

Food Loss And Waste In North Sumatra, Indonesia: Policy Recommendations

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Abstract - Permasalahan food loss and waste (FLW) di Sumatera Utara Indonesia membawa ancaman signifikan yang pada akhirnya berdampak pada kondisi sosial, ekonomi, dan lingkungan. Inefisiensi dalam produksi, distribusi, dan konsumsi pangan memperburuk ketidakamanan pangan, kerugian finansial, dan degradasi lingkungan di kawasan ini. Studi ini mengkaji penyebab dan dampak utama FLW di Sumatera Utara, termasuk kebiasaan budaya, sistem pengelolaan sampah yang tidak memadai, dan kekurangan infrastruktur. Studi ini memberikan rekomendasi berdasarkan evaluasi menyeluruh terhadap peraturan nasional, inisiatif lokal, dan praktik terbaik internasional. Hal ini mencakup perlu adanya peningkatan investasi pada teknologi pemrosesan dan penyimpanan yang canggih, meningkatkan sistem pemulihan pangan, mengadopsi prinsip-prinsip ekonomi sirkular, dan mendorong kampanye kesadaran masyarakat. Dengan mengatasi tantangan-tantangan ini melalui upaya kolaboratif antar pemangku kepentingan dan strategi kebijakan yang inovatif, Sumatera Utara dapat secara signifikan mengurangi FLW, meningkatkan ketahanan pangan, dan berkontribusi terhadap tujuan keberlanjutan Indonesia yang lebih luas—terutama komitmennya terhadap Tujuan Pembangunan Berkelanjutan 12.3 PBB. Studi ini menggarisbawahi pentingnya mengintegrasikan pertimbangan sosial, lingkungan hidup, dan ekonomi ke dalam strategi mitigasi FLW untuk menjamin pembangunan regional jangka panjang.

Keywords: Food Loss and Waste (FLW), North Sumatra, Circular Economy, Food Security, Sustainable Development

INTRODUCTION

Food loss and waste (FLW) is a major global issue that has a negative influence on social structures, the environment, and the economy. Roughly 1,3 billion tons of food are lost or wasted every year, which is almost one-third of the total amount produced (Spang et al., 2019; FAO, 2022). By contributing to greenhouse gas emissions and wasting vital resources like water, energy, and land, this problem worsens food scarcity and hurts the environment. In developing nations like Indonesia, where agriculture is crucial for both the economy and people's livelihoods, addressing FLW is a multifaceted problem that requires immediate solutions (Kinanta et al., 2021).

Indonesia is ranked among the top food-wasting nations, with each individual generating between 115 and 184 kilograms of food waste each year (Bappenas, 2021) according to a report from the United Nations Environment Program (UNEP) titled Food Waste Index 2021, Indonesia will become the country with the most food waste production in Southeast Asia. The total food waste that Indonesia produces annually reaches 20,93 million tons. The food supply chain including production, post-harvesting, retail, and consumption is the main resource of this issue (Cattaneo et al., 2020). North Sumatra Province, a key agricultural area, also experiences similar issues due to ineffective supply chains, waste management practices, and a lack of public understanding surrounding sustainable methods.

Mitigating FLW is vital for Indonesia to fulfill its obligations to the United Nations Sustainable Development Goals (SDGs), particularly Goal 12.3, which seeks to halve food waste and losses by the year 2030. In North Sumatra, where FLW impacts employment, public health, and environmental conditions, addressing this concern is essential (Waluyo & Kharisma, 2023). Furthermore, the economic

ramifications of FLW in North Sumatra are considerable. Inefficient practices in food production and distribution result in wasted resources such as labor, energy, and fertilizers, leading to financial setbacks for both farmers and businesses (Spang et al., 2019). Local administrations and communities also incur significant expenses related to food waste management (Kinantia et al., 2021).

