a sad chicken for us to eat for dinner tonight?” My father proceeded to argue for why we should eat the sad chicken; for why we should put the sad chicken out of its misery. And, to that, I answered: ”But won’t they start growing more chickens if we show that we like their sad chickens?” This question has some larger moral fallacies baked into it, but nevertheless it is what first got me thinking about indirect effects in markets. For this would-you-rather question and for everything else, I am grateful.

2 Abstract

The US grows over 9 billion chickens yearly yet best production practices are heavily contested. The two central opposing parties — the National Chicken Council and Better Chicken Commitment activists — clash on one critical component of industrial production: which is better, fast- or slow-growth chickens? Yet, the arguments by both sides are rooted in competing incentives and contradictory claims and evidence. I provide three additions to this poultry debate. First, supplementary calculations on how a change in the growth rate of chickens would impact consumer surplus in the chicken market. Second, analysis on the net welfare of slow- versus fast-growth chicken populations. And, third, additional calculations and a comprehensive overview of currently overlooked but relevant environmental externalities of both systems. Through an analysis of such evidence, I argue that widespread adoption of industrial slow-growth chicken production would lead to (1) lower economic welfare for American consumers, (2) ambiguous chicken suffering due to a larger population base of industrially-raised chickens, and (3) substantially higher and critically unsustainable environmental externalities.

3 Introduction

In the grocery store, price often signals quality. Shoppers tend to perceive expensive items as better. But better for whom? Better for the consumer? The environment? For some, or for all? In the poultry aisle, higher prices are frequently associated with humanely raised, slow-growth broilers.[1] These products feel more ethical and are interpreted by many consumers as indicators of higher quality.[2] Yet a shift from fast- to slow-growth breeds – particularly toward more resource-intensive, lower-yield systems – introduces a series of unintended consequences that complicate the question of what "better" truly means.

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[1] Chang and Zepeda, "Consumer perceptions and demand for organic food in Australia".

[2] A signal is an action taken by one party (like a seller) that conveys information to another party (like a buyer).(McConnell et al., *Microeconomics*)

Public discourse around chicken production[3] often collapses into a binary: fast-growth versus slow-growth systems, the National Chicken Council versus the Better Chicken Commitment. But engaging seriously with this debate requires more than taking sides – it demands unpacking the positions of key stakeholders, scrutinizing their incentives, and considering the broader social, environmental, and economic implications of each production model.

The Better Chicken Commitment (BCC), a set of voluntary standards backed by animal welfare NGOs, aims to reform industrial poultry practices.[4] Its requirements span several dimensions of production: housing, lighting, slaughter methods, and audit transparency. Most notably, the BCC mandates a transition to specific slow-growth breeds. Specifically, the BCC calls for:

1. A maximum stocking density of 6.0 lbs/sq ft and a ban on broiler cages;
2. At least 3 inches of litter, a minimum of 8 hours of continuous light ($\geq$ 50 lux), 6 hours of darkness ($<$ 1 lux), and at least one form of functional enrichment[5];
3. Processing methods that eliminate pre-stun handling and require multi-step controlled-atmosphere stunning systems;
4. Third-party auditing and public compliance reporting;
5. Exclusive use of BCC-approved breeds that demonstrate higher welfare outcomes for the chickens.[6]

[3]For the purposes of this thesis, I use the terms broiler," chicken," and poultry" interchangeably. When used, chicken" and "poultry" specifically refer to meat-producing broilers. This excludes laying hens, breeding stock, and non-chicken poultry from the scope of analysis.

[4]Chan et al., "The 'sustainability gap' of US broiler chicken production"; *The Better Chicken Commitment - BCC [US]*.

[5]Functional enrichment, for chickens, includes access to structures that allow them to exhibit "normal" behaviors such as perches, platforms, or straw bales.(Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare"; Schuck-Paim and Jimenez Alonso, *Quantifying Pain in Broiler Chickens: Impact of the Better Chicken Commitment and Adoption of Slower-Growing Breeds on Broiler Welfare*; *The Better Chicken Commitment - BCC [US]*)

[6]*EUROPEAN CHICKEN COMMITMENT (ECC) PROGRESS REPORT*; *The Better Chicken Commitment - BCC [US]*.

While the first four criteria target the birds' living and slaughter conditions, the final requirement – breed selection – is central to both the BCC's welfare claims and the controversy surrounding its implementation.

Opposing the BCC is the National Chicken Council (NCC), a trade association representing the major players in U.S. poultry production – often referred to as "Big Chicken." The NCC acts as a political intermediary between producers and lawmakers, shaping policy to reduce production costs.[7] It champions technical efficiency: minimizing feed, water, and land use per kilogram of meat produced,[8] while simultaneously promoting its products as high-quality and environmentally sustainable. Though rarely in direct confrontation, the NCC and BCC embody competing visions of what makes chicken "better." Notably, NCC-endorsed practices fail to meet BCC standards across every domain—from stocking density to breed choice.[9]

At the heart of this conflict is the tradeoff between growth rate and welfare. Improving one often means sacrificing the other.[10] The BCC's list of approved breeds – Rowan Ranger, Ranger Classic, Hubbard, Cobb-Sasso 200 – all share a defining trait: slow growth. These breeds typically reach their slaughter weight[11] between 55 and 75 days of age. Their slower development is associated with fewer health problems, lower stress, and better bone integrity.[12] From the BCC's perspective, meaningful welfare reform requires not only changes to housing or handling, but a fundamental shift in the kinds of birds we raise.

By contrast, industrial producers – aligned with the NCC – primarily rely on two

[7] *The Better Chicken Commitment - BCC [US].*

[8] Input costs can be lowered either by reducing the amount of inputs needed or by reducing the marginal cost of an input.(Chan et al., "The 'sustainability gap' of US broiler chicken production"; McConnell et al., *Microeconomics*)

[9] *The Better Chicken Commitment - BCC [US].*

[10] Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare".

[11] Slaughter weight varies between firms, and even chickens of the same breed are harvested at different slaughter weights depending on the firm's specific methodology.

[12] Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare"; *Rowan Ranger Broiler - Performance Objectives*; *The Better Chicken Commitment - BCC [US].*

breeds: Ross 308 and Cobb 500.[13] Ross 308 reaches market weight (3.0 kg) in 42 days, while Cobb 500[14] does so in just 37 days (2.7 kg).[15] These rapid growth rates, while technically efficient, come at significant cost to the animals' health, mobility, and overall well-being.[16]

But the implications of growth rate extend beyond individual welfare. Growth rate also determines how many chickens must be raised at any given time to meet demand. A "humanely raised" chicken is not a one-for-one replacement for a conventional one. This thesis explores what that substitution implies—across three interconnected domains: consumer experience, animal welfare, and environmental impact.

Extending chickens' lifespans—as slow-growth breeds require—means that more birds must be raised simultaneously to satisfy fixed demand. This, in turn, raises total feed requirements, land use, and emissions. Holding output constant, shifting to slow-growth breeds could necessitate a 45–87% increase in the number of living chickens and a 19–27% rise in annual slaughter rates compared to Ross 308 demographics.[17] Put differently, sustaining the same meat supply could require three to four slow-growth chickens for every two conventional ones.

Thus, efforts to improve welfare by slowing growth come with tradeoffs: increased resource use, higher greenhouse gas emissions, and economic burdens. Understanding the net social welfare effects of this transition requires weighing improvements in animal well-being against these broader environmental and economic costs.

For consumers, the BCC maintains that slow-growth chickens are healthier and bet-

[13] Chan et al., "The 'sustainability gap' of US broiler chicken production".

[14] Cobb 500 is a commonly used breed, but Ross 308 chickens constitute a larger portion of the industrially raised chicken population. Consequently, for my analysis, I use the Ross 308 breed as the archetype for a "slow-growth breed".(Junghans et al., "Data evaluation of broiler chicken rearing and slaughter-An exploratory study"; Martínez and Valdivié, "Efficiency of Ross 308 broilers under different nutritional requirements")

[15] *Cobb500 Broiler Performance & Nutrition Supplement (2022)*; *Ross 308 /308 FF Broiler - Performance Objectives*.

[16] Chan et al., "The 'sustainability gap' of US broiler chicken production"; Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare".

[17] Chan et al., "The 'sustainability gap' of US broiler chicken production".

ter tasting; the NCC counters that they're more expensive and less desirable.[18][19] For chickens, the BCC sees slower growth as a path to higher welfare; the NCC argues that it causes more birds to suffer. Environmentally, the BCC emphasizes reduced reliance on imported soy; the NCC points to increased total feed use and land expansion.[20]

This thesis demonstrates that while slow-growth standards offer moral appeal to consumers, their implementation at scale may reduce consumer welfare, increase total chicken suffering, and intensify environmental externalities. Through an economic analysis of price shifts, utility frameworks, and environmental externalities,[21] this project questions whether slow-growth breeds are truly "better" – and for whom.

4 Background

Growth rate changes tied to different chicken breeds hold implications for consumers, the chickens themselves, and the environment.

For consumers, chicken is a comparatively cheap meat and has a growing market share.[22] Compared to beef and other meat products, chicken is substantially more affordable – per the USDA, for $1, a consumer can buy around half as much beef compared to chicken.[23] Owing to its affordability – driven by the low costs of scaled production – the chicken industry tripled its share of global meat production between 1961 and 2010, outpacing the growth rates of all other meat products.[24]

The low cost of chicken is a product of the intensive nature of chicken production:

[18] Lusk, Thompson, et al., "The Cost and Market Impacts of Slow-Growth Broilers".

[19] "Desirable" often refers to a higher proportion of white meat, which is preferred in the U.S. and other OECD countries, but less valued in some developing nations due to cultural preferences.(Torrella, *Chicken is the most popular meat in the world. And we're expected to eat much more of it. — Vox*)

[20] *ECC Progress Report 2024*.

[21] In environmental economics, externalities refer to the uncompensated impacts (positive or negative) of economic activities on third parties not directly involved in the transaction. These may include pollution, land degradation, noise, etc.

[22] Belova et al., "World chicken meat market - its development and current status"; Neeteson et al., "Evolutions in Commercial Meat Poultry Breeding".

[23] "USDA ERS - Meat Price Spreads".

[24] Belova et al., "World chicken meat market - its development and current status".

poultry is farmed at a precipitous rate given a high feed conversion ratio[25] and high population density. The proposed changes from the BCC, e.g., to increase the feed conversion ratio (through switching to slow-growth breeds) and decrease stocking density, therefore aim at de-intensifying the poultry industry. These changes would increase production costs and retail prices. The higher prices will reduce the quantity demanded of chicken and impact the consumer welfare of low-income households that generally choose chicken over other meats because of the lower price.

Where the consumer does gain, though, is through perceived improvements in the taste and nutrition of the meat. These “upgrades” in quality are baked into the price of the chicken; consumers consider the value they expect to derive from consuming a good and that valuation affects their willingness to pay for the good.[26] The breed is, in fact, a critical component in the taste and nutrition of the meat. The dominant breed, Ross 308, was designed to maximize breast meat — the cut of chicken most preferred in American markets.[27] However, this optimization comes at a nutritional cost: compared to slow-growth breeds, Ross 308 chickens contain more fat and lower levels of vitamin E.[28] While these trade-offs are real, consumer perceptions are often shaped by marketing and labeling, which can introduce noise into the decision-making process. Research suggests that consumers favor slow-growth chicken due to perceived taste and health benefits, but industry marketing complicates their ability to accurately assess differences.[29]

The implications of poultry production extend well beyond consumer choices and animal welfare. Industrial animal agriculture – poultry included – is one of the largest contributors to environmental degradation in the United States. These negative externalities arise across the entire supply chain, from feed cultivation and animal rearing to

[25] Feed conversion is how efficiently an animal converts feed into desired output.

[26] McConnell et al., *Microeconomics*; Torrella, *Chicken is the most popular meat in the world. And we’re expected to eat much more of it. — Vox.*

[27] Lusk and Tonsor, “How Meat Demand Elasticities Vary with Price, Income, and Product Category”.

[28] Epp, *The nutritional needs of slow-growing birds*; Neeteson et al., “Evolutions in Commercial Meat Poultry Breeding”.

[29] Lusk and Tonsor, “How Meat Demand Elasticities Vary with Price, Income, and Product Category”.

transportation and waste management. As global meat consumption is projected to rise 14% by 2030 compared to the 2018–2020 average,[30] the environmental stakes of each production decision continue to grow.

Among the most pressing environmental concerns are land use impacts, both direct and indirect. While chickens require relatively little land individually, the sheer volume of animals raised annually amplifies their aggregate direct land footprint. Furthermore, indirect land use – particularly for feed production – drives deforestation and habitat loss. As demand for feed crops increases, so too does pressure to convert non-agricultural land to farmland. The IPCC attributes approximately 12% of global greenhouse gas (GHG) emissions to land-use change, including deforestation.[31] A comparison between beef and chicken showcases this land use problem saliently: the U.S. slaughters about 32 million beef cattle and over 9.5 billion chickens annually.[32] Quite literally, this means that the US broiler industry houses and feeds over 3000 times more animals than the US cattle industry. While per capita cattle land use is higher and cattle have substantially longer lifespans than poultry, the scale of broiler production implies that broiler land use matters, and it matters a lot.

