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FROM FARM TO FORK: RED MEAT VALUE CHAIN INNOVATIONS TO COMBAT MALNUTRITION IN INDONESIA

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ABSTRACT

This study explores the potential of the red meat value chain in addressing malnutrition in Indonesia, where the "double burden" of malnutrition, encompassing undernutrition and obesity, remains a critical public health issue. Using the Nutrition-Sensitive Value Chain Analysis (NSVCA) framework, the study reviews the literature to evaluate barriers, opportunities, and interventions for enhancing red meat availability, affordability, and nutritional impact. Key findings reveal that inefficiencies in production, distribution, and market access limit the consumption of red meat despite its rich nutritional content, including iron, zinc, and vitamin B12. Additionally, socio-cultural perceptions and high costs further constrain demand. The analysis highlights the need for targeted interventions at each stage of the value chain, such as improving cold chain infrastructure, supporting smallholder farmers, and implementing educational campaigns to promote the benefits of red meat consumption. Recommendations include fostering stakeholder collaboration to streamline logistics, increasing public awareness of red meat's nutritional benefits, and integrating technology for more efficient production and distribution. These measures are crucial for addressing malnutrition sustainably while considering Indonesia's unique socio-economic and geographic challenges. This study contributes actionable insights for policymakers and stakeholders, aiming to strengthen food security and improve public health outcomes in Indonesia.

Keywords: Food security, Indonesia, malnutrition, nutrition-sensitive value chain, red meat.

INTRODUCTION

Value Chain Analysis (VCA), first introduced by Michael Porter in 1985, is a methodology designed to identify a business's competitive advantages by examining the value added at each stage of its internal operations (Porter, 2011). Over time, this framework has evolved to address specific challenges, including nutrition, giving rise to the Nutrition-Sensitive Value Chain Analysis (NSVCA). This concept was initially presented at the 43rd Committee on World Food Security (CFS) session in 2016 and subsequently adopted by Rome-Based Agencies (RBAs). NSVCA focuses on how sustainably developed food value chains can enhance the nutritional status of targeted populations(FAO, 2023). Since the 1990s, this approach has been employed to promote healthier diets(FAO, 2023; Ruel & Alderman, 2013), involving the systematic analysis of food value chains to address nutritional challenges within societies.

Although NSVCA has been applied to various food systems globally, its application to red meat—a high-value but often inaccessible commodity in developing countries like Indonesia—

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remains underexplored. This presents an opportunity to address persistent nutritional challenges specific to this context.

Various interventions have been implemented under this framework, including developing value chains for nutrient-rich commodities(Nicholson et al., 2021; Ridoutt et al., 2019), producing fortified products or specialised varieties(Deribe & Kassa, 2020; Wang et al., 2022), and conducting educational campaigns for better nutritional practices(Chakrabarti et al., 2018; Fanzo et al., 2015). Beyond improving market processes and efficiency(Gereffi et al., 2009; Noort et al., 2022; Peña & Garrett, 2018b), VCA has contributed to reducing food waste, enhancing food safety(Anand & Barua, 2022), and maximising nutritional outcomes by preserving nutrient quality. These efforts align with global initiatives to improve food security(Barling et al., 2022; Noort et al., 2022). As a framework, NSVCA addresses community-level nutrition challenges by tracing the food value chain from production through processing, storage, distribution, and final presentation. This method ensures that nutrients are preserved, damage is minimised, and food quality is enhanced at every stage(Chakrabarti et al., 2018). Studies Duncan et al. (2022) Nguyen et al. (2022) have demonstrated the connection between food and agriculture sectors and nutrition interventions, yielding improved health outcomes.

Despite significant efforts to address malnutrition through diverse food value chains, limited attention has been given to the role of red meat in combating nutritional deficiencies, particularly in countries where economic and cultural factors constrain its consumption.

In Indonesia, factors such as high poverty rates, religious dietary requirements (e.g., halal compliance), and limited infrastructure for meat production and distribution exacerbate the challenge of improving access to high-quality animal-sourced foods like red meat. For instance, the limited supply and high demand for meat have constrained availability and affordability(Susila et al., 2020; Wahyono & Utami, 2018).

This review uniquely focuses on leveraging NSVCA to address barriers specific to the red meat value chain in Indonesia, offering a framework to improve supply chain efficiency, nutritional outcomes, and stakeholder collaboration. It examines intervention strategies aligned with the five pillars of food security and addresses challenges encountered by stakeholders within the red meat value chain. The findings are expected to offer transparent and practical recommendations for refining nutrition-sensitive interventions.