From an environmental perspective, FLW contributes to climate change and the depletion of resources. Organic materials in landfills emit methane, a potent greenhouse gas, while the excessive use of water, land, and energy further damages the ecosystem (FAO, 2011) (Vilariño et al., 2017). In Indonesia Waluyo and Kharisma (2023) states the concept of circular economy is an effective innovation to solve FLW issues, however the implementation is still being a concern as the Environmental Act and the IJC Act 2020 have not been able to oversee the adoption of circular economy policy in Indonesia. Moreover, North Sumatra's dependence on traditional waste management methods like open dumping exacerbates these issues and poses health threats through pollution and disease. On a social level, FLW stands in stark contrast to a region where poverty and hunger persist. The food that is wasted could otherwise be utilized to nourish those in need, thereby enhancing their nutritional intake (Farahdiba et al., 2023). Reducing FLW has the potential to strengthen local food systems, create job opportunities, and uplift rural economies, particularly since agriculture is a major income source (Waluyo & Kharisma, 2023).

Despite these hurdles, addressing FLW in North Sumatra presents an opportunity for substantial progress. Implementing concepts such as the circular economy, adopting innovative technologies, and fostering community engagement can enhance the sustainability of food systems. For instance, methods like composting and anaerobic digestion can convert food waste into renewable energy and fertilizers, while public awareness initiatives can promote more responsible consumption habits (Thompson, 2019) (Spang et al., 2019).

This paper examines FLW in North Sumatra by analysing its causes, consequences, and current policies. It also provides actionable recommendations informed by both local and international best practices. Given North Sumatra's abundant agricultural assets and rich cultural heritage, it has the potential to serve as a model for establishing a fair and sustainable food system. Through the implementation of improved policies, innovative technologies, and collaborative partnerships, the region can significantly minimize FLW and set an inspiring example for other regions.

METHODOLOGY

This study employs a qualitative approach using the literature review method to explore FLW in North Sumatra. The literature review method is chosen due to its effectiveness in synthesizing existing knowledge, identifying research gaps, and providing a comprehensive understanding of the topic based on credible sources. The study identifies the key drivers, impacts, and policy gaps related to FLW by synthesizing findings from academic journals, government reports, and international case studies. A systematic search using keywords such as "food loss and waste," "North Sumatra," and "sustainable food systems" ensured the inclusion of recent and relevant studies. Thematic analysis was used to organize data into economic, environmental, and social impacts and policy frameworks. The findings were cross-validated against international best practices, providing a robust foundation for actionable policy recommendations tailored to the local context. This methodology enables a comprehensive understanding of FLW while highlighting evidence-based strategies for intervention.

RESULT AND DISCUSSION

KEY FINDINGS

Food Loss and Waste (FLW) Trends in North Sumatra

Based on the data from *SISPN* (National Waste Management Information System) from 2021-2024, North Sumatra was the biggest waste producer daily and annually among the other 10 provinces in Sumatera Island. On average, the daily waste generated in north Sumatra far exceeds those of other provinces, peaking at over 6000 tons in 2024. This trend underscores the critical scale of the FLW problem in this region, which is demanding urgent attention and action.

FLW is very prevalent in North Sumatra, a significant agricultural region. The province's enormous agricultural output is hampered by supply chain inefficiencies, which result in severe food losses. Inadequate storage facilities, poor transit infrastructure, and a lack of access to contemporary preservation technology all worsen the issue (S Mardiana, et al 2017). Furthermore, cultural norms and a lack of public understanding about sustainable consumption lead to high levels of food waste among consumers. Addressing FLW in North Sumatra involves a multimodal approach that includes infrastructural expenditures, public education programs, and the implementation of innovative technology to improve efficiency throughout the food supply chain (Augustin Natasya et al, 2023).

