

# Bergelimang Program: Community Innovation in Organic Waste Management in Banyumas Regency, Central Java

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**Abstract.** This study addresses the critical issue of waste management in Banyumas Regency, Central Java, where only 14.9% of waste was properly managed in 2024. This issue is further exacerbated by the significant reduction of Integrated Waste Disposal Sites (TPST) and the accumulation of approximately 26 tons of durian peel waste per harvest season in Alasmalang Village. To overcome this challenge, the Alasmalang community, supported by the CSR program of PT Pertamina Patra Niaga Fuel Terminal Maos, implemented “Bergelimang Program: Berdikari Mengelola Limbah Lingkungan”. This study employed a qualitative approach, utilizing in-depth interviews and desk research. The results highlight program innovations in transforming durian peel into environmentally friendly Class A fire extinguishers (APAR) by mixing durian peel powder with *monoammonium phosphate* (MAP), organic fertilizers for horticulture, and plant-based rodenticides utilizing flavonoids, polyphenols, and saponins. These innovations significantly contribute to environmental sustainability, advancing toward a net-zero waste movement, while simultaneously fostering economic empowerment in Alasmalang Village and its surrounding areas.

**Keywords:** Innovation, Durian Peel, Waste Management, Bergelimang Program.

## A. INTRODUCTION

The waste problem in various regencies and cities across Indonesia remains a critical issue, including in Banyumas Regency, Central Java. At the national level, according to the Sistem Informasi Pengelolaan Sampah Nasional (SIPSN), Indonesia produces approximately 18.6 million tons of waste annually, of which only 10.8 million tons are managed. At the same time, the remaining 41.9% accumulates in final disposal sites (SIPSN, 2024). Waste accumulation at landfills causes various issues, including unpleasant odors from decomposition, methane gas emissions that can trigger explosions, and multiple forms of pollution in surrounding areas. Waste-related contamination can pollute water sources such as wells and rivers, even after landfills are no longer operational (Royani et al., 2021).

The waste generation data in Banyumas Regency in 2024 indicates a larger portion of unmanaged waste. Of the 350,814 m<sup>3</sup> of waste entering landfills, only 52,622 m<sup>3</sup> (14.9%) can be sorted and processed at the landfill (Banyumas Communication and Information Office, 2025). This demonstrates that the waste problem in Banyumas Regency requires more focused attention. In several regencies and cities, grassroots initiatives for organic waste management have been widely implemented. For instance, in Riau Province, organic waste processing is commonly conducted through composting and biopore infiltration systems (Widayat et al., 2021). These two processes are the most common approaches to organic waste processing.

In other areas, such as at Giwangan Market in Yogyakarta, more innovative waste management practices have been implemented, including converting market waste into energy (Maarif et al., 2019). This waste-to-energy effort not only helps minimize waste generation but also contributes to the use of renewable energy (Khalil et al., 2019). Other innovations in converting organic waste go beyond generating gas compounds. Waste can also be transformed into solid fuel through wet torrefaction processes. The resulting solid material from organic

waste conversion can serve as a renewable energy source (Triyono et al., 2018). Consequently, organic waste can essentially be converted into various valuable products such as fertilizers, pesticides, and even processed food products (Putra et al., 2024).

This article, with a similar spirit, aims to present innovations from the community of Alasmalang Village, Banyumas Regency, in managing organic waste into various innovative products. These initiatives are encapsulated in a program widely known as “Bergelimang Program: Berdikari Mengelola Limbah Lingkungan.” Bergelimang was designed to address the pressing and complex waste management challenges in Banyumas. One of its key activities involves processing durian peel waste, a major problem in Alasmalang Village, into various products such as fertilizers, rodenticides, and durian peel powder. This waste management effort has not been carried out independently; it is supported by the Corporate Social Responsibility (CSR) program of PT Pertamina Patra Niaga Fuel Terminal Maos, which serves as the main partner of the Alasmalang community.

## B. METHODS

This study employed a qualitative approach from data collection to analysis to sharpen the understanding of real-world issues encountered by the informants, particularly the residents of Alasmalang Village (Tenny et al., 2025). Technically, the data were obtained through in-depth interviews with various stakeholders, including the Alasmalang community and the CSR team of PT Pertamina Patra Niaga Fuel Terminal Maos. Additionally, this study is supported by a desk study to enrich the analysis both before and following the interviews (Guerin et al., 2018). The desk study involved reviewing and analyzing various company reports, such as the Social Mapping Report prepared by the company, several unpublished or non-public corporate reports, as well as reports from national and local governments, particularly from Banyumas Regency.