MATERIALS AND METHODS

Population

The population of this literature review comprised peer-reviewed journal articles, government reports, and institutional publications related to the red meat value chain and malnutrition. Studies were selected based on their relevance to the Nutrition-Sensitive Value Chain Analysis (NSVCA) framework, published between 2000 and 2023, and written in English or Bahasa Indonesia. Key themes included nutrient retention (iron, zinc, and vitamin B12), supply chain dynamics, stakeholder roles, and interventions to improve food security. Data sources included PubMed, Scopus, FAO archives, and Indonesian Ministry of Agriculture reports. These criteria ensured that the literature captured both global perspectives and regional insights specific to Indonesia.

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Research Methodology

This study utilised a literature review to explore the dynamics of the red meat value chain in addressing malnutrition in Indonesia. The review focused on identifying global and regional challenges, opportunities, and interventions within the framework of Nutrition-Sensitive Value Chain Analysis (NSVCA). Data were sourced from a variety of academic and institutional databases, including PubMed, Scopus, and ScienceDirect, alongside reports from organisations such as the FAO, WHO, and the Indonesian Ministry of Agriculture. These sources provided insights into key issues such as nutrient retention (iron, zinc, and vitamin B12), food security strategies, and red meat value chain inefficiencies.

The inclusion criteria encompassed studies published between 2000 and 2023 that addressed red meat production, processing, distribution, or consumption and analysed nutritional impacts within a value chain framework to ensure relevance. Publications in English and Bahasa Indonesia were prioritised. Exclusion criteria included non-empirical studies, articles unrelated to nutrition-sensitive interventions, and publications outside the defined scope.

Data extraction focused on identifying key themes such as barriers to red meat accessibility, stakeholder roles, and global best practices for improving nutritional outcomes. Findings were synthesised to highlight gaps in current research and establish the importance of targeted interventions for enhancing the nutritional impact of red meat in Indonesia. Microsoft Excel 365 was used to systematically organise and categorise the reviewed data, enabling comparative analysis across studies. This literature review formed the foundation for understanding existing inefficiencies and proposing actionable strategies to strengthen the red meat value chain.

Data Analysis

The data analysis involved several interconnected approaches to comprehensively evaluate the red meat value chain in Indonesia. First, a step-by-step value chain mapping was conducted to trace processes from production to consumption. This analysis aimed to identify inefficiencies, bottlenecks, and areas for potential nutritional enhancement. Schematic representations of the value chain stages and key actors were created using data visualisation tools to provide a clear understanding of the system's dynamics.

Nutritional impact assessments were then performed to evaluate nutrient retention—specifically iron, zinc, and vitamin B12—at each stage of the value chain. These findings were compared against global benchmarks provided by FAO and WHO guidelines to highlight opportunities for improving nutritional outcomes. Quantitative data collected from surveys and secondary sources were analysed using Microsoft Excel 365. Descriptive statistics, including averages, percentages, and frequencies, were employed to summarise key findings related to stakeholder dynamics and consumer trends.

Finally, a comparative analysis was undertaken to benchmark Indonesia's red meat value chain against international best practices. This included evaluating cold chain logistics and examining regulatory frameworks in other developing countries. The comparative analysis identified gaps and informed targeted recommendations to enhance the nutritional and operational efficiency of the red meat value chain in Indonesia.

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RESULT AND DISCUSSION

Value Chain in Indonesia's Meat Industry: Challenges and Opportunities

Indonesia, as the world's largest archipelagic nation and a developing country, faces unique logistical challenges in its meat industry value chain. These obstacles include unstable natural conditions, high inter-island transportation costs, inadequate traffic facilities and infrastructure, inconsistent port regulations for loading and unloading, and reliance on manual logistics services(Sandee, 2016). Such disruptions in the food supply chain, compounded by undernourishment challenges, are fundamental contributors to the global prevalence of malnutrition.

Despite these challenges, Indonesia is endowed with rich biodiversity, supported by a favourable climate and distinctive geographical features, such as volcanic mountains. However, environmental instability remains a critical issue for sustainable food security, directly impacting the sufficiency of food supplies and limiting access to animal-sourced foods. While fish remains the dominant source of protein in the Indonesian diet, red meat is often viewed as a luxury item(Khusun et al., 2022; Vanany et al., 2021). Similarly, egg consumption tends to increase alongside income levels(Komarek et al., 2021). However, price hikes often lead households to substitute animal-based foods with cheaper alternatives that lack adequate protein and micronutrient content(Maestre et al., 2017; Saskia et al., 2021). Consequently, many households prioritise carbohydrate-rich foods over those with high-value animal protein, exacerbating nutritional deficiencies. This condition significantly affects Indonesia’s nutritional status, with millions facing a "double burden of malnutrition" characterised by the coexistence of undernutrition and overnutrition(WHO, 2021b).