Water and waste pollution present additional, more tangible environmental risks. Freshwater scarcity is an escalating global crisis, exacerbated by climate change and extreme weather events.[33] Industrial animal agriculture already consumes an estimated 10% of annual global water flow, primarily through feed irrigation and direct animal consumption.[34] As food production expands to meet population demands, reducing per capita water footprints and maximizing agricultural yield per unit of rainfall will be crucial in mitigating food insecurity, drought, and ecosystem collapse.[35]

[30] OECD and Nations, *Statistical Annex*.

[31] Wang, "Assessment of land use change and carbon emission".

[32] *FAOSTAT*.

[33] Ingrao et al., "Water scarcity in agriculture".

[34] Ingrao et al., "Water scarcity in agriculture"; Minasyan, "WATER USE IN LIVESTOCK PRODUCTION SYSTEMS AND SUPPLY CHAINS".

[35] El Sabry et al., "Water scarcity can be a critical limitation for the poultry industry"; Kebebe et al., "Strategies for improving water use efficiency of livestock production in rain-fed systems".

Moreover, poultry farming produces enormous quantities of waste – particularly manure – which poses environmental and public health risks. Poultry waste contaminates both water and air: nitrogen- and phosphorus-rich manure can leach into waterways, contributing to eutrophication and algal blooms, such as the Gulf of Mexico dead zone.[36] Additionally, manure emissions include ammonia and nitrous oxide, both of which contribute to air pollution and GHG emissions.[37] Beyond pollution, improper waste management increases the risk of zoonotic disease outbreaks, posing direct threats to human health.[38] Recognizing these risks, legal frameworks increasingly classify poultry manure as industrial waste, reinforcing the urgency of stricter management practices to limit its public health and environmental impacts.

In sum, changes to chicken growth rates are not isolated technical decisions – they reverberate through consumer markets, animal welfare outcomes, and environmental systems. As the poultry industry continues to expand, future production models must strike a careful balance between economic accessibility, ethical responsibility, and ecological sustainability.

5 Research & Conceptual Framework

5.1 Thesis statement

There are multiple dimensions implicated in the poultry industry's breed decision. Focusing solely on outcomes like direct pollution levels or the number of chickens is insufficient. For instance, the welfare concerns and environmental externalities of animal agriculture exist at nearly all points along the supply chain, from birth to growth to transport to packaging. Nevertheless, much of the public debate includes only a subset of selective claims: individual studies often consider only one outcome of interest, one

[36] Gržinić et al., "Intensive poultry farming".

[37] Gržinić et al., "Intensive poultry farming".

[38] Stel et al., "Mitigating Zoonotic Risks in Intensive Farming"; White and Razgour, "Emerging zoonotic diseases originating in mammals".

sector of the industry, or one party of interest in the larger system; therefore, it is simple for each side to pick only the outcome of interest that supports their claim rather than evaluating the breadth of evidence on all outcomes of interest.

This thesis intends to be more comprehensive. Through an analysis of the impacts of prices change for consumers, utility considerations for the chickens themselves, and related externalities for the global environment, this project demonstrates that widespread adoption of slow-growth chicken would lead to (1) higher costs of production that decrease consumer surplus and force low-income households to pay premiums if they continue to consume, (2) requirements that necessitate the breeding, cultivation, and harvesting of a substantially larger chicken population which holds implications for net societal welfare, and (3) increased feed production that promotes intensive land use, raising a multitude of environmental externalities.

5.2 Assumptions

To focus on the chicken breed comparison while narrowing tractability, this research adopts three simplifying assumptions aimed at holding some dimensions of the poultry market constant.

1. *Housing & Slaughter Practices:* While enhanced housing standards generally yield positive outcomes for animal welfare and cleanliness – albeit with some increase in land use – they are not the primary determinant of welfare differences across chicken breeds.[39] Van der Eijk et al. find that growth rate, whether influenced by genetics or diet, plays the most significant role in determining animal welfare, rather than housing conditions or slaughter methods.[40] More humane slaughter practices, although associated with high fixed costs, are uniformly beneficial to welfare.[41] Given that housing and slaughter practices are comparatively well-

[39]Chan et al., "The 'sustainability gap' of US broiler chicken production".

[40]Eijk et al., "Growth rate, either through genetics or diet, mainly determines the outcome concerning broiler welfare".

[41]*Positive Welfare Indicators and Their Association with Sustainable Management Systems in*

studied and less contested in policy debates, this project assumes these factors remain constant across breeds – whether through improvements or maintenance of current standards.[42] As such, the analysis isolates breed growth rate as the focal point of investigation, since this is where the primary conflict between the Better Chicken Commitment (BCC) and National Chicken Council (NCC) resides.

2. *Demand Curve*[43]*:* I assume that the demand curves for both fast- and slow-growth broilers are influenced solely by changes in production methods – specifically, the change in breeds. Many other factors could shift demand curves – higher incomes, for instance. In particular, I do not account for potential exogenous shocks or transformations in the alternative protein market (e.g., lab-grown or plant-based meats) that could independently shift broiler demand disproportionately between the two markets. Nonetheless, I will abstract away from such factors.

3. *Existential Risk:* This model does not incorporate major existential threats – such as those posed by avian influenza, zoonotic disease, or climate change. While these factors are critically important in broader discussions of poultry production and food system resilience, their exclusion here allows for a focused analysis of breed-specific welfare and economic impacts.

6 Literature Review

Existing research on the implications of altering the growth rate of industrial chicken breeds tends to be siloed within distinct academic disciplines: economists analyze price effects, philosophers debate moral considerations, and climate scientists assess environmental externalities. If economists prioritize present-day consumers, philosophers em-

Poultry.

[42]Chan et al., "The 'sustainability gap' of US broiler chicken production"; Espinosa and Treich, *The Animal-Welfare Levy*.

[43]In economics, a demand curve is a graphical representation that shows the relationship between the price of a good and the quantity demanded. Typically, as price decreases, quantity demanded increases.

phasize animal welfare, and climate scientists focus on future sustainability, how should policymakers determine which data to use? This disciplinary divide highlights the need for a multidisciplinary approach.

At the center of the growth rate debate lies a tripartite tension: quantity versus quality across three domains. For consumers, the choice is between affordability and nutritional value. For chickens, there can be a tradeoff between lifespan and quality of life. For the environment, the dilemma is one of resource efficiency versus ecological sustainability. The following sections synthesize key findings across these domains, identifying crucial gaps this research seeks to address.

6.1 Consumer Welfare and Market Dynamics

American consumers have long benefited from low poultry prices, but shifting attitudes toward industrial agriculture have fueled demand for "natural" or "sustainable" alternatives.[44] Studies comparing slow- and fast-growth breeds reared under similar production systems and diets show that slow-growth chickens yield meat with 18% more protein, 22% less fat, and significantly higher Vitamin E levels per kilogram – supporting the nutritional argument for quality over quantity.[45]

However, affordability remains critical – especially for low-income households. Since 1960, U.S. poultry consumption has quintupled, with chicken now the most consumed meat among socioeconomically vulnerable populations.[46] Transitioning to slow-growth breeds threatens to undermine this accessibility: EU models project a 37.5% per kilogram price increase following such a shift, disproportionately changing the consumption choices of price-sensitive consumers.[47] While economic theory anticipates that supply-

[44]Chang and Zepeda, "Consumer perceptions and demand for organic food in Australia".

[45]Fanatico et al., "Meat Quality of Slow- and Fast-Growing Chicken Genotypes Fed Low-Nutrient or Standard Diets and Raised Indoors or with Outdoor Access"; Han and Baker, "Lysine Requirements of Fast- and Slow-Growing Broiler Chicks1".

[46]Birhanu et al., "Smallholder poultry production in the context of increasing global food prices"; Clonan et al., "Socioeconomic and demographic drivers of red and processed meat consumption".

[47]*EUROPEAN CHICKEN COMMITMENT (ECC) PROGRESS REPORT*.

side shocks widen nutritional disparities, no existing study quantifies the direct welfare loss imposed on low-income households and whether the increased willingness to pay for perceived "better" chicken outweighs the price premium. This research addresses that gap by modeling the distributional impacts of a price increase across income tiers.

6.2 Chicken Welfare

Chickens are often treated as cognitively negligible commodities, but growing evidence contradicts this view. Neurobiological and behavioral research shows that poultry experience pain and stress similarly to mammals[48], and exhibit advanced cognitive capacities in domains such as numeracy, memory, and self-control – even rivaling young children in controlled tasks.[49]

The ethical debate becomes more precise when decoupling sentience from suffering. Cognitive sentience remains stable across breeds, but physical health outcomes vary markedly.[50] Slow-growth breeds suffer fewer musculoskeletal problems,[51] exhibit higher mobility,[52] and experience less contact dermatitis[53] than their fast-growth counterparts.[54] Thus, the moral imperative lies not in abstract debates over consciousness but in tangible differences in physical well-being.

Efforts to quantify welfare improvements and physical well-being often rely on frameworks like the Five Freedoms, which – despite criticisms of simplicity – remain

[48]Nicol, *The Behavioural Biology of Chickens*.

[49]Marino, "Thinking chickens"; *Opinion — Are Chicks Brighter Than Babies? - The New York Times*.

[50]Baxter et al., "A comparison of fast growing broiler chickens with a slower-growing breed type reared on Higher Welfare commercial farms"; Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare".

[51]Paz et al., "Locomotor Problems in Broilers Reared on New and Re-Used Litter".

[52]Knowles et al., "Leg Disorders in Broiler Chickens: Prevalence, Risk Factors and Prevention".

[53]Dinev et al., "Pathomorphological investigations on the prevalence of contact dermatitis lesions in broiler chickens".

[54]Baxter et al., "A comparison of fast growing broiler chickens with a slower-growing breed type reared on Higher Welfare commercial farms"; Morris, "The Ethics and Politics of Animal Welfare in New Zealand"; Rayner et al., "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare".

widely used in academic research on animal welfare.[55] Schuck-Paim et al. estimate a 34% welfare improvement in systems aligned with the Better Chicken Commitment (BCC), but conflate breed-specific effects with housing and slaughter reforms.[56] This project addresses that limitation by isolating welfare gains attributable exclusively to breed differences, offering a conservative, breed-focused analysis grounded in the Five Freedoms framework.

6.3 Environmental Externalities

The environmental consequences of poultry production are substantial: agriculture accounts for approximately 35% of global greenhouse gas emissions.[57] The indirect land use cost of broiler production primarily comes from feed production – Agudelo et al. estimate that over 70% of the environmental impact of chicken cultivation stems from the production of their feed – and growth rate substantially impacts feed efficiency in several key manners.[58] Slower growth chickens, because of (1) longer lifespans and (2) a larger population base on a fixed output basis, demand more feed – thereby increasing land use requirements and greenhouse gas emissions.[59] However, feed composition also matters. The feed makeup of industrially raised chickens is a combination of maize, soy, and miscellaneous grains, with specific breakdowns depending on the breed and age of the chicken.[60] The composition difference, though, that is pertinent to this debate is protein requirements. In their paper on differential lysine requirements, an amino acid critical to feed efficiency, Han et al. show that slow-growth chickens require substantially

[55] Mellor, "Updating Animal Welfare Thinking".

[56] Schuck-Paim and Jimenez Alonso, *Quantifying Pain in Broiler Chickens: Impact of the Better Chicken Commitment and Adoption of Slower-Growing Breeds on Broiler Welfare*.

[57] Tetteh et al., "Carbon Footprint".

[58] Agudelo Higuita et al., "Climate change, industrial animal agriculture, and the role of physicians – Time to act"; Beal et al., "Economic and environmental assessment of U.S. broiler production"; Macleod et al., *Impact of animal breeding on GHG emissions and farm economics*; Röös et al., "Greedy or needy?"

[59] Chan et al., "The 'sustainability gap' of US broiler chicken production"; Röös et al., "Greedy or needy?"

[60] Martínez and Valdivié, "Efficiency of Ross 308 broilers under different nutritional requirements".

less protein than fast-growth chickens to maximize feed conversion ratios.[61]

Protein, for chickens, is secured through soy consumption – a bean grown predominantly in the US and Brazil for livestock feed.[62] Yet, while BCC-supported reports delineate that "lower reliance on soya in [slow-growth chicken] feed help to reduce emissions", there is no academic consensus on this claim.[63] Slow-growth chickens are known to have lower protein requirements, but these lower protein requirements do not ubiquitously help to "reduce emissions."[64] Academic literature on the topic shows that the comparative global warming potential (GWP)[65] of soy and other grains is variable and dependent on the context, Guisti et al. find that in Brazil soybean production has lower GWP than wheat and maize, while Ghasempour et al. find that in Iran soy has a higher GWP than wheat and maize. Therefore, the environmental impact of different crops are highly regional and context-based, and meta-analyses have shown that the GWP of crops varies depending on the local production methodology and regulation practices.[66]

These geographic disparities complicate blanket conclusions about environmental costs. Indirect land use is tied to feed production; more feed generally requires more land.[67] Yet, simultaneously, the type of crop being cultivated also impacts the environmental impact of the farmland.[68] In order to model the land use implications of slow-growth production, Chan et al. model a 30% increase in land use from a full industry transition to slow-growth breeds due to population size increase..[69] Yet, they omit feed-

[61] Han and Baker, "Lysine Requirements of Fast- and Slow-Growing Broiler Chicks1".