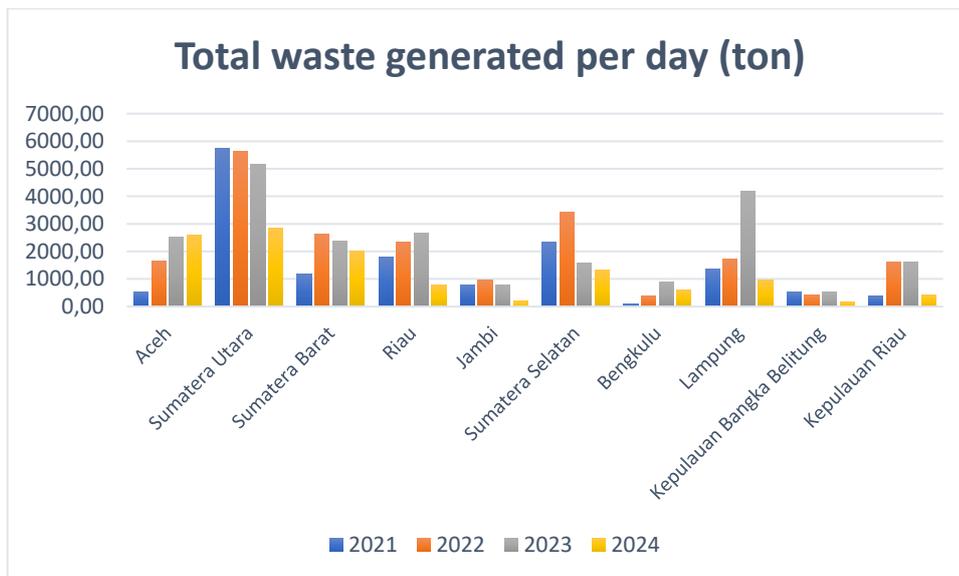


Figure 1 Total Waste Generated daily (ton) in All Provinces in Sumatera

Furthermore, based on the annual data obtained from the same resource, North Sumatra remains the largest contributor to annual waste generation on Sumatera Island from 2021 to 2024, consistently producing over 2 million tons of waste by 2024. This places the province at a critical juncture, requiring urgent interventions in waste reduction and management. While North Sumatra generates substantially more waste compared to neighboring provinces, this is likely linked to its larger economic activities, population size, and insufficient systemic interventions in waste management.

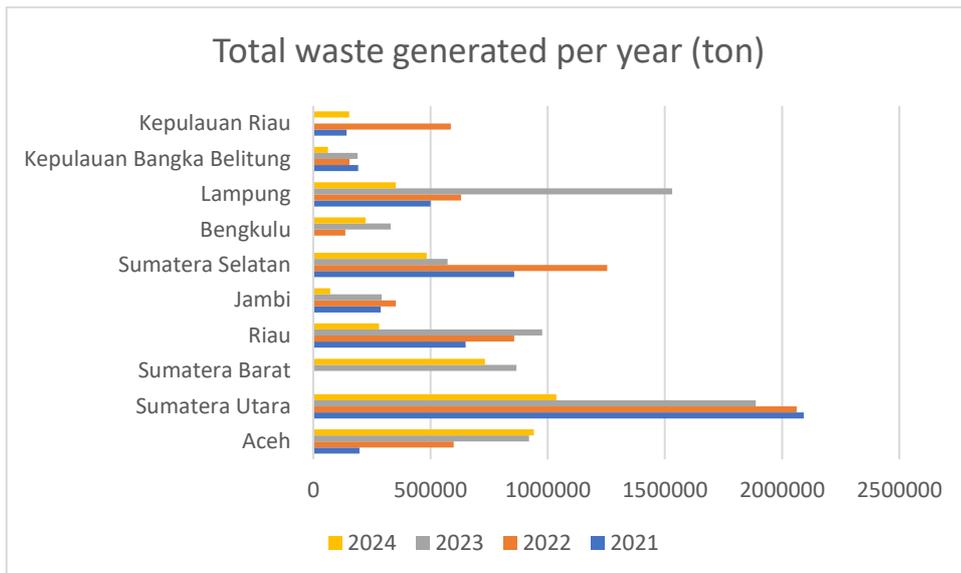


Figure 2 Total waste produced annually (ton) in all provinces in Sumatera Island

The data analysis reveals that the majority of FLW in North Sumatra originates from inefficiencies across the consumption and food supply chain. Based on the pie chart illustrating the composition of waste in North Sumatra from 2021 to 2024, food waste emerges as the largest contributor, accounting for 158.03% (relative to other types of waste), underscoring the region's significant challenges in addressing food loss and waste (FLW). This dominance highlights inefficiencies in the food supply chain, including agricultural production, post-harvest handling, and consumer behavior.