Government Efforts and Industry Dynamics

The Indonesian government has integrated meat industry development into its broader livestock industry initiatives (Indonesia Ministry of Agriculture, 2022). Programs aim to achieve food security from animal sources, enhance the competitiveness of breeders, and create value-added export-oriented products. Stakeholders are also working to improve public access to meat while embedding additional value into livestock products and distribution systems.

In terms of economic impact, the livestock industry's contribution to Indonesia's GDP grew at an average annual rate of 7% in 2022, compared to 1.2% growth in the broader agricultural sector(BPS-Statistic Indonesia, 2022). However, Indonesia's trade-to-GDP ratio stood at 33.19% in 2020, significantly lower than the global average of 55–60%(World Bank, 2022). This limited trade integration highlights missed opportunities for economic growth and value chain optimisation(Gereffi et al., 2005; Warner, 2017).

Challenges in the Beef Value Chain

Indonesia's beef value chain remains complex. The marketing system primarily involves small-scale farmers and various intermediaries, leading to increased intermediary costs and suppressed producer prices. Most transactions are based on live weight estimates rather than scales, with only a few markets using scales for pricing. Meat from government-owned slaughterhouses is primarily distributed through local markets to households, street vendors, and small restaurants. High-end restaurants and hotels rely on a mix of locally sourced meat (65%) and imported frozen beef (35%)—mainly from Australia(Agus & Widi, 2018).

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Despite these systems, regulatory gaps persist. Farmers are often unprotected from intermediaries, resulting in reduced profits despite high market prices. Regulatory frameworks addressing upstream reproduction and feeding, as well as downstream marketing, are needed to support smallholder farmers and improve meat production efficiency.

Socioeconomic and Environmental Considerations

Approximately 95% of Indonesia's cattle industry stakeholders are smallholders, making them the backbone of beef production(Agus & Widi, 2018). However, small-scale operations meet only 30% of national consumption, necessitating alternative strategies to increase meat supply sustainably. Globally, much of the research on beef production focuses on commercial markets, with imports from Australia, New Zealand, and other countries meeting 50% of Indonesia's meat demand(BPS-Statistic Indonesia, 2021). Meat consumption remains low at 2.7 kg per capita annually(OECD, 2022).

Sacrificial Meat and Its Potential

Sacrificial meat distributed during Eid al-Adha holds a crucial role in supplementing the national meat supply and consumption (Figure 1). In 2022, the economic potential of sacrificial meat reached approximately IDR 20.5 trillion, nearly matching the volume of imported beef(BPS-Statistic Indonesia, 2021). However, while this market provides higher profits for farmers(Ibrahim et al., 2022; Ibrahim et al., 2019), it is seasonal and does not address year-round nutritional needs.