[62] *Soybeans — USDA Foreign Agricultural Service*.

[63] *Sustainability and the Better Chicken Commitment*.

[64] Han and Baker, "Lysine Requirements of Fast- and Slow-Growing Broiler Chicks1"; *Sustainability and the Better Chicken Commitment*.

[65] Global warming potential (GWP) measures how much heat a greenhouse gas traps in the atmosphere over a specific time period, relative to carbon dioxide (CO_2). GWP helps to put various gases and types of emissions in the same units, and is often used to provide a common scale when comparing the environmental burden of producing crops. Nevertheless, GWP is considered to be a variable and often unreliable estimate of the true impacts of production.(US EPA, *Understanding Global Warming Potentials*)

[66] Sun et al., "Importing food damages domestic environment".

[67] Searchinger et al., "The Global Land Squeeze".

[68] Röös et al., "Greedy or needy?"

[69] Chan et al., "The 'sustainability gap' of US broiler chicken production".

composition effects on emissions and how this "soy" argument alters the calculations on GWP and the impacts of this land use.[70] Therefore, my research integrates both feed quantity and crop-specific global warming potential (GWP) to offer a more nuanced account of breed-related environmental impacts.

6.3.1 Ancillary Impacts: Water & Waste

While the land use debate primarily considers greenhouse gas emissions, other inputs and outputs – namely water and waste – of poultry production contribute to deleterious environmental externalities. Therefore, a question arises: how do the different growth models affect water scarcity and waste management problems? For both water and waste, the risks can be split into two camps: (1) the quantity required and (2) the pollution implications.

While water usage per kilo of chicken meat is substantially lower than for other types of industrially raised livestock, there are significant differences in required water usage and pollution between the types of poultry production systems. For instance, slow-growth chickens require 20% more water than fast-growth due to the longer lifespans of the broilers themselves, and the NCC estimates that switching one-third of industrial production to slow-growth breeds could require the use of an additional billion gallons of water annually.[71] In contrast, Gržnic et al. argue that the larger water threat from poultry stems from pollution from excessive fertilization and manure production seeping into water supplies resulting from the improper management of intensive production.[72] Waste follows a similar logic: slow-growth chickens produce more waste but – under the other BCC requirements – would pose less of a threat to public health. Therefore, scientific opinion on the main water and waste threats from industrial poultry production is divided, but nonetheless these dimensions form a critical component of the evaluation

[70] Chan et al., "The 'sustainability gap' of US broiler chicken production".

[71] *Impacts of the Better Chicken Commitment on the UK Broiler Sector*; Ingrao et al., "Water scarcity in agriculture"; *National Chicken Council's 7 Things You Need to Know About the Better Chicken Commitment(*.

[72] Gržinić et al., "Intensive poultry farming".

process in determining which breed model is "better."

Given this research project holds management practices fixed and the water and waste issue implicates the regulation practices of the industry, it is excluded from this project's main analysis. Regardless, a critical component is to consider in the overarching debate of how to regulate and manage poultry.

6.3.2 Ancillary Impacts: Zoonoses

Zoonotic diseases "can be transmitted naturally from vertebrate animals to humans or from humans to vertebrate animals."[73] According to the CDC, over 60% of human pathogens are zoonotic in origin. In general, the relative risks associated with industrial broiler production can be split into two categories: fixed and quantifiable vs. existential and indeterminable. The zoonotic disease transmission threat falls into the latter category because, while improbable, a mass outbreak has the capacity to be immeasurable in scale.[74] Yet, because of its existential nature, it is a highly discussed and researched topic.

Zoonotic disease risk is shown to be exacerbated by large-scale poultry production because of increased habitat erosion "at the agricultural–wildlife interface."[75] The immense scale of broiler production means that farmed animals frequently come into contact with wildlife because of (1) the sheer number of farmed animals means the likelihood of interaction is probable and (2) farmed animals are often raised in countrysides with ample land for grazing and proximity to feed production facilities – areas often concurrently inhabited by wild animals.[76] Furthermore, large-scale animal agriculture production necessitates habitat conversion for feed and housing land, conversion that inevitably forces the migration and displacement of wild populations into farmed areas

[73] Rahman et al., "Zoonotic Diseases".

[74] Rahman et al., "Zoonotic Diseases".

[75] Ayala et al., "A Review of Pathogen Transmission at the Backyard Chicken–Wild Bird Interface"; CDC, *About Zoonotic Diseases*.

[76] Rahman et al., "Zoonotic Diseases".

that livestock inhabits.[77] Given higher direct and indirect land use requirements for slow-growth chicken, land conversion would likely increase likely leading to higher rates of contact between farmed and wild animals that increase zoonotic disease incidence.[78] In contrast, fast-growth chickens are also widely considered to be more likely to contract and spread disease than slow-growth chickens given their weakened immunity systems and higher stress levels.[79] Implicitly, therefore, there exists a tradeoff between increased likelihood of initial contact and increased likelihood of contraction and proliferation of disease. While a full epidemiological model is beyond this project's scope, these opposing effects underscore the need for integrated systems analysis in public health risk assessments.

6.4 Synthesis and Research Contributions

Three key gaps emerge across the literature. First, while affordability-nutrition tradeoffs are well-theorized, few models quantify how price shocks redistribute dietary access across income brackets. Second, existing welfare assessments often confound breed-specific suffering with improvements from husbandry or slaughter reforms. And, third, GWP assessments neglect how feed composition varies and interacts with land-use dynamics.

This research advances the field by developing a micro-simulation model to estimate consumer welfare losses from rising chicken prices, with a focus on low-income households, applying a modified Five Freedoms framework to isolate welfare impacts tied specifically to breed, controlling for other production variables, and synthesizing feed composition data with GWP coefficients to refine environmental impact estimates.

By bridging disciplinary silos and introducing new empirical strategies, this study equips policymakers with a unified, cross-sectoral framework for evaluating the tradeoffs

[77] Bartlett et al., "Understanding the relative risks of zoonosis emergence under contrasting approaches to meeting livestock product demand".

[78] White and Razgour, "Emerging zoonotic diseases originating in mammals".

[79] Abo-Al-Ela et al., "Stress and immunity in poultry".

of industrial breed transitions – balancing economic viability, ethical responsibility, and environmental sustainability.

7 Methods & Data Sources

Given this thesis is split into three categories — consumer welfare, chicken welfare, and the environment — the methods and data consequently are split along the same dimensions.

7.1 Consumer Welfare and Market Dynamics

The first question most Americans ask is simple and predictable: how much more will a pound of slow-growth chicken cost in the grocery store? While difficult to exactly predict a post-BCC enactment world in the United States, the European Union is an apt case study for predictive modeling. The EU's *European Chicken Commitment Report* outlines yearly price shocks and economic trends following the enactment of a similar program, therefore helping to provide a baseline prediction for a similar program in the United States.[80] First, I determine how a price premium for BCC chicken, calculated with non-BCC equilibrium prices and predicted BCC price premiums, and an increased willingness-to-pay (WTP) for perceived improvements in nutrition and flavor affect consumer welfare. Second, I use the own-price elasticities of demand[81] (i.e. price sensitivities) for different socio-economic stratas to determine the differential impacts of the price change on households of varying income levels.

[80] *EUROPEAN CHICKEN COMMITMENT (ECC) PROGRESS REPORT*.

[81] Own-price elasticity of demand measures how much the quantity demanded of a good changes as a result of a change in its own price. In simpler words, own-price elasticity is a measure of how "price sensitive" consumers are in a given market. The estimate is typically calculated as a percentage change in quantity demanded divided by the percentage change in price. In general, demand for a good is said to be inelastic (i.e. price insensitive) when the absolute value of the own-price elasticity is less than one; demand for a good is said to be elastic (i.e. price sensitive) when own-price elasticity is greater than one.(McConnell et al., *Microeconomics*)

7.2 Chicken Welfare

Chickens likely deserve some moral weight, but knowing how to adjudicate relative moral suffering under different farming infrastructures is an arduous and subjective task.[82] Therefore, I use representative polling and the Five Freedoms Framework to subjectively determine relative pain, welfare, and suffering under the two systems. Using this, I then augment existing utility functions to model net chicken welfare under slow- versus fast-growth systems and include a threshold analysis.

7.3 Environmental Externalities

There are several pertinent questions related to the environmental ramifications of the two breed types. For the purposes of this project, I am primarily focusing on (1) differential greenhouse gas emissions caused by feed and land use changes and (2) the indirect effects on other markets.

First, the land use and feed emissions questions are intrinsically tied up together – more feed begets more land use. For feed calculations, my preliminary estimates are based on the modeling of Chan et al. and Aviagen's *Breed Performance Objectives* (i.e. the breed manufacturer). From these, I calculate feed consumption and slaughter weight.[83] Furthermore, using data published by Ghasempour and Ahmadi from a life-cycle analysis on the individual components of the feed (e.g., maize, wheat, and soy), I then attempt to calculate per component environmental impact.[84] Their estimates include the impact from land use, cultivation practices, inputs (e.g., fertilizer, pesticides, and water), and labor and convert to a standard metric – global warming potential (GWP). Therefore, in conjunction with the differential population calculations that Chan et al.

[82] Macer, "Ethical Poultry and the Bioethics of Poultry Production".

[83] *(PDF) Economic impact of chicken diseases and other causes of morbidity or mortality in backyard farms in low-income and middle-income countries: A systematic review and meta-analysis*; Chan et al., "The 'sustainability gap' of US broiler chicken production"; *Ross 308 /308 FF Broiler - Performance Objectives*; *Rowan Ranger Broiler - Performance Objectives*.

[84] Ghasempour and Ahmadi, "Evaluation of Environmental Effects in Producing Three Main Crops (Corn, Wheat and Soybean) Using Life Cycle Assessment".

calculate, I model the total GWP per kg of feed and per kg of chicken for slow- and fast-growth chickens.

There are two primary limitations to this indirect land use and feed analysis. First, the GWP estimate per crop type that Ghasempour and Ahmadi use is from a region of Iran and likely inaccurate with respect to US maize, soybean, and wheat production. While this implies that the scale of the emissions are inaccurate, the relative differences between the three crops are likely accurate given similar methodologies. Second, I use wheat as a proxy for "other cereal," and this proxy is not fully reflective of actual feed composition. For the purpose of this analysis, wheat remains static irrespective of protein requirements but nevertheless it implies that the net GWP is imprecise in terms of the scale of emissions.

For the second part of this section, I estimate how the widespread adoption of slow-growth chicken would affect quantity demanded of a substitute good – beef – as an indicator of the indirect effects of an overhaul of the chicken population. To do so, I use the cross-price elasticity of chicken to beef to determine updated quantity demanded of beef, and then a life-cycle analysis of the environmental externalities associated with beef to calculate the increase in emissions.

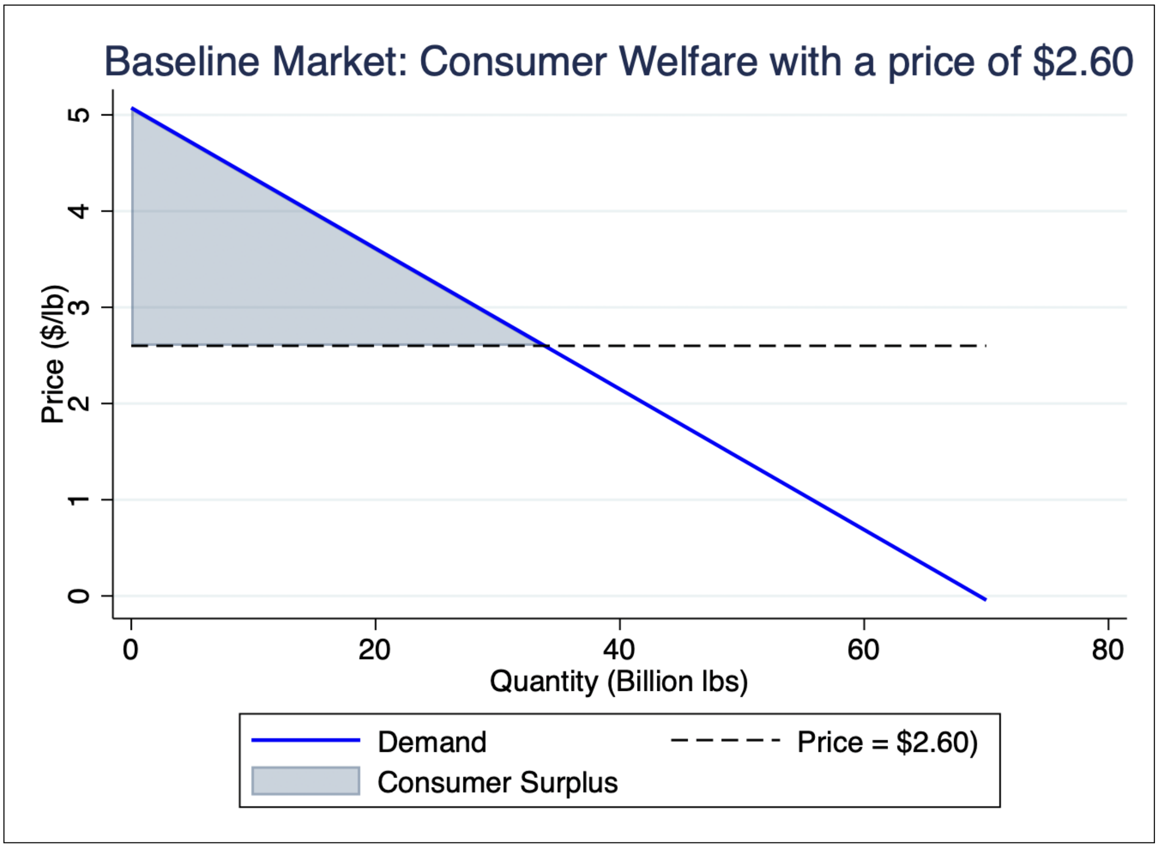
8 Data Analysis

8.1 Consumer Welfare and Market Dynamics

A transition to slow-growing chickens would undoubtedly change the taste, nutrition, and price of chicken meat. But the subsequent question is difficult to answer: is this change net good or bad for consumers?