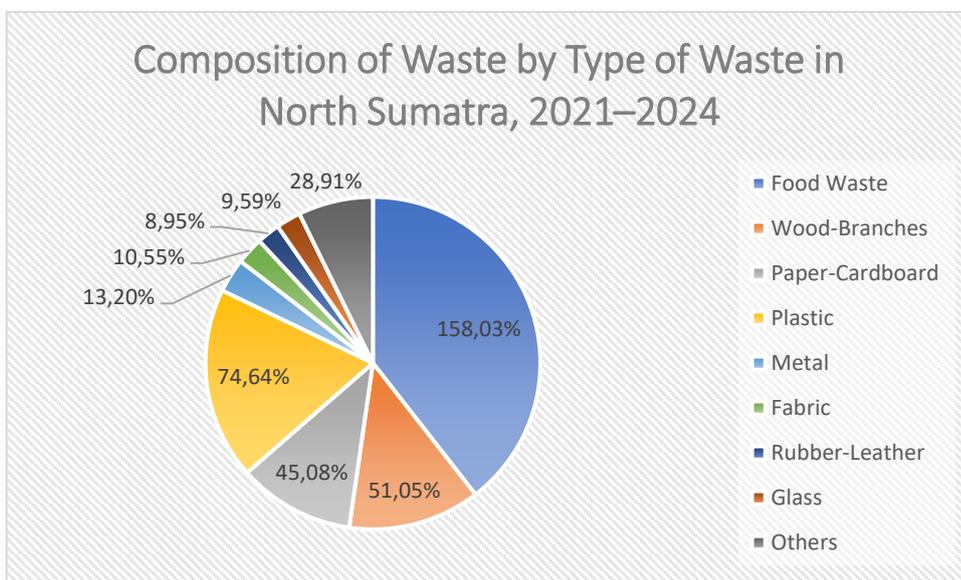


Figure 3 Composition of Waste by Type of Waste in North Sumatra, 2021–2024

The pie chart shows that food waste will be the major contributor to waste composition in North Sumatra from 2021 to 2024. This emphasizes a major issue in the region's food supply chain: inefficiencies in production, storage, distribution, and consumption result in excessive food loss and waste. High levels of food waste suggest that perishable items including fruits, vegetables, rice, and seafood may be lost owing to deterioration, poor post-harvest handling, or unsold market surplus. Furthermore, food waste

from households and food services contributes to the problem, frequently caused by over-purchasing, inappropriate storage, and excessive portion sizes. Addressing this issue is critical to improving waste management, lowering environmental impact, and increasing food security.

Conversely, rubber leather, fabric, and glass account for the lowest proportions of overall waste. These items often have lower disposal rates because they are reused, repurposed, or dumped less frequently than food or plastic waste. Smaller waste categories have distinct environmental concerns than food waste, which is biodegradable yet troublesome owing to methane emissions in landfills. These concerns include non-biodegradability and resource depletion. However, given their low proportion to total waste, policy should prioritize food waste reduction initiatives such as food recovery programs, improved cold storage, and public awareness campaigns to encourage responsible consumption.

In addition, at 74.64%, plastic waste is the second-largest contributor, followed by paper and cardboard (51.05%), indicating significant environmental concerns tied to these materials. The presence of plastic waste reflects growing consumerism, inadequate recycling systems, and a lack of alternatives to single-use plastics. Meanwhile, smaller percentages of metal, fabric, and glass waste indicate potential opportunities for material recovery and recycling programs, which could be scaled up to complement broader waste management strategies. These findings emphasize the need for a comprehensive and integrated waste management approach in North Sumatra.

Economic Impacts

Cattaneo and Vaz (2020) states that the Netherlands has significantly reduced food waste through various initiatives involving government, the private sector, academia and civil society. The key success of the initiative is the cross-sector collaboration to optimize the economic benefits of food that is still fit for consumption while minimizing the environmental impact of food waste.

One of the benefits of reducing food waste is not only protecting the environment but also increasing efficiency in the food supply chain. By reducing the amount of food wasted, companies can optimize the use of resources, from raw materials to energy. This leads to a reduction in production and distribution costs, which will ultimately positively impact the company's profitability. In addition, efforts to utilize food surpluses can open up new market opportunities. Food previously considered waste can be processed into value-added products, such as processed or ready-to-eat foods. This creates new products and opens up opportunities to develop new businesses and create jobs. Thus, investments in innovation and technology to reduce food waste can also significantly contribute to economic growth

In addition, companies that successfully reduce food waste will have a competitive advantage in a market increasingly concerned about sustainability. Consumers today are increasingly aware of the environmental impact of their consumption and tend to choose products from socially and environmentally responsible companies. Thus, companies that successfully reduce food waste will gain a good reputation and attract more consumers. Lastly, reducing food waste can save companies costs. The cost of disposing of food waste is a significant burden for many companies, especially food and beverage companies. By reducing food waste, companies can save on waste disposal costs and allocate these funds to other, more productive activities.