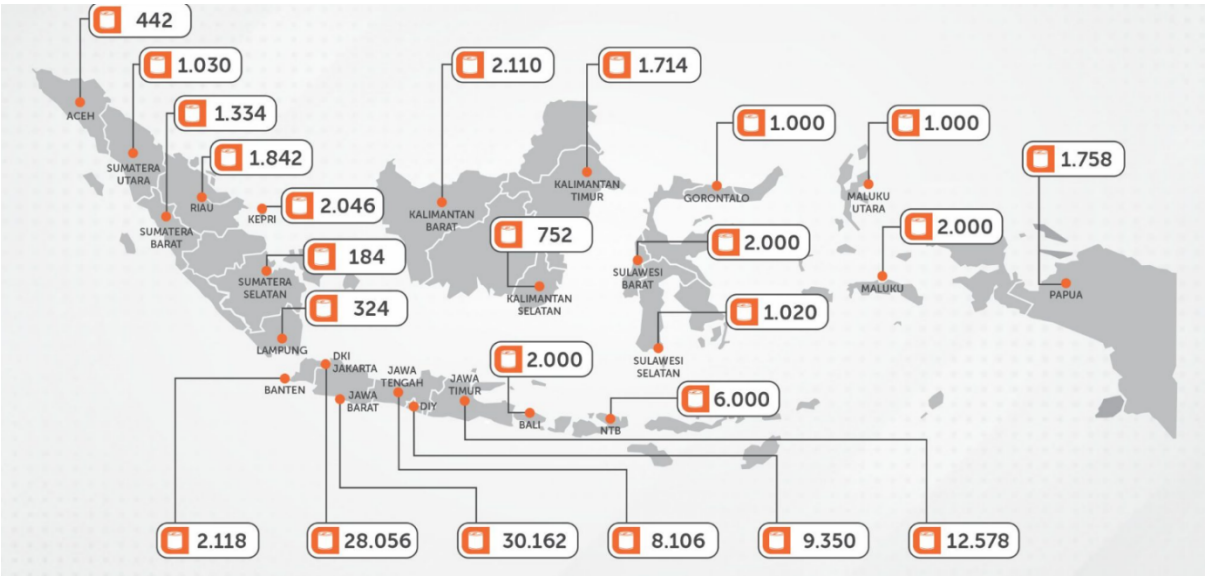

Figure 1. The distribution of sacrificial red meat between January and March 2022. Numbers indicate units of sacrificial red meat distributed per province (Rumah Zakat Indonesia, 2022).

While sacrificial meat can temporarily narrow the gap between supply and demand, sustainable strategies are required to ensure consistent access to high-quality meat throughout the year.This highlights the need for integrating sacrificial practices into broader value chain improvements, such as enhancing cold storage, processing infrastructure, and year-round production planning, to maximise its potential as a reliable nutritional and economic resource.

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Moving Forward: Opportunities for Improvement

Improved meat processing and distribution can extend the shelf life of fresh meat and make it accessible to vulnerable populations in remote or disaster-affected areas(McClements, 2023). Inclusive agribusiness development, focusing on enhancing knowledge, consumer engagement, and supportive environments, could empower local smallholders(Hermiatin et al., 2022).

Addressing Indonesia's nutrition challenges requires a holistic approach that considers economic, environmental, and social dimensions. Emphasising sustainable meat value chain practices, including environmentally friendly production and robust economic integration, is essential for improving food security and nutritional outcomes(Garcez de Oliveira Padilha et al., 2021).

This is affected by the reliance on intermediaries, which diminishes producers' profits and increases consumers' costs. Furthermore, red meat consumption in Indonesia is notably low, at 2.7 kg per person annually, as it is often perceived as a luxury good. This low consumption correlates with a high prevalence of stunting and malnutrition, which remains a pressing issue.

Environmental stability adds another layer of complexity, as frequent natural disasters disrupt sustainable food security and supply chains. The absence of robust cold chain infrastructure contributes to significant nutrient losses during transportation and storage, reducing the nutritional impact of red meat. These challenges collectively exacerbate Indonesia's struggles with malnutrition, underscoring the need for systemic improvements in the meat value chain.

Malnutrition in Indonesia

Malnutrition arises from an imbalance in energy and protein intake due to either insufficient or excessive nutrient consumption(WHO, 2021a). Adequate protein and energy intake can have long-term implications, including diminished intellectual capacity, reduced economic productivity, impaired reproductive performance, and an increased prevalence of malnutrition and Non-Communicable Diseases (NCDs). The effects of malnutrition manifest in various ways, and Table 1 describes different types of malnutrition.

Table 1. Types and Definitions of Malnutrition

Type	Definition (WHO, 2021a)
Stunting	Impaired growth and development in children due to poor nutrition, repeated infections, and inadequate psychosocial stimulation. Stunting is defined as a height-for-age more than two standard deviations below the WHO Child Growth Standards median.
Wasting	A condition where a child is too thin for their height due to recent and severe weight loss, often linked to insufficient food intake or infections like diarrhea.
Underweight	Defined as having a BMI below 18 for children or a BMI below 18.5 for adults. It indicates insufficient weight relative to age or height.
Micronutrient Deficiency	A lack of essential vitamins and minerals required for enzyme production, hormone regulation, and overall development.

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Type	Definition (WHO, 2021a)
Overweight and Obesity	Results from consuming excessive energy relative to expenditure. Overweight is indicated by a BMI of 25–29, while obesity is classified as a BMI > 30.
Diet-Related NCDs	Medical conditions not caused by infections but associated with poor dietary habits. These include heart disease, certain cancers, diabetes, and strokes, often linked to high sugar and fat consumption (WHO, 2021).

Indonesia has set ambitious targets to reduce malnutrition and improve the nutritional status of mothers, infants, and toddlers (Figure 2). However, progress varies across different indicators. Between 2000 and 2020, anaemia among women of childbearing age (15–49 years) remained at 33.3%–34.2%, decreasing to 26.9% in 2011 but rising again after 2012. Obesity and wasting among children have doubled over the past two decades.