## C. RESULTS AND DISCUSSION

### 1. The Organic Waste Problem in Alasmalang Village: Structural and Instrumental Dimensions

The waste problem, particularly organic waste, is not merely an individual problem that stems from personal attitudes or moral failings in the absence of proper waste governance. Fundamentally, waste management problems are also structural, compelling individuals or even entire communities to behave improperly when confronted with large and accumulated waste volumes. Such conditions frequently arise due to macro factors, such as the lack of adequate facilities for waste separation (Diaz-Ruiz et al., 2018). These macro-level challenges are also evident in Banyumas Regency, where the proportion of waste entering Integrated Waste Disposal Sites (*Tempat Pembuangan Sampah Terpadu /TPST*) and being sorted remains minimal year after year. The following table presents the trend of incoming waste and sorting outcomes based on the Data and Information Report of Banyumas Regency (2025), published by the Banyumas Communication and Information Office:

**Table 1. Waste Input and Sorting Trends in Banyumas Regency in 2022-2024**

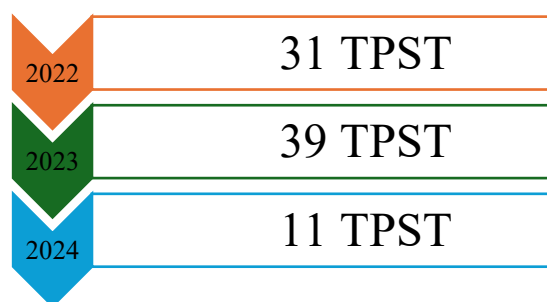
Year	Incoming Waste	Sorted Waste	Sorting Rate
2022	651,192.5 m <sup>3</sup>	227,917.38 m <sup>3</sup>	35%
2023	659,194.70 m <sup>3</sup>	59,327.50 m <sup>3</sup>	8.9%
2024	350,814 m <sup>3</sup>	52,622 m <sup>3</sup>	14.9%

Source: Processed by Researchers (2025)

Based on the data above, in the past three years, the proportion of waste sorted at TPST facilities provided by the local government has never exceeded 40%. This situation is a critical concern. Waste that cannot be sorted leads to broader problems, such as landfill explosions due

to accumulated waste, foul odors, as well as soil and water pollution around TPST sites (Muslimah & Si, 2017; Widayat et al., 2021). Pollution of soil and water sources can be severe because the compounds generated from waste accumulation can be both hazardous and non-hazardous. Waste heaps can emit gases such as methane, arsenic, and nitrogen, which pose potential risks to nearby residents, including waste pickers.

This fundamentally structural problem does not arise from the moral failings of the Banyumas community but from the inability of local government waste facilities to optimally manage and sort waste. This issue is not unique to Indonesia. In China, for instance, landfill explosions caused by unsorted waste are often attributed to fiscal deficits that lead to cuts in local government spending. Consequently, waste separation infrastructure is deliberately neglected (Liu & Zheng, 2023). A similar scenario may well be occurring in Banyumas Regency, where, based on the same data, the number of TPST facilities has drastically decreased rather than increased between 2022 and 2024.



**Figure 1. Trend of TPST Numbers in Banyumas Regency in 2022-2024**

Source: Processed by Researchers (2025)

Based on these data, it remains unclear why the number of TPST facilities in Banyumas Regency sharply declined from 39 in 2023 to just 11 in 2024. This drastic reduction has caused significant problems, especially given that the waste sorting rate has not surpassed 35%. The reduction of TPST facilities has recently led to serious issues, particularly at TPST Sumber Rejeki and TPST Sumpiuh, both located near Alasmalang Village, Kemranjen District. Although these TPST facilities remain operational, they are currently experiencing a large-scale accumulation of waste sludge (Social Mapping Report of PT Pertamina Patra Niaga Fuel Terminal Maos, 2025). Over time, the accumulation of unprocessed waste sludge can trigger various environmental issues, especially considering that areas around the TPST are not only residential but also agricultural zones.