Environmental Impacts

Excessive and ultimately wasted food production results in inefficient agricultural land use, leading to biodiversity loss, land degradation, and increased greenhouse gas emissions. In addition, intensive food production processes require large amounts of water. Food waste means wasting precious water resources, impacting availability for other needs (Kinantia et al, 2021). Rotting food in landfills produces methane, a greenhouse gas contributing to climate change. Furthermore, food waste production,

processing, and disposal can pollute the environment, including land, water, and air. Other indirect impacts include deforestation to meet increasing food needs, overfishing, which damages marine ecosystems, and plastic pollution from food packaging.

FLW also puts a lot of pressure on natural resources. Producing food that ends up being wasted takes up huge amounts of water, energy, and land. In Indonesia, this is a serious issue, with FLW contributing to water shortages and declining soil health, especially in agricultural areas like North Sumatra (Bappenas, 2021). On top of that, when organic waste isn't composted or reused properly, it can pollute the soil and water. This not only hurts local ecosystems but also affects biodiversity in the region.

Social Impacts

Food waste is not only an environmental and economic problem but also a complex social problem (Gustavsson et al, 2011). Farmers, producers, and traders suffer financial losses due to unsold food. Millions of people around the world still suffer from hunger and malnutrition, while at the same time, we witness massive food waste in big provinces like North Sumatra. This stark contrast exacerbates social inequality and injustice in food distribution. Then, widespread food waste can trigger social instability, especially in developing countries. When natural resources such as land and water are used inefficiently to produce food, which is wasted, this can trigger conflict and dissatisfaction in society.

Food loss and waste (FLW) in North Sumatra have far-reaching social effects, particularly about food insecurity and inequality. Each year, the food wasted in Indonesia could feed up to 125 million people—nearly half the population (Farahdiba et al., 2023). In North Sumatra, many rural communities face economic struggles and lack access to nutritious food. Distributing surplus food could greatly enhance food security and improve diets in these areas.

Smallholder farmers, a key part of North Sumatra's agricultural sector, are among those most affected by FLW. They suffer post-harvest losses due to inadequate infrastructure and inefficient markets (Waluyo & Kharisma, 2023). Investments in rural development could help reduce these inequalities. Thus, the effect of reducing food waste is significant to protect the environment and contribute to achieving sustainable development goals, such as reducing poverty and increasing food security which involve various sectors and stakeholders.

POLICY RECOMMENDATIONS

Best Practices from Other Countries

Lessons learned abroad are helpful in North Sumatra's management of food loss and waste (FLW). China, the Netherlands, and Germany provide examples of how creative policies and frameworks for the circular economy can successfully handle FLW.

Resource conservation, recycling, and waste avoidance are prioritized under Germany's Circular Economy Act. Germany became a global leader in waste management through policy-driven incentives and compliance after revisions in 2012 that increased recycling objectives and encouraged industrial reuse (Farahdiba et al., 2023). Similar to, the Netherlands has pledged to eliminate waste by 2050, with the help of yearly expenditures of 300 million euros in circular projects that concentrate on consumer products, plastics, and biomass. The Netherlands exemplifies effective public-private partnerships and knowledge-sharing networks by recycling 80% of its garbage (Farahdiba et al., 2023).

Through tax breaks and financial assistance, China's Circular Economy Promotion Law encourages companies to implement clean technology and sustainable practices, increasing industrial efficiency,

especially in urban areas (Farahdiba et al., 2023). Public education is essential for raising awareness and promoting systemic reforms in all three nations. The successful use of these frameworks is ensured by cooperation between the government, the private sector, and civil society (Farahdiba et al., 2023). North Sumatra can lower FLW, improve sustainability, and further its circular economy objectives by modifying these tried-and-true tactics.