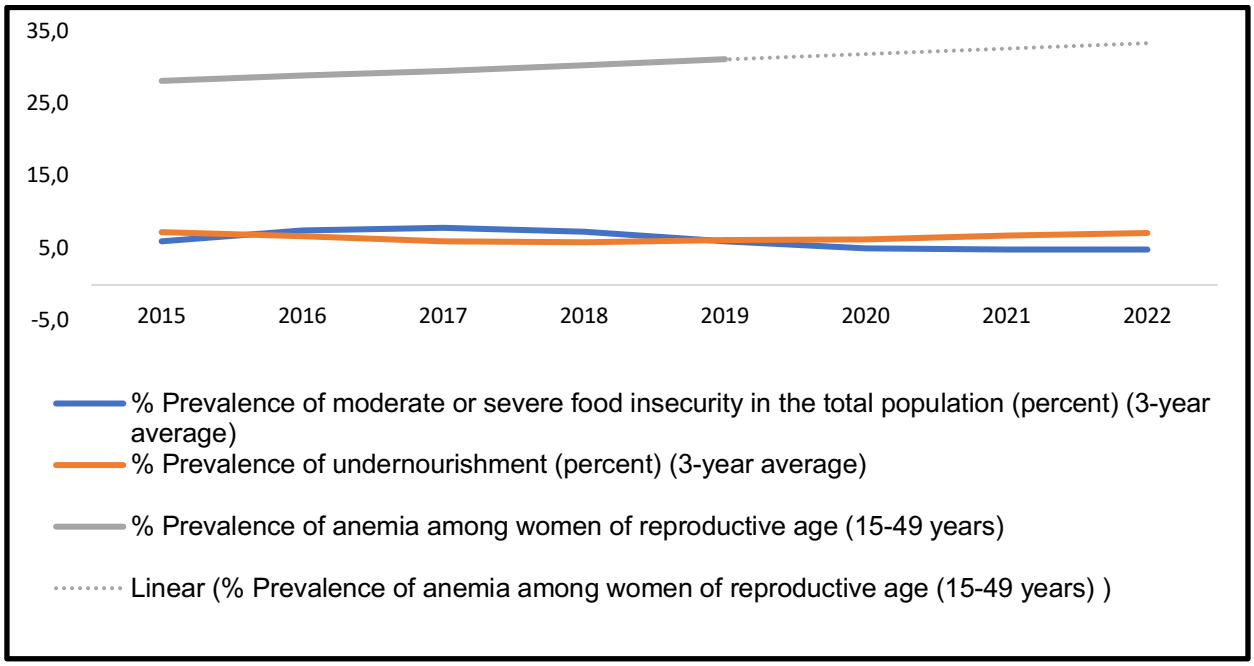

Figure 2. Malnutrition trends in Indonesia during 2015-2022 (FAO, 2022)

The prevalence of stunting among Indonesian toddlers stands at 27.7%, with 7.4% experiencing wasting and 16.3% classified as underweight (Ministry of State Secretariat of the Republic of Indonesia, 2019). Meanwhile, overweight and obesity rates among adults have risen significantly over the last 15 years(UNICEF, 2019). Before the COVID-19 pandemic, 50% of infants under six months were exclusively breastfed. Despite safety concerns during the pandemic, most Indonesian mothers continued breastfeeding children aged 12–23 months(UNICEF, 2021). Efforts to reduce Low Birth Weight (LBW) babies have shown progress, but 10% of babies still fall below the standard birth weight.