One way to assess the net effect on consumers is through the lens of consumer welfare – the benefit derived from purchasing a good at a market price lower than what consumers are willing to pay. This is typically measured using consumer surplus. Graphically, consumer surplus is the size of the area between the demand curve and the price of the good.[85] Below is a baseline graph (Figure 1) to give a visual representation of consumer surplus.[86]

Figure 1:



My question is essentially: if all fast-growth chickens in the U.S. are replaced by slow-growth chickens, how does consumer welfare change? Because slow- and fast-growing chickens are ultimately similar goods with different pricing and consumer willingness to pay (WTP), I assume slow-growth own-price elasticities are equal to fast-growth own-price elasticities. The goal is to estimate the change in consumer surplus resulting from the increased price associated with a transition to slow-growth chicken.

[85] Lusk, Thompson, et al., "The Cost and Market Impacts of Slow-Growth Broilers".

[86] The slope and intercepts of the demand curve shown in the figure are not empirically accurate to the poultry market. Rather, the graph is included to visually illustrate how consumer surplus is represented in a typical supply and demand framework. You do not need to use or specify anything about supply elasticity to calculate welfare changes from price changes.

Expected price premiums for slow-growth chickens are variable, but Lusk et al. estimate premiums to range from \$0.10/lb to \$0.36/lb.[87] Furthermore, Lusk et al. show that consumers are willing to pay around \$0.18/lb more for chicken marketed as slow-growth.[88]

Starting with the original fast-growth chicken price of \$2.60/lb,[89] the mean slow-growth price premium of \$0.23 increases the price to \$2.83/lb. However, because consumers are also willing to pay more for slow-growth chicken due to perceived improvements in taste and nutrition, the estimated willingness to pay (WTP) is \$2.78/lb. This WTP figure is slightly noisy, as it averages across several different labeling practices and studies, but it is the best available estimate of consumer valuation.

The net cost burden on the consumer, therefore, is the difference between the price and the willingness to pay: \$2.83 - \$2.78 = \$0.05/lb. While the actual marginal cost of slow-growth chicken may vary, particularly under premiums ranging from \$0.10 to \$0.36/lb, this estimate is grounded in the best available market data.

Now, to understand how the price change impacts chicken consumption and net consumer welfare. Using data on how sensitive buyers are to price changes (an "elasticity" of -1.05),[90][91] a 1.9% price increase (from \$2.78 to \$2.83) reduces annual U.S. chicken consumption by:

$$\%\Delta Q = -1.05 \times 1.9\% \approx -2.0\%.$$

Therefore, total U.S. consumption falls from 33.84 billion pounds to 33.16 billion pounds per year. The consumer welfare loss from this price burden (\$0.05/lb) and re-

[87] Lusk, Thompson, et al., "The Cost and Market Impacts of Slow-Growth Broilers".

[88] This estimate of their increased willingness to pay is adjusted to the price premium used here rather than the one used in the original paper.

[89] "USDA ERS - Meat Price Spreads".

[90] A measure of how much demand for a product changes when its price changes. This estimate is uncompensated, meaning it measures how the quantity demanded of chicken changes in response to a price change holding income constant but allowing the consumer's purchasing power and income effect to change. Therefore, it is considered the Marshallian elasticity of demand.(McConnell et al., *Microeconomics*)) I use their estimates of the own-price elasticity within the United States given elasticity varies between geographic region and culture.

[91] Bouyssou et al., "Food for thought".

duced consumption is calculated as the area beneath the demand curve between these two points.

Importantly, this loss includes two parts: (1) the reduction in consumer surplus from buyers who stop purchasing chicken due to the price increase (a triangle), and (2) the increased cost paid by consumers who continue buying chicken despite the price change (a rectangle). In total, this area forms a trapezoid, calculated as follows:

$$\Delta CS \approx \left[\frac{1}{2}(Q_0 + Q_1)\right] \times (P_1 - P_0)$$

$$\approx \frac{1}{2}(33.84 + 33.16) \times 0.05 = 33.5 \times 0.05 = \boxed{\$83.75 \,\text{million per year}}.$$

Therefore, the size of the difference in consumer welfare between the slow- and fast-growth markets is approximately $83.75 million per year using the mean estimate for a price premium. This estimate reflects both reduced consumption and the higher cost paid by consumers who continue to purchase chicken. Using the mean price premium, though, ignores variability in the range of expected price changes. Therefore, below, I conduct a sensitivity analysis to look at the range of welfare impacts depending on the minimum and maximum predicted price premiums.

If the price rises by $0.10/lb (best case):

$$\text{Net Burden} = 0.10 - (0.10 \times 0.777) = \$0.02/\text{lb},$$
$$Q_1 = 33.84 \times (1 - 1.05 \times 0.02) \approx 33.13,$$
$$\Delta CS \approx \frac{1}{2} \times (33.84 + 33.13) \times 0.02$$
$$\approx \boxed{\$0.67 \,\text{billion-lbs} \times 0.02 = \$13.4 \,\text{million/year}}.$$

If the price rises by $0.36/lb (worst case):

$$\text{Net Burden} = 0.36 - (0.36 \times 0.777) = \$0.08/\text{lb},$$

$$Q_1 = 33.84 \times (1 - 1.05 \times 0.08) \approx 30.97,$$
$$\Delta CS \approx \frac{1}{2} \times (33.84 + 30.97) \times 0.08$$
$$\approx \boxed{\$2.65\,\text{billion-lbs} \times 0.08 = \$212.1\,\text{million/year}}.$$

The results show that under this mean expected price premium for improved nutrition and taste, annual chicken consumption and consumer welfare are lower for slow-growth chicken than fast-growth chicken by approximately $83.75 million per year. When we test the sensitivity of this estimate to the lower and upper bounds of predicted price premiums, welfare losses range from $13.4 million per year to $212.1 million per year. While, all else equal, chicken consumption decreasing is net positive for the environment and chicken welfare, consumer welfare declines with the fall in consumption.

8.1.1 Supply Curve Shift Impacts on Low-Income Households

The previous analysis uses a singular own-price elasticity for demand, i.e. it is effectively assuming that all consumers, regardless of income, respond similarly to price changes. This is a simplifying assumption that averages out differences in expected behavior change between households in different income strata.[92] To avoid this over-simplification, and to focus on the group that arguably requires the most attention – lower-income households – below is an extended analysis that shows the specific welfare loss for lower-income households.

The elasticity estimate I use for this section differs from the previous own-price elasticity due to a difference in the cut of the meat product, the methodology of analysis, and the considerations regarding income. Bouyssou et al. considers the entire chicken and the entire U.S. population base, whereas the Lusk et al. paper considers just breast meat split between income brackets. The estimates of Lusk et al. are $\varepsilon_L = -1.503$, $\varepsilon_M = -1.394$, and $\varepsilon_H = -1.151$, each of these corresponding to an income bracket with L corresponding to low-income, M for middle-income, and H for high-income.[93] All of

[92] McConnell et al., *Microeconomics*.

[93] Lusk and Tonsor, "How Meat Demand Elasticities Vary with Price, Income, and Product

these elasticity values are negative, with the absolute values given above; therefore, they follow the general law of demand – when the price increases, the quantity demanded decreases.

Transition to slow-growth chickens imposes costs on consumers through higher prices, but these costs are not distributed equally. Lower-income households face disproportionate burdens due to differences in spending patterns and financial flexibility.[94] While all consumers experience the same nominal price increases, lower-income households spend a significantly larger share of their budgets on basic necessities like food, leaving them more vulnerable to price hikes.[95] This analysis compares the impacts on low- and high-income households, emphasizing both absolute losses (in dollar terms) and proportional burdens (relative to income).

For every 1% increase in the price of chicken, low-income households reduce purchases by 1.5%, compared to a 1.15% reduction by high-income households. This difference reflects tighter budget constraints: chicken represents 5.7% of food spending for low-income families but only 1.2% for high-income families. The "net burden" of switching to slow-growth chickens – the effective price increase after accounting for consumers' willingness to pay (WTP) for perceived benefits – is critical. Using a mean price increase of $0.23/lb and a WTP adjustment of $0.18/lb (based on consumer surveys), the net burden becomes $0.05/lb. This smaller, adjusted price drives behavioral changes and welfare losses.

To calculate these welfare losses, I use the full area beneath the demand curve – not just the triangle reflecting foregone consumption, but also the rectangle that reflects higher prices paid by continuing consumers. This approach yields the total consumer surplus loss as the area of a trapezoid:

Category".

[94] McConnell et al., *Microeconomics*.

[95] Lusk and Tonsor, "How Meat Demand Elasticities Vary with Price, Income, and Product Category"; McConnell et al., *Microeconomics*.

$$\Delta CS \approx \left[\frac{1}{2}(Q_0 + Q_1)\right] \times (P_1 - P_0)$$

Under the mean net burden ($0.05/lb), both income groups experience substantial absolute welfare losses: approximately $213 million/year for low-income households and $271.6 million/year for high-income households. While these losses appear larger for high-income consumers in absolute terms, they impose dramatically different impacts on the lived experiences of both groups. For example, losing $100 imposes minimal hardship on a high earner but significant strain on someone living paycheck-to-paycheck. Similarly, a $213 million loss represents a far larger share of low-income households' total food spending compared to high-income households.

To test robustness, a sensitivity analysis evaluates worst- and best-case price increases (Table 1). In extreme scenarios, absolute losses diverge:

Table 1: Sensitivity Analysis - Welfare Losses by Scenario and Income Group

Scenario (Price Increase)	Income Group	Net Burden ($/lb)	Welfare Loss ($M/year)
Best-case ($0.10/lb)	Low-income	0.02	85.2
	High-income	0.02	108.6
Mean-case ($0.23/lb)	Low-income	0.05	213.0
	High-income	0.05	271.6
Worst-case ($0.36/lb)	Low-income	0.08	341.0
	High-income	0.08	434.5

Notes: Net burden = Price increase - (Price increase × 0.777). The 0.777 ratio reflects willingness-to-pay (WTP) for slow-growth chicken.[96] Elasticities: Low-income = -1.503; High-income = -1.151. Welfare loss estimates include both the triangle and the rectangle beneath the demand curve to reflect full surplus loss. Baseline quantities: 4.31B lbs (low-income), 5.49B lbs (high-income).

Under a worst-case price hike ($0.36/lb), high-income households lose $434.5 million/year compared to $341.0 million/year for low-income households. This divergence arises because high-income households start with larger baseline consumption (5.49 billion lbs vs. 4.31 billion lbs), amplifying their absolute losses despite lower price sensitivity. However, proportional burdens remain tilted toward low-income households: their losses consume 4.75 times more of their food budgets.

The price premium for slow-growth chicken resembles a regressive tax – one that takes a larger percentage of income from lower-income households. Like a flat tax on t-shirts, the price increase applies equally across all income groups. However, because food accounts for a greater share of spending in low-income households, the impact disproportionately affects low-income groups. While high-income households lose more in absolute dollars under extreme price shocks, low-income households bear heavier relative burdens due to constrained budgets. This disparity likely understates true impacts, as lower-income households may value labeling benefits (e.g., animal welfare, taste) less than wealthier consumers, further increasing their effective net burden.

In conclusion, price increases from production shifts impose measurable harms on all consumers, but these harms are neither morally nor economically neutral. Lower-income households shoulder disproportionate sacrifices, even when dollar losses showcase that high-income households are affected more. Policymakers and industry stakeholders must weigh these equity concerns against potential benefits of transitioning to slow-growth poultry.

8.2 Chicken Welfare

Beyond the consumer, the chicken itself must be considered. Hedonistic act utilitarianism dictates that an individual "act" is morally right if and only if it produces as much pleasure minus pain as an alternative act available to the agent.[97] In other words, utility can be defined as pleasure minus pain. Therefore, to justify fast-growth chicken industrial production, an individual who subscribes to hedonistic utilitarianism must prove that the fast-growth chicken model produces more – or the same amount – of utility as the slow-growth chicken model.