Proposed Policy Recommendations

A multi-faceted approach involving both short-term and long-term strategies is necessary to address the issue of FLW (Food Loss and Waste) in North Sumatra, Indonesia. The following recommendations aim to provide a comprehensive framework for reducing food waste, enhancing sustainability, and fostering a circular economy:

a. Infrastructure development

An essential initial stage is the construction of suitable infrastructure for the distribution, transportation, and storage of food. This entails enhancing market and distribution infrastructure, constructing better storage facilities, and boosting cold chain logistics (Ali et al, 2019). Losses can be reduced, especially in rural and isolated locations, by shortening the time it takes for food to travel from farm to table. Investing in effective transportation infrastructure will assist ensure that perishable commodities reach customers in good condition by reducing deterioration caused by delays (Parfiit et al, 2010).

Furthermore, by implementing food recovery systems, food insecurity, and FLW can be addressed (Kumar et al, 2020). Organized processes for collecting surplus food from various sources and dispersing it to more vulnerable groups must be established. Tax benefits and subsidies for businesses involved in food recovery should promote participation even further.

b. Circular economy practices

The key to cutting waste in the food industry is to promote circular economy techniques. This entails creating methods that reduce, reuse, or repurpose food waste instead of throwing it away (FAO, 2013). For example, extra food could be utilized to feed the poor or as raw material for animal feed or compost. Priority should be given to policies that encourage food companies to implement waste-reducing technology, such as repurposing non-edible portions of food or utilizing waste in energy production. By implementing specific incentives and sustainability-promoting laws, local food systems can include the concepts of the circular economy.

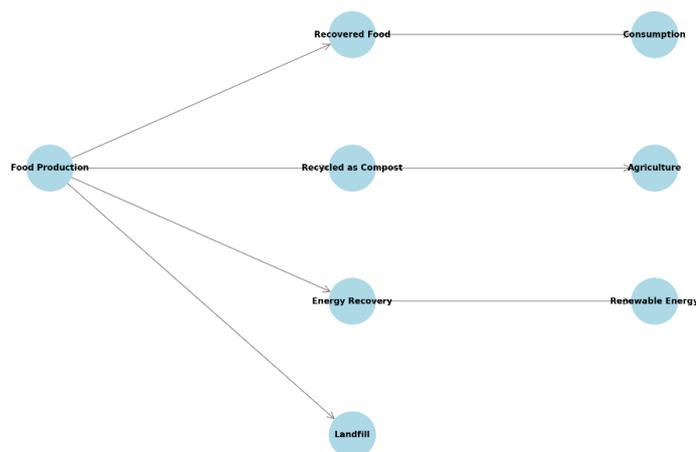


Figure 4 The circular Economy model for FLW

FLW's circular economy approach emphasizes sustainability, recycling, and resource recovery. According to this concept, the production of food leads to four main pathways: landfill, energy recovery, recovered food, and recycled compost (Bappenas, 2021). Recycled compost promotes sustainable agriculture by increasing soil fertility, while recovered food combats food insecurity by rerouting it for consumption. Landfills act as a residual channel, lowering the environmental impact, while energy recovery produces renewable energy, reducing reliance on non-renewable sources.

c. Strengthening the Policy Frameworks

North Sumatra's FLW management initiatives are directed by regional and national frameworks that prioritize socioeconomic development and sustainability. Through the Ministry of National Development Planning (Bappenas), Indonesia has initiated FLW programs nationwide, including food recovery and redistribution plans (Bappenas, 2021). However, the efficacy of these initiatives has been hampered by inadequate infrastructure and a lack of cooperation.

Although North Sumatra places a strong emphasis on preserving natural resources and enhancing environmental quality, their influence is limited by uneven implementation (Farahdiba et al., 2023). According to survey results, a large number of government initiatives are still in the planning stages and provide no community benefit. Plantation firms' CSR (corporate social responsibility) programs offer promise, but they haven't made a big difference in local livelihoods or waste management (Kinantia et al., 2021). An opportunity is presented by a circular economy concept, which emphasizes recycling trash into renewable resources. To make these initiatives viable, more community involvement and integration are required (Farahdiba et al., 2023).