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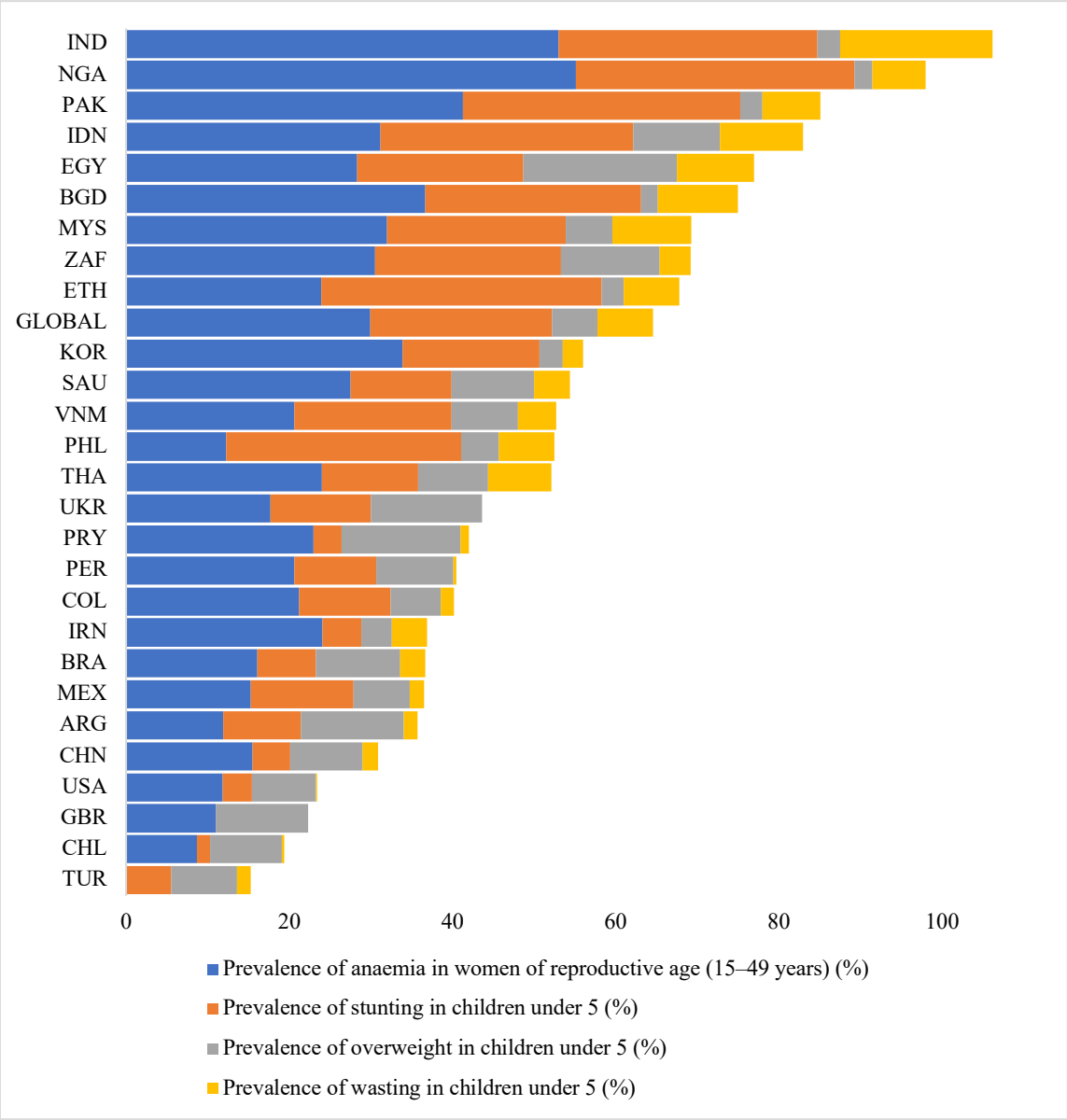

Figure 3. Comparative analysis of nutritional health indicators in women and children across selected countries. Turkey (TUR), Chile (CHL), the United Kingdom (GBR), the United States of America (USA), China (CHN), Argentina (ARG), and Mexico (MEX). Subsequent entries include Brazil (BRA), Iran (IRN), Colombia (COL), Peru (PER), Paraguay (PRY), Ukraine (UKR), Thailand (THA), the Philippines (PHL), Vietnam (VNM), and Saudi Arabia (SAU). South Korea (KOR), GLOBAL, reflects a collective measure rather than an individual nation; Ethiopia (ETH), South Africa (ZAF), Malaysia (MYS), Bangladesh (BGD), Egypt (EGY), Indonesia (IDN), Pakistan (PAK), Nigeria (NGA), and India (IND). Source: (WHO, 2023)

Access to nutritious diets remains limited, particularly for women and girls(Bai et al., 2022). Contributing factors to high stunting rates include low exclusive breastfeeding rates, socio-economic disparities, high preterm birth rates, and insufficient knowledge of pregnancy, maternity, and childcare s(Beal et al., 2018).

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The Role of Nutrition in Addressing Malnutrition

Indonesia joined the Scaling-Up Nutrition (SUN) movement in 2011(United Nation, 2022). The SUN initiative integrates global frameworks, such as the Stunting Intervention Program (2012), involving both nutrition-specific and nutrition-sensitive strategies. However, despite comprehensive implementation, these efforts alone have not sufficiently reduced stunting in children.

From a value chain perspective, the SUN program has notable gaps(Chakrabarti et al., 2018). It does not fully address the importance of intervention across all value chain stages, including raw material input, processing, and distribution. These stages are critical, particularly given the shifting consumption patterns toward ready-to-eat and fast foods. Additionally, the program overlooks environmental impacts such as greenhouse gas emissions, forest degradation, and biodiversity loss, and its economic outcomes lack long-term sustainability.