Some complex models attempt to determine a chicken's relative moral weight and suffering in factory farms compared to human utility. However, given I am not comparing chicken utility to human utility, I disregard arguments discussing the moral "patient-hood"[98] of chickens. Rather, I attempt to determine the relative utility experienced by chickens under different farming infrastructures (and assume constant probability of moral patient-hood between slow- and fast-growth chickens). As such, the only variables of interest are population size, lifespan, and quality of life under the two systems. Principal to this analysis is understanding the difference in lifespan: fast-growth chickens are slaughtered, on average at 42 days old while slow-growth chickens are slaughtered, on average, at 69 days old.[99]

First, following Espinosa et al., I estimate the utility level v of an animal species s using the function:[100]

[97] Rosenqvist, "Hedonistic Act Utilitarianism".

[98] Moral patient-hood is defined as whether an object is of moral concern or consideration.

[99] Chan et al., "The 'sustainability gap' of US broiler chicken production"; *Ross 308 /308 FF Broiler - Performance Objectives*; *Rowan Ranger Broiler - Performance Objectives*.

[100] Espinosa and Treich, *The Animal-Welfare Levy*.

$$v = \theta_s * m \int_{t=0}^{t=T} q(t)dt$$

where $q(t)$ is the animal-welfare score at any point in time t, θ_s is the utility potential of a species s, and m is the monetization parameter that allows for the transformation of utility points into monetary units.

Given slow- and fast-growth chickens have similar capacity to experience emotion and reality, their "moral patient-hood" is equal. For Espinosa et al., "moral patient-hood" roughly equals "utility potential" or the intensity for which different species of animals experience the world. Therefore, for the purpose of this analysis, θ_s is considered fixed and equal for both breeds.

To calculate the animal-welfare score at any point in time, Espinosa et al. uses the Five-Freedoms framework.[101] The framework outlines principles that should guide the care of animals under human control, and explicitly include: (1) freedom from hunger, malnutrition, and thirst; (2) freedom from fear and distress; (3) freedom from heat stress or physical discomfort; (4) freedom from pain, injury, and disease; and (5) the freedom to express normal patterns of behavior.

These Five Freedoms can be either attained or violated to different extents; the extents of these violations can be mild, moderate, severe, or very severe. Violations therefore increase in severity sequentially from 0 to 5. "Misery scores" or quality-adjusted life scores[102] are calculated by using the total number of violation points (W) for various breeds under different systems. W_0, defined as the "mercy killing point" is the point at which welfare becomes negative i.e., the number of freedom-violation points above which an animal's life is no longer worth living. While rather conservative, Espinosa et al. assume that welfare is linear: the animal welfare score can be determined with the

[101] Brambell, "Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems."

[102] Quality-adjusted life scores (QALYs) are a metric used in health economics to measure the impact of an intervention on both the quantity and quality of life.(Budolfson et al., "Monetizing Animal Welfare Impacts for Benefit–Cost Analysis")

following formula:

$$q(t) = \frac{W_0 - W(t)}{W_0}$$

This formula implies that each additional violation point reduces animal welfare by the same amount: a constant marginal disutility of a welfare violation. In other words, given welfare is considered "linear", severe violations of some fundamental needs can be "fixed" by improving standards in other fundamental needs. This is a quite conservative assumption.

In Espinosa et al., they consider two scenarios: $W_0 = 7$ and $W_0 = 10$. To attain these estimates, Espinosa et al. polled a representative UK sample and asked two different questions to respondents: when is a chicken's life net negative in welfare and when is a chicken's life "not worth living." They attained the estimate $W_0 = 7$ for the latter and $W_0 = 10$ for the former. While arguably similar questions, given they received different responses depending on the framing of the question, Espinosa et al. include both metrics in analysis. The further implication of this difference, though, is the rather subjective nature of this manner of polling, and therefore a relatively large error term. To build on their results and adapt their approach to the US poultry production system, I make four alterations: (1) I exclude the monetary conversion parameter given I am not attempting to calculate the size of a tax[103] to internalize the welfare externality imposed on chickens from human poultry consumption, (2) I exclude the "utility potential" as it is irrelevant when comparing such similar breeds, (3) I alter the lifespan durations to adapt it appropriately to US broiler production – Espinosa et al. use EU standard life spans instead of

[103]In environmental and welfare economics, a tax is a policy meant to force producers to pay a tax equal to the external damage (i.e. externality) that is caused by their production decisions. Taxes are applied in order to allow the market to take into consideration the full costs associated with a good. In this instance, the welfare cost to the chicken is not considered in the price of chickens, so therefore Espinosa et al. are attempting to determine the size of the externality imposed on chickens in order to develop a tax to internalize the welfare externality of industrial broiler production. While related to my research, the issue of appropriate taxing is a corollary and not directly related to my policy recommendation and therefore excluded.(McConnell et al., *Microeconomics*)

US. Therefore, the updated formula is:

$$v = \int_{t=0}^{t=T} q(t)dt, \text{ where } q(t) = \frac{w_0 - w(t)}{w_0}$$

W_0 is a benchmark level of cumulative welfare violations – effectively the threshold beyond which a chicken's life is considered "not worth living" – and $W(t)$ is the total number of welfare violation points the chicken has experienced at time t.

The net welfare value of a chicken over its lifetime, denoted v, is calculated by integrating $q(t)$ from birth ($t = 0$) to death ($t = T$). However, because $W(t)$ is modeled as a piecewise constant function – assuming welfare is constant within each life stage (e.g., farm, transport, abattoir) – I can simplify the integral to a summation over discrete periods of the chicken's life:

$$v \approx \sum_{t=0}^{T} \frac{W_0 - W(t)}{W_0}$$

$$\approx \sum_{\text{period}} days_{\text{period}} \cdot \frac{W_0 - W_{\text{period}}}{W_0}$$

In this equation, $days_{\text{period}}$ refers to the number of days a chicken spends in each distinct stage of life—on the farm, in transport, and at the abattoir. W_{period} is the total number of welfare violation points incurred in that specific period. This simplification reflects that welfare violations accumulate differently depending on the stage of production and allows for easy comparison across breeds or systems by plugging in stage-specific values.

The tables below summarize these values for fast- and slow-growth breeds, respectively, including the violation point assessments drawn from Espinosa et al., and the time spent in each life stage. These values are then used to compute total lifetime welfare under different W_0 thresholds.

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Table 2: Fast-growth Welfare-Score

	Farm	**Transport**	**Abattoir**
Freedom from hunger, malnutrition, thirst	Mild (1)	Moderate (2)	Moderate (2)
Freedom from fear, distress	Severe (3)	Very severe (4)	Very severe (4)
Freedom from heat stress, physical discomfort	Very severe (4)	Very severe (4)	Very severe (4)
Freedom from pain, injury, disease	Very severe (4)	Severe (3)	Severe (3)
Freedom to express normal patterns of behavior	Very severe (4)	Very severe (4)	Very severe (4)
Total number of violation points: $W(t)$	16	17	17
Number of days	40	1	1

,

Table 3: Slow-growth Welfare-Score

	Farm	**Transport**	**Abattoir**
Freedom from hunger, malnutrition, and thirst	Mild (1)	Moderate (2)	Moderate (2)
Freedom from fear and distress	Severe (3)	Very severe (4)	Very severe (4)
Freedom from heat stress or physical discomfort	Severe (3)	Severe (3)	Severe (3)
Freedom from pain, injury, and disease	Severe (3)	Severe (3)	Severe (3))
Freedom to express normal patterns of behavior	Very severe (4)	Very severe (4)	Very severe (4)
Total number of violation points: $W(t)$	14	16	16
Number of days	67	1	1

First, to do just $W_0 = 7$ and $W_0 = 10$ and use the violation point data from Espinosa et al.:

$$W_0 = 7 \quad \begin{cases} \textbf{Fast} = \sum_{\text{p}} days_p \cdot \frac{7-W_p}{7} = \boxed{-54.29} \\ \textbf{Slow} = \sum_{\text{p}} days_p \cdot \frac{7-W_p}{7} = \boxed{-69.57} \end{cases}$$

$$W_0 = 10 \begin{cases} \textbf{Fast} = \sum_{\text{p}} days_p \cdot \frac{10-W_p}{10} = \boxed{-25.4} \\ \textbf{Slow} = \sum_{\text{p}} days_p \cdot \frac{10-W_p}{10} = \boxed{-28} \end{cases}$$

where $p =$ period

These calculations show that slow-growth chickens have net lower utility. While slow-growth chickens have per-day higher welfare, over their extended lifespan they have lower net welfare. The wide-scale adoption of slow-growth chickens would lead to a larger population of broilers with lower welfare. Overall, this signals that fast-growth rates are counterintuitively "better" for minimizing the pain and suffering of industrially raised chickens.

8.2.1 Threshold Analysis

In the previous section, we found that fast-growth chickens had a higher (i.e., less negative) net welfare score than slow-growth chickens under the violation scoring system outlined by Espinosa et al. However, this conclusion depends critically on the assumed welfare violation scores, especially in the farm stage, where slow-growth chickens spend significantly more time. This opens an important question:

> *How much would welfare conditions for slow-growth chickens have to improve for them to have higher lifetime utility (i.e., less suffering) than fast-growth chickens?*

To evaluate whether slow-growth chickens offer greater welfare than fast-growth breeds, I conduct a threshold analysis. Specifically, I solve for the maximum farm-stage welfare violation score ($W_{\text{farm}}^{\text{slow}}$) at which the total lifetime welfare of a slow-growth chicken just exceeds that of a fast-growth chicken. In other words, I solve for the point at which:

$$v_{\text{slow}} > v_{\text{fast}}$$

Here, v represents the total lifetime welfare score of a chicken, calculated as the sum of welfare violation points for each stage of life, weighted by the number of days spent in that stage. The lifetime welfare score is computed as:

$$v = \sum_{\text{period}} \text{days}_{\text{period}} \cdot \frac{W_0 - W_{\text{period}}}{W_0}$$

This equation reflects the idea that welfare loss increases as the observed violation score (W_{period}) deviates from a maximum potential welfare score W_0. The denominator normalizes scores across different assumptions about ideal welfare levels.

Using a maximum welfare score of $W_0 = 10$ and welfare violation data from Espinosa et al., the lifetime welfare score for a fast-growth chicken is calculated as:

$$v_{\text{fast}} = 40 \cdot \frac{10-16}{10} + 1 \cdot \frac{10-17}{10} + 1 \cdot \frac{10-17}{10}$$

$$= -24 - 0.7 - 0.7 = \boxed{-25.4}$$

For a slow-growth chicken, we hold the transport and abattoir scores constant and solve for the unknown farm score $x = W_{\text{farm}}^{\text{slow}}$:

$$v_{\text{slow}} = 67 \cdot \frac{10-x}{10} + 1 \cdot \frac{10-16}{10} + 1 \cdot \frac{10-16}{10}$$

$$= 67 \cdot \frac{10-x}{10} - 0.6 - 0.6 = 67 \cdot \frac{10-x}{10} - 1.2$$

Solving the inequality, $v_{\text{slow}} > v_{\text{fast}}$, we then get:

$$67 \cdot \frac{10-x}{10} - 1.2 > -25.4 \implies 67 \cdot \frac{10-x}{10} > -24.2 \implies 67 \cdot (10-x) > -242$$

$$\implies 10 - x > -3.6119 \implies x < \boxed{13.6119}$$

This result suggests that, under a 10-point welfare scale, the farm-stage violation score must be below 13.61 for slow-growth chickens to offer greater lifetime welfare. To test whether this conclusion holds under a stricter welfare standard, I repeat the analysis with $W_0 = 7$ and find that the threshold is lower: $W_{\text{farm}}^{\text{slow}} < 12.40$.

These results highlight that lifespan alone does not determine welfare superiority. Although slow-growth chickens live longer, they are also exposed to adverse conditions for more days. For slow-growth breeds to offer better welfare outcomes overall, the per-day level of suffering must be significantly lower. Because the farm-stage accounts for the vast majority of a chicken's life, improving welfare during this phase is especially critical to improving total lifetime welfare.

Overall, these findings highlight the high sensitivity of the analysis: even marginal reductions in per diem suffering for slow-growth chickens could *flip* the results. If slow-growth breeds suffer less than current estimates suggest, their total net suffering could fall below that of fast-growth populations. Such reductions in suffering could be achieved either through improved breeding that mitigates health issues without increasing lifespan or implementation of other elements of the BCC, particularly enhanced housing practices.

This analysis, therefore, shows that under these assumptions of expected welfare gains for an isolated breed switch, the total net population of slow-growth chickens has lower utility than the fast-growth population. Yet, this estimate is highly sensitive to per diem suffering and therefore investment in improving per diem welfare could be extremely influential in altering the utility calculations.

Furthermore, the above calculations demonstrate that, in order to maximize chicken welfare—regardless of whether fast- or slow-growth breeds are used—the optimal quantity of industrially raised chickens is zero. Since utility is negative for all breeds, the most definitive way to reduce chicken disutility is to eliminate industrial chicken production altogether.