To effectively address food loss and waste, a strong and unified policy framework is required. This entails establishing precise rules and regulations for the production, handling, and storage of food as well as providing incentives to companies that reduce waste. Regulations about food waste should be harmonized and brought into line with the best global practices, and national and regional governments should establish a legal framework that promotes accountability throughout the food supply chain. Implementing green tax reforms and sustainable waste management legislation is essential. Financial incentives for renewable energy initiatives, such as the production of biogas from organic waste, might help to connect economic interests with environmental goals.

d. Public awareness

To promote a culture of reducing food waste, public education initiatives are crucial (Kumar et al, 2020). People need to be aware of the negative effects that food loss and waste have on the environment and the economy, as well as doable strategies for lowering waste at the consumer level. Raising awareness of food conservation techniques, such as appropriate food storage, portion management, and inventive applications for leftover food, can be greatly aided by schools, the media, and neighborhood associations.

The main goals of educational programs in communities and schools should be to increase nutrition knowledge and encourage sustainable consumption. Food loss and waste (FLW) can be decreased, and healthier lifestyles can result from people making educated dietary decisions thanks to the inclusion of food literacy in the curriculum (Yumei et al, 2021). Since schools have a significant influence on how kids view food (Thompson, 2019), it is imperative to implement programs that teach sustainable eating practices, appropriate portion control, and the negative effects of food waste on the environment. Urban agricultural projects, food-sharing programs, and cooking classes are examples of community-based activities that can further promote responsible consumption habits.

e. Stakeholder collaboration

The Netherlands, where corporations, government agencies, and research institutions collaborate to minimize FLW, is a good example of multi-sector collaboration. The United Against Food Waste program, which unites players from all over the food system to exchange knowledge and create creative solutions, is one of the national policies that the Dutch government has put into place. Platforms for exchanging knowledge have been essential in encouraging innovative ideas like repurposing food scraps, streamlining supply chains, and creating environmentally friendly packaging (E Chioatto et al 2023).

Therefore, the government, commercial sector, academics, non-governmental organizations (NGOs), and local communities must all work together to address the complexity of food loss and waste. To enable various groups to work together on solutions, discuss best practices, and carry out cooperative projects, a forum for frequent communication and information sharing should be set up. Solutions will be both workable and culturally appropriate if local farmers, food processors, retailers, and waste management firms are included in the policy-making process.

In other words, to effectively overcome the problem of food loss and waste, a comprehensive series of policies is needed. One important step is to encourage the adoption of more efficient and sustainable agricultural technology. Cattaneo et al., (2020) highlights to minimize the environmental impact, the forward-looking pragmatist suggests to provide better resource use efficiency to meet the growing demand for food consumption in the future. In addition, developing adequate infrastructure for food storage and distribution, especially in developing countries, is also crucial. Raising public awareness through education about the importance of reducing food waste and providing knowledge about managing food well is another key step. Spang et al., (2019) suggest that raising consumer awareness gives a longer-term result on the first stages of reduction, recovery, and recycling, although to change the consumers behavior is not an instant process and needs to address how people relate to food in their everyday life. Implementing stricter regulations, especially for the food and beverage industry, in managing food waste also needs to be strengthened. Finally, strong collaboration between the government, the private sector, academia, and civil society is the key to successfully overcoming this complex problem.

CONCLUSION

In North Sumatra, food loss and waste (FLW) present significant social, economic, and environmental issues that impact sustainability, resource efficiency, and food security. The study's conclusions show that the province produces the most food waste in Sumatra, which is caused by ineffective food supply chain processes, a lack of proper waste treatment facilities, and a lack of public awareness. Beyond just causing farmers and companies to lose money, FLW exacerbates food insecurity and contributes to environmental deterioration through greenhouse gas emissions.

An all-encompassing and integrated strategy is needed to address these problems. Strengthening food distribution and storage infrastructure, encouraging circular economy principles, implementing strong policy frameworks, raising public awareness, and encouraging multi-stakeholder cooperation are among the recommendations made by this study. The efficacy of cross-sector alliances, regulatory incentives, and waste reduction initiatives is demonstrated by lessons learned from successful foreign practices, such as those in the Netherlands and Germany. By implementing comparable strategies and adapting them to the local environment, North Sumatra can improve food security, drastically lower FLW, and support Indonesia's larger sustainability objectives, especially SDG 12.3.

Assessing the long-term effects of FLW reduction programs, enhancing waste tracking systems, and investigating cutting-edge technology for food preservation and redistribution should be the main goals of future research and policy activities. North Sumatra might serve as a model for FLW management throughout Indonesia by emphasizing inclusive and sustainable solutions, which would ultimately promote social cohesion, environmental resilience, and economic prosperity.

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