Another limitation is the program's lack of engagement with the private sector, particularly in processing and distribution. It also fails to recognise women as a potential source of empowerment. While the program considers socio-economic and cultural diversity, deeper interventions involving a broader range of stakeholders are necessary(Chakrabarti et al., 2018).

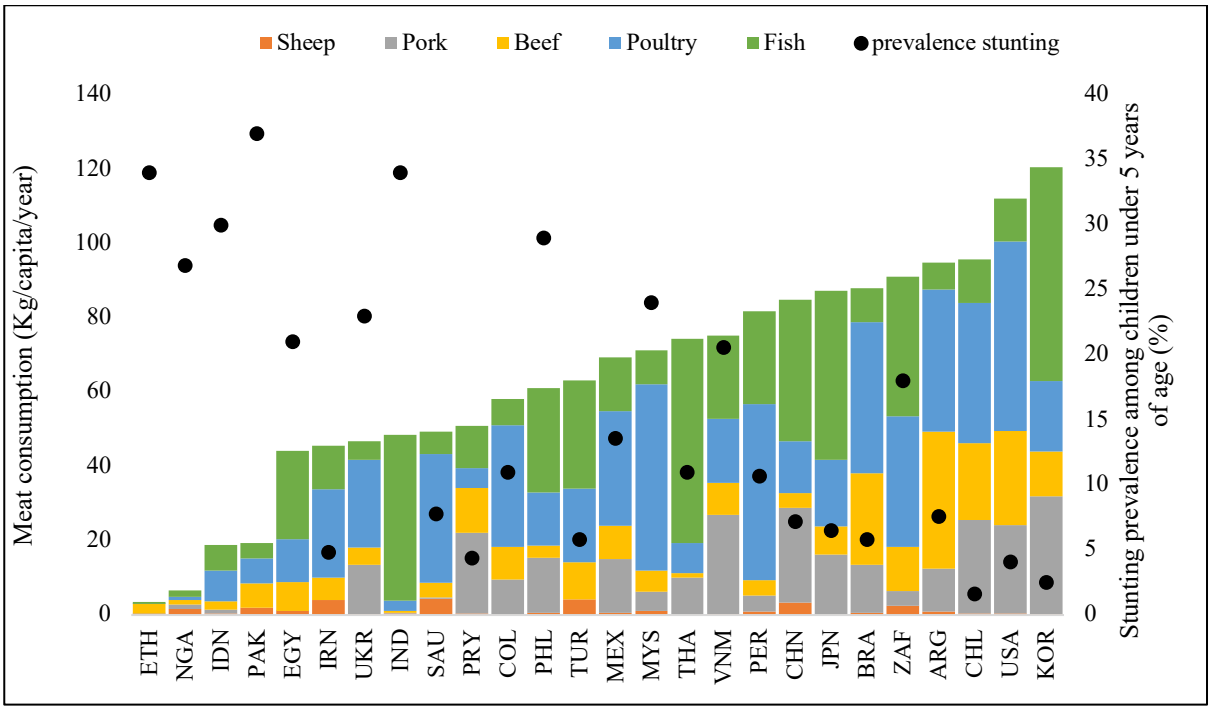

Figure 4. Annual Animal-Sourced Food Consumption and Stunting Prevalence (FAOSTAT, 2022)

Indonesia's per capita meat consumption is among the lowest in Southeast Asia, contributing to a high prevalence of stunting(Beal et al., 2018). Moreover, obesity and overweight rates have steadily risen over the past 15 years(Rachmi et al., 2017). Although research on nutrition-sensitive food value chains is growing(Gereffi et al., 2009; Maestre et al., 2017; Morgan, 2019), few studies focus on the role of meat in reducing malnutrition prevalence. This highlights a need for targeted approaches to integrate meat consumption into strategies for addressing malnutrition.

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Nutrition-Sensitive Red Meat Value Chain Analysis (NSMVC)

Nutrition-Sensitive Value Chain Analysis (NSVCA) is an analytical framework designed to improve community nutrition through strategic interventions (Allen & De Brauw, 2018). This framework highlights the interactions among key stakeholders and examines how these dynamics can enhance public nutrition profiles. A critical step involves identifying commodities, such as meat, that can address nutrition-related challenges(de Brauw et al., 2015). Beyond economic profits, actors in the meat value chain are encouraged to prioritise making commodities accessible and affordable to meet nutritional needs. This perspective supports awareness and effective interventions throughout the value chain, with potential benefits for public health, sustainability, and equity.