8.3 Environmental Externalities

The National Chicken Council (NCC) and the Better Chicken Commitment (BCC) both claim that their approach is the more "environmentally sustainable" option. To evaluate these claims, I examine two key areas: (1) land use associated with chicken production and (2) the impact of changing chicken growth rates on related markets. In the first section, I present supplementary calculations to assess whether the total amount of cultivated land or the type of cultivation has a greater environmental impact. In the second, I analyze the expected externalities in the beef market, a substitute good[104], to understand how shifts in poultry production may influence broader agricultural systems.

8.3.1 Land Use

Land use can be considered in two manners: direct and indirect.[105] Direct land use is the physical space needed to raise the chicken – for example, the factory itself – while indirect land use is the amount of land used for all other purposes to grow the chicken – for example, the cropland for the feed and the waste management facilities. While an increase in the chicken population would necessitate more direct land use, the environmental implications of this growth are well-studied and marginal compared to the indirect land use costs.[106] Therefore, I primarily discuss the indirect land use costs and the implications of the switch on feed cultivation and its relevant greenhouse gas emissions.

While the NCC claims that switching to slow-growth breeds necessitates additional feed cultivation which has higher environmental externalities, the BCC groups claim that switching to slow-growth chickens requires different feed compositions that have lower environmental externalities.[107] Therefore, the question is obvious: what is the marginal[108] environmental footprint of each chicken?

The first step is determining the differential feed compositions. Chan et al., considers the land requirements from the variably-sized chicken populations under fast- versus slow-growth systems.[109] According to Chan et al., the feed breakdown for Ross 308 is roughly as follows:

$$F(f) = 26.8\% \text{ soy} + 60.3\% \text{ maize} + 12.9\% \text{ wheat}$$

[104] A substitute good is a product or service that can replace another because it serves a similar function. For example, when Coca-Cola prices rise, consumers may switch to Pepsi, viewing them as interchangeable in the soft drink market.

[105] Searchinger et al., "The Global Land Squeeze".

[106] Chan et al., "The 'sustainability gap' of US broiler chicken production".

[107] *The Better Chicken Commitment - BCC [US].*

[108] In economics, a marginal benefit or cost refers to the additional gain or loss resulting from one more "unit" of a good or service.

[109] Chan et al., "The 'sustainability gap' of US broiler chicken production".

where $F(f)$ represents the typical feed composition for fast-growth breeds such as Ross 308.

Yet, when analyzing the indirect land use costs from feed, they use the same nutritional diet for both fast- and slow-growth breeds. Scientific literature on necessary protein requirements for slow-and fast-growth chicken breeds, however, has determined that slow-growth breeds require about half the amount of protein as fast-growth chickens to maximize feed efficiency.[110] Therefore, a simplistic estimate of a general slow growth diet involves reducing the soy component by 50%:

$$F(s) = 13.4\%\ \text{soy} + 73.7\%\ \text{maize} + 12.9\%\ \text{wheat}$$

where $F(s)$ denotes the adjusted feed composition for slow-growth breeds, reflecting their lower protein needs

The second step is determining the environmental externality from these differential feed compositions. Using estimates on the global warming potential (GWP) of each of these crops – a metric that converts all greenhouse gas emissions per kg of harvested crop into standardized CO_2 units — I estimate the per crop and net greenhouse gas emissions it would require to produce 1 kg of feed. Given the GWP of soy compared to maize and wheat is variable depending on geographic location and management practices, I use a conservative estimate to determine a "worst-case scenario" where soy is substantially more environmentally taxing than maize and wheat.[111] This approach should provide an upper bound estimate of the environmental benefit of reducing soy cultivation for feed in a scenario where there is a widespread shift to slow-growth chicken production. The third step is to determine the per kg of meat GWP based off of cumulative feed intake at slaughter weight for both breeds. These outputs are displayed in Table 4, Figure 2, Figure 3, and Figure 4.

[110] Han and Baker, "Lysine Requirements of Fast- and Slow-Growing Broiler Chicks1".

[111] Ghasempour and Ahmadi, "Evaluation of Environmental Effects in Producing Three Main Crops (Corn, Wheat and Soybean) Using Life Cycle Assessment"; Martínez and Valdivié, "Efficiency of Ross 308 broilers under different nutritional requirements".

Table 4: Global Warming Potential Comparison of Feed Compositions

GWP*	SG Diet	FG Diet	% Diff.
Maize	73.21	59.90	-18.2%
Soy	19.84	39.69	+100.02%
Wheat	14.04	14.04	+0.00%
Per kg feed	107.09	113.63	+6.1%
P/C	534.72	407.24	-23.84%
Per kg of meat	211.61	184.98	+14.4%
P/C cum. intake of feed in kg	5.924	4.586	-28.4%

Abbreviations: SG Diet = slow-growth breed diet, FG Diet = fast-growth diet, GWP = global warming potential, P/C = per chicken, cum = cumulative. *Note:* GWP is calculated using kg CO_2 equivalent. It is a noisy estimate of GWP magnitude, but relative differences are accurate.

Therefore, while soy GWP and total GWP per kg of feed increase under fast-growth diets, wheat GWP and per chicken GWP decrease under fast-growth diets. This difference is further demonstrated in Figures 2, 3, and 4.

Figure 2:

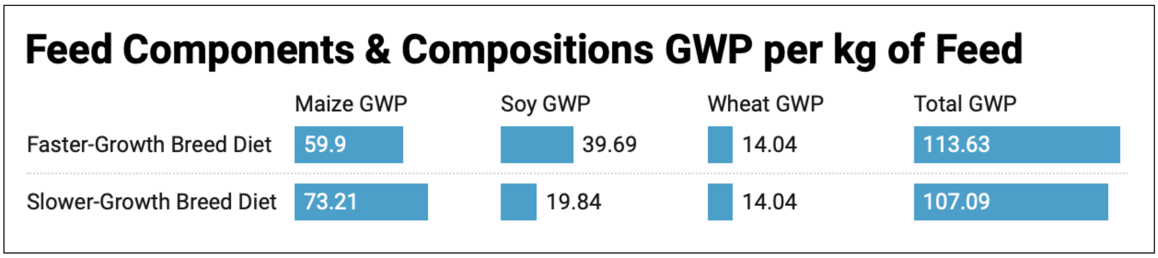

Figure 3:

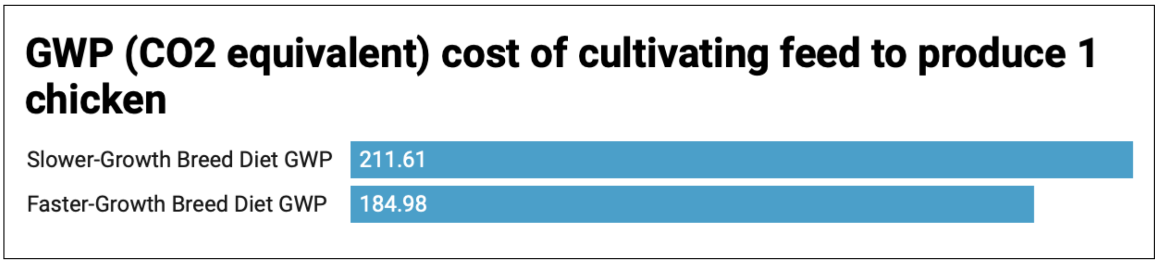

Figure 4:

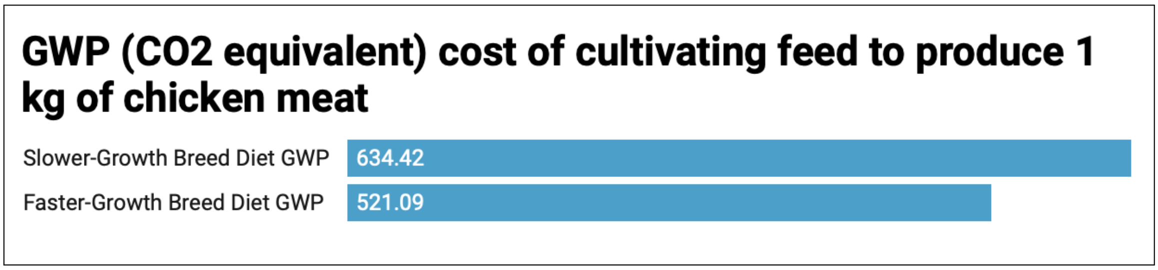

Figure 2 shows the amount of CO_2 equivalents emitted from each crop's part of the 1 kg of feed — e.g., per 1 kg of feed in a slow-growth breed diet, the maize component of the feed emits roughly 73 kg CO_2 equivalents. The main takeaway from these calculations is that slow-growth feed compositions, per kg of feed produced, have lower GWP externalities than fast-growth breeds. Figure 3 shows the GWP cost to produce one chicken, and Figure 4 shows the GWP cost to produce 1 kg of slow- versus fast-growth chicken meat. The main takeaways from these figures are that fast-growth breeds, per kg of meat and per chicken, have lower GWP than slow-growth breeds.

Even with the same data, how one uses the data is critical. The table and charts all use standardized, published, and accessible data – data that does not lie. Yet a study's methodology holds drastic implications for appropriate interpretation. Figure 2, 3 and 4 look at the same base data: the emissions cost of producing feed for chickens. But the specific outcome of interest, whether that be the GWP per kg of feed or GWP per kg of meat or GWP per chicken produced, reverses the relative environmental externalities associated with each breed's feed. Evidence can be mustered to support either the widespread adoption of slow-growth breeds or fast-growth breeds.

Understanding the environmental implications of different feed compositions and quantity requirements is critical given land use is one of the most significant environmental externalities of industrial animal agriculture.[112] Even small changes in feed re-

[112] Searchinger et al., "The Global Land Squeeze".

quirements or crop composition – such as a shift from soy to maize – can have long-lasting deleterious implications for emissions, deforestation, water use, and biodiversity loss across global agricultural supply chains. This analysis, therefore, shows that while slow-growth chickens may reduce greenhouse gas emissions per kilogram of feed produced, they require more feed per unit of meat, resulting in higher emissions per kilogram of meat. This trade-off underscores how the choice of outcome – whether per unit of feed or meat – profoundly shapes the narrative around which products are "better" for environmental sustainability. Because of the sheer scale of the poultry industry, which produces over 9.5 billion chickens in the US each year, even marginal changes in feed efficiency or crop allocation translate into enormous shifts in land use and carbon emissions. Thus, feed-based land use analysis is not a minor technical question, but a major determinant of whether proposed welfare improvements align with broader climate goals.

8.3.2 Beef Substitution

Meat markets are related: changes in the demand and production of one often affect the other. When the price of chicken increases, consumers may shift their purchases toward beef, which is commonly considered a "substitute good" for chicken.[113] However, per pound, beef has significantly higher environmental externalities and land use implications due to different production systems—for example, beef cattle often graze on pasture land rather than being raised in enclosed facilities.

In this section, I estimate the indirect environmental effects of switching all chicken production from fast- to slow-growth breeds. This change would result in a systematic shift in the poultry supply curve, increasing the equilibrium price of chicken. I then calculate how this price increase would affect beef consumption, using the cross-price elasticity between chicken and beef. The goal is to determine the environmental consequences of the resulting increase in beef demand, specifically through additional water use, land use, energy consumption, and greenhouse gas emissions.

[113] McConnell et al., *Microeconomics*.

A switch to slow-growth breeds, as shown above, leads to an 8.85% price increase for chicken. Given the cross-price elasticity, $\varepsilon_{\text{chicken-beef}} = 0.023$[114] and baseline consumption,[115] I determine that quantity demanded of beef would increase by 56.5 million lbs/year given the proposed price premium for chicken, as shown below:

$$\%\Delta Q_{\text{beef}} = \varepsilon_{\text{chicken-beef}} \times \%\Delta P_{\text{chicken}}$$

$$= 0.023 \times 8.85\% = 0.20355\%$$

$$\Delta Q_{\text{beef}} = Q_{\text{beef, initial}} \times 0.0020355$$

$$= 27.8 \times 0.0020355 \approx 0.0565\,\text{billion lbs/year} = \boxed{\text{56.5 million lbs/year}}$$

In other words, a shift to slow-growth chicken across the entire industry would lead to an estimated 56.5 million additional pounds of beef consumed annually (roughly 25.68 million kg). To estimate the environmental consequences of this shift, I use life-cycle analysis data from Asem-Hiablie et al., which calculates environmental impacts of beef production across two stages—cradle-to-farm gate and post-farm gate.[116] The results (Table 5) show the environmental impact of this marginal increase in beef consumption.

Table 5: LCA of Environmental Impacts of Beef

	Per kg of beef	**Total Increase (from 25.68M kg)**
Water Use	7005 L	396 million L
Energy Use	1110 MJ	62 billion MJ
Land Use	47.4 m^2	2.6 billion m^2
Global Warming Potential	48.4 kg CO_2 eq	2.7 billion kg CO_2 eq
Ozone Depletion Potential	1686 μg CFC_{11} eq	95.5 billion μg CFC_{11} eq

This analysis provides a preliminary estimate of the environmental spillovers result-

[114]Tonsor and Bina, "Assessing Cross-Price Effects of Meat Alternatives on Beef, Pork, and Chicken Retail Demand in 2022".

[115]*Slaughter - Annual for CATTLE - Quick Stats Lite*.

[116]Cradle-to-farm gate refers to resource use and emissions from birth through animal rearing; post-farm gate includes slaughter, processing, and distribution.

ing from a full switch to slow-growth chicken breeds. While market dynamics would likely adjust over time—potentially improving beef production efficiency or distributing demand across other substitute meats—this calculation offers a short-term view of the consequences in the beef market. It also serves as a template for further modeling of related markets such as pork, fish, or lamb, highlighting how seemingly isolated changes in one sector can have far-reaching ripple effects across the broader food system.

9 Discussion

The findings of this analysis reveal a complex interplay of economic, ethical, and environmental trade-offs inherent in the debate over broiler chicken growth rates. While the Better Chicken Commitment (BCC) advocates for slow-growth breeds to improve individual chicken welfare, the data underscores unintended consequences that challenge the simplicity of this narrative.

Consumer Welfare and Market Dynamics: The projected 8.85% price premium for slow-growth chicken disproportionately burdens low-income households and offsets any perceived gains in nutrition and flavor. This aligns with existing literature highlighting poultry's role as a budget protein source for vulnerable populations.

Chicken Welfare: Counterintuitively, slow-growth systems may increase net suffering due to the larger population required to meet demand. While individual chickens experience marginally better conditions (e.g., reduced leg disorders, skin lesions, and the ability of chickens to exhibit normal behaviors), their extended lifespans in industrial settings – coupled with a 45–87% population increase – result in greater cumulative disutility. The threshold analysis shows that the utility estimator is highly sensitive to per diem suffering, and therefore marginal increases in daily welfare for slow-growth chickens are extremely pertinent. This analysis challenges the BCC's ethical framing and highlights a critical tension between individual welfare and systematic scale.

Environmental Externalities: The NCC's argument that slow-growth breeds exacerbate land use and emissions is partially validated. While slow-growth feed compositions reduce soy reliance (potentially lowering GHG emissions per kg of feed), the 30% rise in land demand and 31% higher emissions per kg of meat produced reveal a sustainability gap. Substitution effects further compound risks: a 56.5 million lb/year increase in beef consumption could add 2.7 billion kg CO_2 eq annually, undermining climate goals.

These findings underscore the limitations of siloed approaches. Economists prioritizing affordability, ethicists focusing on individual welfare, and environmentalists emphasizing emissions each capture valid concerns but fail to reconcile competing priorities. The exclusion of existential exogenous shocks in the poultry market and extreme zoonotic risks – due to scope constraints – further narrow the analysis, suggesting future models should incorporate dynamic market responses and existential threats.

Other key avenues for future research that I have chosen to exclude due to scope and resource constraints include: (1) the standardization of units across all three sectors to facilitate easy comparison on key outcomes; (2) a threshold analysis chart that delineates at what value of a "chicken life" (e.g., dollar amount from AQALY estimates) an individual's consumer welfare gain from fast-growth is offset by the harm to the animal; (3) additional research into water and waste to determine which matters more—the scale of the input and output or the management practice; and (4) additional analysis and quantification of the environmental externalities associated with substitution to other goods.

10 Policy Recommendations

Policymakers should pursue hybrid approaches that balance the competing imperatives of affordability, animal welfare, and environmental sustainability. While my analysis is constrained to the existing animal agriculture system, alternative structural interventions could shift the aforementioned dynamics entirely. Based on the findings of this research, I propose the following recommendations:

Decouple breed mandates from broader welfare improvements: While the BCC's slaughter and housing standards offer clear welfare gains, mandating slow-growth breeds introduces significant economic and environmental costs. A targeted adoption of slaughter reforms – without a blanket breed switch requirement – could yield welfare improvements with fewer unintended economic, ethical, and environmental consequences.

Encourage reduced meat consumption through public education and nudges: Given the chicken disutility and copious environmental externalities associated with factory-farmed poultry, eliminating and/or reducing broiler consumption would ease pressure on welfare and environmental systems. To promote reduced consumption, policymakers could support campaigns that normalize lower-meat diets such as through transparent labeling (e.g., GHG impact labels, improved welfare labels, etc.) and requirements for a default plant-based option in public buildings. While these interventions appear meager, even marginal shifts in cultural and behavioral norms have substantial impacts on consumption behavior that can help reduce aggregate demand and mitigate the deleterious ethical and environmental implications of the chicken industry.

Mitigate affordability challenges through subsidies or targeted assistance: To reduce the regressive impact of slow-growth price premiums, governments could introduce income-based meat subsidies or food vouchers that support low-income households while promoting higher-welfare meat choices.

Invest in sustainable protein alternatives: Public and private sector investments in cellular agriculture (i.e. lab-grown meat) and plant-based proteins could expand affordable, low-emission options and reduce reliance on environmentally-taxing substitution goods like beef.

Incentivize integrated measurement frameworks: Future policy debates would benefit from standardized tools that evaluate trade-offs across consumer, animal, and environmental domains rather than siloed approaches. Establishing consistent welfare quantification methods, life-cycle emissions models, and economic incidence assessments into policy briefs and modeling would aid in more holistic policymaking.

The goal of these policy recommendations is to reconcile competing priorities rather than elevate one set of concerns above all others.

11 Conclusion

This project demonstrates that the question of "better" chicken production defies binary answers. A shift to slow-growth systems would likely (1) reduce economic accessibility for low-income consumers, exacerbating food insecurity despite potential nutritional benefits; (2) increase net chicken suffering by prolonging lives in industrial conditions while expanding the size of the population subjected to them; and (3) intensify environmental burdens through land-use changes and beef substitution, offsetting any gains from lowering soy production.

The NCC and BCC both highlight selective metrics – whether price, welfare, or emissions – to advance competing agendas. Policymakers must recognize these trade-offs and avoid one-dimensional solutions. Instead, hybrid approaches could balance incremental welfare reforms (e.g., adopting BCC slaughter standards without breed mandates) with subsidies to offset consumer costs and investments in alternative proteins.

Ultimately, the broiler debate mirrors broader tensions in food policy and systems: well-intentioned reforms risk unintended harm without systemic analysis. As global meat demand continues to rise, my research underscores the urgency of implementing policies that coordinate economics, ethics, and the environment – not as competing priorities, but as interconnected sectors with shared interests in maximizing societal utility.

References

(PDF) Economic impact of chicken diseases and other causes of morbidity or mortality in backyard farms in low-income and middle-income countries: A systematic review and meta-analysis. URL: https://www.researchgate.net/publication/374577263_Economic_impact_of_chicken_diseases_and_other_causes_of_morbidity_or_mortality_in_backyard_farms_in_low-income_and_middle-income_countries_A_systematic_review_and_meta-analysis (visited on 09/24/2024).

Abo-Al-Ela, H. G. et al. "Stress and immunity in poultry: light management and nanotechnology as effective immune enhancers to fight stress". In: *Cell Stress & Chaperones* 26.3 (May 2021), pp. 457–472. ISSN: 1355-8145. DOI: 10.1007/s12192-021-01204-6. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8065079/ (visited on 01/17/2025).

Agudelo Higuita, N. I., R. LaRocque, and A. McGushin. "Climate change, industrial animal agriculture, and the role of physicians – Time to act". In: *The Journal of Climate Change and Health* 13 (Sept. 2023), p. 100260. ISSN: 2667-2782. DOI: 10.1016/j.joclim.2023.100260. URL: https://www.sciencedirect.com/science/article/pii/S2667278223000603 (visited on 03/29/2025).

Ayala, A. J., M. J. Yabsley, and S. M. Hernandez. "A Review of Pathogen Transmission at the Backyard Chicken–Wild Bird Interface". In: *Frontiers in Veterinary Science* 7 (Sept. 2020), p. 539925. ISSN: 2297-1769. DOI: 10.3389/fvets.2020.539925. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7541960/ (visited on 01/17/2025).

Bartlett, H. et al. "Understanding the relative risks of zoonosis emergence under contrasting approaches to meeting livestock product demand". In: *Royal Society Open Science* 9.6 (), p. 211573. ISSN: 2054-5703. DOI: 10.1098/rsos.211573. URL:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9214290/ (visited on 08/19/2024).

Baxter, M. et al. "A comparison of fast growing broiler chickens with a slower-growing breed type reared on Higher Welfare commercial farms". en. In: *PLoS ONE* 16.11 (Nov. 2021), e0259333. DOI: 10.1371/journal.pone.0259333. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC8568122/ (visited on 10/28/2024).

Beal, C. M. et al. "Economic and environmental assessment of U.S. broiler production: opportunities to improve sustainability". In: *Poultry Science* 102.10 (July 2023), p. 102887. ISSN: 0032-5791. DOI: 10.1016/j.psj.2023.102887. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10428061/ (visited on 08/19/2024).

Belova, A. V., L. Smutka, and E. Rosochatecká. "World chicken meat market - its development and current status". en. In: *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 60.4 (Aug. 2013), pp. 15–30. ISSN: 12118516, 24648310. DOI: 10.11118/actaun201260040015. URL: http://acta.mendelu.cz/doi/10.11118/actaun201260040015.html (visited on 12/08/2024).

Birhanu, M. Y. et al. "Smallholder poultry production in the context of increasing global food prices: roles in poverty reduction and food security". In: *Animal Frontiers: The Review Magazine of Animal Agriculture* 13.1 (Feb. 2023), pp. 17–25. ISSN: 2160-6056. DOI: 10.1093/af/vfac069. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9947327/ (visited on 12/09/2024).

Bouyssou, C. G., J. D. Jensen, and W. Yu. "Food for thought: A meta-analysis of animal food demand elasticities across world regions". In: *Food Policy* 122 (Jan. 2024), p. 102581. ISSN: 0306-9192. DOI: 10.1016/j.foodpol.2023.102581. URL: https://www.sciencedirect.com/science/article/pii/S0306919223001793 (visited on 03/31/2025).

Brambell, F. W. R. B. "Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems." In: *London: H.M.S.O.* Vol. 2836 (1965).

Budolfson, M. et al. “Monetizing Animal Welfare Impacts for Benefit–Cost Analysis”. en. In: *Journal of Benefit-Cost Analysis* (Apr. 2024), pp. 1–18. ISSN: 2194-5888, 2152-2812. DOI: 10.1017/bca.2024.19. URL: https://www.cambridge.org/core/product/identifier/S2194588824000198/type/journal_article (visited on 02/14/2025).

CDC. *About Zoonotic Diseases*. en-us. May 2024. URL: https://www.cdc.gov/one-health/about/about-zoonotic-diseases.html (visited on 01/17/2025).

Chan, I., B. Franks, and M. N. Hayek. “The ‘sustainability gap’ of US broiler chicken production: trade-offs between welfare, land use and consumption”. en. In: *Royal Society Open Science* 9.6 (June 2022). Publisher: The Royal Society. DOI: 10.1098/rsos.210478. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9156924/ (visited on 08/19/2024).

Chang, H.-S. and L. Zepeda. “Consumer perceptions and demand for organic food in Australia: Focus group discussions”. In: *Renewable Agriculture and Food Systems* 20.3 (2005). Publisher: Cambridge University Press, pp. 155–167. ISSN: 1742-1705. URL: https://www.jstor.org/stable/44491526 (visited on 12/07/2024).

Clonan, A., K. E. Roberts, and M. Holdsworth. “Socioeconomic and demographic drivers of red and processed meat consumption: implications for health and environmental sustainability”. en. In: *The Proceedings of the Nutrition Society* 75.3 (Mar. 2016), p. 367. DOI: 10.1017/S0029665116000100. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC4974628/ (visited on 10/29/2024).

Cobb500 Broiler Performance & Nutrition Supplement (2022). 2022. URL: https://www.cobbgenetics.com/assets/Cobb-Files/2022-Cobb500-Broiler-Performance-Nutrition-Supplement.pdf.

Dinev, I., S. Denev, and I. Vashin. “Pathomorphological investigations on the prevalence of contact dermatitis lesions in broiler chickens”. en. In: (2019). URL: https://doi.org/10.1080/09712119.2019.1584105.

ECC Progress Report 2024. en. URL: https://openwingalliance.org/ (visited on 02/14/2025).

Eijk, J. A. J. van der et al. “Growth rate, either through genetics or diet, mainly determines the outcome concerning broiler welfare”. In: *animal* 19.3 (Mar. 2025), p. 101431. ISSN: 1751-7311. DOI: 10.1016/j.animal.2025.101431. URL: https://www.sciencedirect.com/science/article/pii/S175173112500014X (visited on 03/29/2025).

El Sabry, M. I. et al. “Water scarcity can be a critical limitation for the poultry industry”. In: *Tropical Animal Health and Production* 55.3 (2023), p. 215. ISSN: 0049-4747. DOI: 10.1007/s11250-023-03599-z. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10203017/ (visited on 03/13/2025).

Epp, M. *The nutritional needs of slow-growing birds*. en-US. June 2019. URL: https://www.poultryworld.net/health-nutrition/the-nutritional-needs-of-slow-growing-birds/ (visited on 11/20/2024).

Espinosa, R. and N. Treich. *The Animal-Welfare Levy*. en. 2024. DOI: 10.2139/ssrn.4901342. URL: https://www.ssrn.com/abstract=4901342 (visited on 02/14/2025).