Meat, as an essential component of food systems, is influenced by supply and demand dynamics (Table 2). Strategies under NSMVC include increasing meat supply, maintaining or enhancing nutritional value, and stimulating demand for meat. These actions span the entire value chain, from production and processing to distribution, marketing, and consumption(de Brauw et al., 2015). Addressing these elements requires understanding consumer preferences and demands, making the approach multidimensional. This enables stakeholders to navigate the complexity of the system and identify opportunities to build a nutrition-sensitive value chain(Ruel & Alderman, 2013).

In Indonesia, NSMVC emphasises the relationship between nutritional challenges and the limitations in meat supply and demand. Allen and De Brauw (2018)underscore the interconnected factors that must be addressed. On the consumer side, considerations include nutrition awareness, affordability, availability, and acceptability of food products(Maestre et al., 2017). From the producers' perspective, key factors involve capturing nutritional value, equitable incentive distribution, governance of value chain coordination, cost management, and sustainability(Maestre et al., 2017).

Table 2. Nutrition-Sensitive Meat Value Chain—Expanding the Framework (Chakrabarti et al., 2018).

Category	Input	Meat Production	Storage & Processing	Distribution & Transport	Trading & Marketing	Health & Nutrition Promotion	Preparation & Consumption
Key Actors	Local farmers, meat importers (live animals/meat)	Meat industries, slaughterhouses, feedlots, charity agencies	Meat industries	Traders, Bureau of Logistics	Traders	GovernmentNGOs, advertising	Households, restaurants, hotels, charity targets
VC Entry Points	Access to feed, breeders, vaccines, animal insurance	Access to production technology, extension, capacity building	Cold chain infrastructur, processing technology	Archipelago connectivit, distribution channels	Multilevel stakeholder engagemen, contract agreements	Health & nutrition campaigns	Health & nutrition literacy
NSMVC Entry Points	Biofortification, diversificati	NSCV extension, integrated farming, safe, healthy, and	Fortification, nutrient-preserving	Cold chain monitoring, distribution	Halal meat safety education,	Social marketing, behavioural change	Food aid, women's empowermen

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Category	Input	Meat Production	Storage & Processing	Distribution & Transport	Trading & Marketing	Health & Nutrition Promotion	Preparation & Consumption
	on, micronutrient supplements	halal production practices	processing, labour upgrading	networking	health literacy	communication, consumer education	t in household nutrition

The framework presented in Table 2 outlines key actors and entry points at each stage of the meat value chain, highlighting opportunities for interventions, such as biofortification, diversification, micronutrient supplementation, cold chain monitoring, and social marketing.

In Indonesia, limited availability, affordability, and acceptability of nutrient-dense resources represent significant barriers to reducing stunting prevalence, which remains higher than the global average. Increasing meat consumption offers a promising pathway to address these issues. However, low demand and restricted incomes hinder sufficient meat intake across the population. To address these challenges, the NSMVC framework serves as a tool for identifying targeted investments and interventions at every stage of the value chain(Peña & Garrett, 2018a).

While current supply constraints are mitigated through meat imports to stabilise prices and improve availability, a comprehensive solution requires cross-sectoral improvements. For example, integrating technology into livestock production can facilitate micronutrient-rich feed development(Varijakshapanicker et al., 2019). Efforts are also underway to enhance cold chain infrastructure tailored for meat distribution. Additionally, initiatives focused on empowering women to make independent household nutrition decisions contribute to this strategy.

Employing these multifaceted approaches, the goal is clear: to alleviate supply and demand challenges surrounding meat by improving its availability, affordability, and acceptability. These efforts are expected to elevate national nutritional standards significantly, address critical public health concerns, and promote sustainable development.

CONCLUSION

This study highlights the critical role of the red meat value chain in addressing malnutrition in Indonesia, particularly the dual challenges of undernutrition, micronutrient deficiency and obesity. Using the Nutrition-Sensitive Value Chain Analysis (NSVCA) framework, the research identifies significant inefficiencies in production, distribution, and market access that hinder the availability and affordability of red meat. Socio-economic constraints, cultural perceptions, and the lack of robust infrastructure further exacerbate these challenges. Targeted interventions—such as improving cold chain logistics, supporting smallholder farmers, and promoting public awareness of red meat's nutritional benefits—emerge as essential strategies. By fostering multi-stakeholder collaboration and leveraging technology, the study provides actionable insights for policymakers and stakeholders to strengthen food security and advance public health outcomes sustainably in Indonesia's unique socio-economic and geographic context.

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