EUROPEAN CHICKEN COMMITMENT (ECC) PROGRESS REPORT. 2024.

Fanatico, A. C. et al. “Meat Quality of Slow- and Fast-Growing Chicken Genotypes Fed Low-Nutrient or Standard Diets and Raised Indoors or with Outdoor Access”. In: *Poultry Science* 86.10 (Oct. 2007), pp. 2245–2255. ISSN: 0032-5791. DOI: 10.1093/ps/86.10.2245. URL: https://www.sciencedirect.com/science/article/pii/S0032579119392594 (visited on 12/07/2024).

FAOSTAT. URL: https://www.fao.org/faostat/en/#data/QCL (visited on 03/14/2025).

Ghasempour, A. and E. Ahmadi. “Evaluation of Environmental Effects in Producing Three Main Crops (Corn, Wheat and Soybean) Using Life Cycle Assessment”. en. In: *Agricultural Engineering International: CIGR Journal* 20.2 (Nov. 2018). Number: 2, pp. 126–137. ISSN: 1682-1130. URL: https://cigrjournal.org/index.php/Ejounral/article/view/4687 (visited on 11/21/2024).

Gržinić, G. et al. “Intensive poultry farming: A review of the impact on the environment and human health”. In: *Science of The Total Environment* 858 (Feb. 2023), p. 160014. ISSN: 0048-9697. DOI: 10.1016/j.scitotenv.2022.160014. URL: https://www.sciencedirect.com/science/article/pii/S0048969722071145 (visited on 10/29/2024).

Han, Y. and D. H. Baker. “Lysine Requirements of Fast- and Slow-Growing Broiler Chicks1”. In: *Poultry Science* 70.10 (Oct. 1991), pp. 2108–2114. ISSN: 0032-5791. DOI: 10.3382/ps.0702108. URL: https://www.sciencedirect.com/science/article/pii/S0032579119333589 (visited on 11/21/2024).

Impacts of the Better Chicken Commitment on the UK Broiler Sector. URL: https://www.nfuonline.com/archive?treeid=139718#:~:text=Based%20on%20differences%20in%20FCR,5%20pence%20at%20retail%20prices..

Ingrao, C. et al. “Water scarcity in agriculture: An overview of causes, impacts and approaches for reducing the risks”. In: *Heliyon* 9.8 (Aug. 2023), e18507. ISSN: 2405-8440. DOI: 10.1016/j.heliyon.2023.e18507. URL: https://www.sciencedirect.com/science/article/pii/S2405844023057158 (visited on 03/13/2025).

Junghans, A., L. Deseniß, and H. Louton. “Data evaluation of broiler chicken rearing and slaughter-An exploratory study”. eng. In: *Frontiers in Veterinary Science* 9 (2022), p. 957786. ISSN: 2297-1769. DOI: 10.3389/fvets.2022.957786.

Kebebe, E. G. et al. “Strategies for improving water use efficiency of livestock production in rain-fed systems”. In: *Animal* 9.5 (Jan. 2015), pp. 908–916. ISSN: 1751-7311. DOI: 10.1017/S1751731114003115. URL: https://www.sciencedirect.com/science/article/pii/S1751731114003115 (visited on 12/08/2024).

Knowles, T. et al. “Leg Disorders in Broiler Chickens: Prevalence, Risk Factors and Prevention”. en. In: (2008). DOI: 10.1371/journal.pone.0001545. URL: https:

//journals.plos.org/plosone/article?id=10.1371/journal.pone.0001545.

Lusk, J. L. "Consumer preferences for and beliefs about slow growth chicken". In: 97 (2018). ISSN: 0032-5791. DOI: 10.3382/ps/pey301. URL: https://www.sciencedirect.com/science/article/pii/S0032579119302433.

Lusk, J. L., N. M. Thompson, and S. L. Weimer. "The Cost and Market Impacts of Slow-Growth Broilers". In: *Journal of Agricultural and Resource Economics* 44.3 (2019). Publisher: Western Agricultural Economics Association, pp. 536–550. ISSN: 1068-5502. URL: https://www.jstor.org/stable/26797574 (visited on 02/23/2025).

Lusk, J. L. and G. T. Tonsor. "How Meat Demand Elasticities Vary with Price, Income, and Product Category". en. In: *Applied Economic Perspectives and Policy* 38.4 (2016). _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1093/aepp/ppv050, pp. 673–711. ISSN: 2040-5804. DOI: 10.1093/aepp/ppv050. URL: https://onlinelibrary.wiley.com/doi/abs/10.1093/aepp/ppv050 (visited on 03/30/2025).

Macer, D. "Ethical Poultry and the Bioethics of Poultry Production". In: *The Journal of Poultry Science* 56.2 (Apr. 2019), pp. 79–83. ISSN: 1346-7395. DOI: 10.2141/jpsa.0180074. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7005410/ (visited on 08/19/2024).

Macleod, M. et al. *Impact of animal breeding on GHG emissions and farm economics*. en. ISBN: 9789276109433 9789276141433 ISSN: 1831-9424. Sept. 2019. DOI: 10.2760/731326. URL: https://publications.jrc.ec.europa.eu/repository/handle/JRC117897 (visited on 08/19/2024).

Marino, L. "Thinking chickens: a review of cognition, emotion, and behavior in the domestic chicken". In: *Animal Cognition* 20.2 (2017), pp. 127–147. ISSN: 1435-9448. DOI: 10.1007/s10071-016-1064-4. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5306232/ (visited on 12/08/2024).

Martínez, Y. and M. Valdivié. "Efficiency of Ross 308 broilers under different nutritional requirements". In: *Journal of Applied Poultry Research* 30.2 (June 2021), p. 100140. ISSN: 1056-6171. DOI: 10.1016/j.japr.2021.100140. URL: https://www.sciencedirect.com/science/article/pii/S1056617121000039 (visited on 03/29/2025).

McConnell, C., S. Brue, and S. Flynn. *Microeconomics*. Vol. McGraw-Hill Education; 22nd edition. McGraw-Hill, Jan. 2020.

Mellor, D. "Updating Animal Welfare Thinking". In: (2016). URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4810049/.

Minasyan, K. "WATER USE IN LIVESTOCK PRODUCTION SYSTEMS AND SUPPLY CHAINS". en. In: ().

Morris, M. C. "The Ethics and Politics of Animal Welfare in New Zealand: Broiler Chicken Production as a Case Study". In: *Journal of Agricultural and Environmental Ethics* 22.1 (Feb. 1, 2009), pp. 15–30. ISSN: 1573-322X. DOI: 10.1007/s10806-008-9128-3. URL: https://doi.org/10.1007/s10806-008-9128-3 (visited on 04/08/2025).

National Chicken Council's 7 Things You Need to Know About the Better Chicken Commitment(.

Neeteson, A.-M. et al. "Evolutions in Commercial Meat Poultry Breeding". In: *Animals : an Open Access Journal from MDPI* 13.19 (Oct. 2023), p. 3150. ISSN: 2076-2615. DOI: 10.3390/ani13193150. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10571742/ (visited on 12/08/2024).

Nicol, C. *The Behavioural Biology of Chickens*. Journal Abbreviation: The Behavioural Biology of Chickens Publication Title: The Behavioural Biology of Chickens. May 2015. ISBN: 978-1-78064-249-9.

OECD and F. a. A. O. o. t. U. Nations. *Statistical Annex*. en. Tech. rep. Paris: OECD, July 2021. DOI: 10.1787/8f76cc2a-en. URL: https://www.oecd-ilibrary.

org/agriculture-and-food/oecd-fao-agricultural-outlook-2021-2030_8f76cc2a-en (visited on 12/08/2024).

Opinion — Are Chicks Brighter Than Babies? - The New York Times. URL: https://www.nytimes.com/2013/10/20/opinion/sunday/are-chicks-brighter-than-babies.html (visited on 12/09/2024).

Paz, I. C. L. A. et al. "Locomotor Problems in Broilers Reared on New and Re-Used Litter". In: (2016). URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4810049/.

Positive Welfare Indicators and Their Association with Sustainable Management Systems in Poultry. URL: https://www.mdpi.com/2071-1050/15/14/10890 (visited on 12/08/2024).

Rahman, M. T. et al. "Zoonotic Diseases: Etiology, Impact, and Control". In: *Microorganisms* 8.9 (Sept. 2020), p. 1405. ISSN: 2076-2607. DOI: 10.3390/microorganisms8091405. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7563794/ (visited on 01/17/2025).

Rayner, A. C. et al. "Slow-growing broilers are healthier and express more behavioural indicators of positive welfare". eng. In: *Scientific Reports* 10.1 (Sept. 2020), p. 15151. ISSN: 2045-2322. DOI: 10.1038/s41598-020-72198-x.

Röös, E. et al. "Greedy or needy? Land use and climate impacts of food in 2050 under different livestock futures". In: *Global Environmental Change* 47 (Nov. 2017), pp. 1–12. ISSN: 0959-3780. DOI: 10.1016/j.gloenvcha.2017.09.001. URL: https://www.sciencedirect.com/science/article/pii/S0959378016306872 (visited on 08/19/2024).

Rosenqvist, S. "Hedonistic Act Utilitarianism". en. In: ().

Ross 308 /308 FF Broiler - Performance Objectives. 2022.

Rowan Ranger Broiler - Performance Objectives. 2018.

Schuck-Paim, C. and W. Jimenez Alonso. *Quantifying Pain in Broiler Chickens: Impact of the Better Chicken Commitment and Adoption of Slower-Growing Breeds on Broiler Welfare*. May 2022. ISBN: B09ZDWWD97.

Searchinger, T. et al. "The Global Land Squeeze: Managing the Growing Competition for Land". en. In: *World Resources Institute* (July 2023). DOI: 10.46830/wrirpt.20.00042. URL: https://www.wri.org/research/global-land-squeeze-managing-growing-competition-land (visited on 10/01/2024).

Slaughter - Annual for CATTLE - Quick Stats Lite. URL: https://www.nass.usda.gov/Quick_Stats/Lite/result.php?E0D425E5-A5F5-38F2-A8A6-9CC22ED7C4CC (visited on 03/13/2025).

Soybeans — USDA Foreign Agricultural Service. URL: https://www.fas.usda.gov/data/production/commodity/2222000.

Stel, M., J. Eggers, and W. J. Alonso. "Mitigating Zoonotic Risks in Intensive Farming: Solutions for a Sustainable Change". en. In: *EcoHealth* 19.3 (Sept. 2022), pp. 324–328. ISSN: 1612-9210. DOI: 10.1007/s10393-022-01605-8. URL: https://doi.org/10.1007/s10393-022-01605-8 (visited on 10/11/2024).

Sun, J. et al. "Importing food damages domestic environment: Evidence from global soybean trade". In: *Proceedings of the National Academy of Sciences* 115.21 (May 2018). Publisher: Proceedings of the National Academy of Sciences, pp. 5415–5419. DOI: 10.1073/pnas.1718153115. URL: https://www.pnas.org/doi/full/10.1073/pnas.1718153115 (visited on 03/29/2025).

Sustainability and the Better Chicken Commitment. May 2024. URL: https://assets.ctfassets.net/ww1ie0z745y7/71lV9ayuqM0bforkvH8yfr/c4fc5aa0680f18e3ca62f11312b5a8
Sustainability_and_the_Better_Chicken_Commitment__Updated_May_2024_.pdf.

Tetteh, H. et al. "Carbon Footprint: The Case of Four Chicken Meat Products Sold on the Spanish Market". en. In: *Foods* 11.22 (Nov. 2022), p. 3712. DOI: 10.3390/

foods11223712. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC9689854/ (visited on 10/29/2024).

The Better Chicken Commitment - BCC [US]. en-US. URL: https://betterchickencommitment.com/us/ (visited on 03/14/2025).

Tonsor, G. T. and J. D. Bina. "Assessing Cross-Price Effects of Meat Alternatives on Beef, Pork, and Chicken Retail Demand in 2022". en. In: ().

Torrella, K. *Chicken is the most popular meat in the world. And we're expected to eat much more of it. — Vox*. URL: https://www.vox.com/future-perfect/2023/8/4/23818952/chicken-meat-forecast-predictions-beef-pork-oecd-fao (visited on 03/31/2025).

US EPA, O. *Understanding Global Warming Potentials*. en. Overviews and Factsheets. Jan. 2016. URL: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials (visited on 03/29/2025).

"USDA ERS - Meat Price Spreads". In: (). URL: https://www.ers.usda.gov/data-products/meat-price-spreads/ (visited on 12/08/2024).

Wang, L. "Assessment of land use change and carbon emission: A Log Mean Divisa (LMDI) approach". In: *Heliyon* 10.3 (Feb. 2024), e25669. ISSN: 2405-8440. DOI: 10.1016/j.heliyon.2024.e25669. URL: https://www.sciencedirect.com/science/article/pii/S2405844024017006 (visited on 12/08/2024).

White, R. J. and O. Razgour. "Emerging zoonotic diseases originating in mammals: a systematic review of effects of anthropogenic land-use change". en. In: *Mammal Review* 50.4 (2020). _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/mam.12201, pp. 336–352. ISSN: 1365-2907. DOI: 10.1111/mam.12201. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/mam.12201 (visited on 01/17/2025).