Tracing the structural problems, from the reduction of TPST facilities due to local government policies to the accumulation of waste sludge at several TPST sites at the district level, requires waste analysis and management down to the village level. This study particularly highlights Alasmalang Village in Kemranjen District, where no adequate TPST facility exists. Moreover, the village significantly contributes to waste generation, particularly durian peel waste. If this organic waste is not managed properly, the burden on nearby TPST facilities relied upon by the Alasmalang community will become even more severe.

Alasmalang Village is well known as one of the largest durian-producing villages in Java. According to unpublished data presented by the CSR team of PT Pertamina Patra Niaga Fuel Terminal Maos (2025), approximately 825 villagers work as durian farmers, and 125 are durian entrepreneurs. The total area of durian plantations is significant, reaching 18.8 hectares, with seasonal harvests of around 80 tons. However, behind this impressive durian production lies the problem of massive durian peel waste, amounting to approximately 26 tons per season. While durian peel waste is organic, its sheer volume requires specific “management instruments” for proper decomposition and processing.

At this point, the issue of large-scale organic waste, particularly durian peel waste, has become a separate problem. This high-volume durian peel waste can be categorized as an “instrumental problem” that emerges in the midst of the Alasmalang community, which depends economically on durian plantations. The term instrumental problem specifically refers to the “absence of a management framework” for durian peel waste. Without proper management instruments, durian peel waste remains untreated and poses future risks due to unsanitary conditions, foul odors, and pollution. The lack of processing instruments has also hindered the potential utilization of durian peels (Nieswandt, 2024).

Returning to the structural problem, specifically, the absence of TPST facilities in Kemranjen District, where Alasmalang Village is located, and considering the village’s dependence on external TPST facilities such as Sumber Rejeki, the organic waste problem in Alasmalang Village can be characterized as multi-layered. On the one hand, the absence of TPST facilities, which should be provided by the Banyumas local government, represents a structural issue. On the other hand, the massive volume of durian peel waste generated from large-scale harvests, combined with the lack of adequate waste management instruments, constitutes an instrumental issue. Without solutions addressing both structural and instrumental dimensions, innovative waste management strategies are imperative.

## 2. The Abundance of Durian Peel: Between Problems, Potential, and Innovation

According to several studies, the large volume of durian peel waste can pose serious problems if left untreated, such as causing environmental contamination due to the decomposition process (Prabowo, 2009; Widhiantari et al., 2020). However, other studies have emphasized that when high-volume durian peel waste is properly managed, its abundance, previously regarded as an environmental hazard, can be transformed into a valuable resource. This is precisely what the community of Alasmalang Village, in collaboration with the CSR program of PT Pertamina Patra Niaga Fuel Terminal Maos, has begun to practice by converting the abundant durian peel waste into useful and economically valuable products. This collaborative effort is firmly grounded in sound academic foundations.

Based on best practices and numerous studies, durian peel contains activated carbon compounds that can be converted into biogas, biodiesel, bioethanol, and other forms of sustainable fuel (Agustina et al., 2018; Asnita et al., 2023a; Elizabeth, 2021; Zhivkova, 2024). These energy products are categorized as renewable energy sources (Royani et al., 2021). Beyond energy products, durian peel waste can also be processed into various types of fertilizers, pesticides, and even food products (Hayati et al., 2025; Putra et al., 2024; Sari et al., 2025a). To illustrate the potential of durian peel as a raw material for diverse products, the following table maps the potential applications of durian peel waste, which is often dismissed as mere trash but, in reality, is rich in valuable uses when processed and managed effectively.

**Table 2. Potential Products Derived from Durian Peel Waste**

Processing Method	Product	Contribution	Source
<ul style="list-style-type: none"> <li>• Compaction process</li> </ul>	<ul style="list-style-type: none"> <li>• Durian peel briquettes</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable fuel</li> </ul>	(Asnita et al., 2023b; Mahmudati, 2021; Prabowo, 2009; Widhiantari et al., 2020)

<ul style="list-style-type: none"> <li>● Burned &amp; dried</li> <li>● Durian peel pulp is dried and tested</li> </ul>	<ul style="list-style-type: none"> <li>● Activated carbon from durian peel</li> <li>● Bioadsorbent from durian peel</li> <li>● Polyamide-charcoal</li> </ul>	<ul style="list-style-type: none"> <li>● Filtration enhancer for wastewater from animal slaughterhouses</li> <li>● Bioadsorbent for heavy metal removal in water</li> <li>● Processing used cooking oil</li> <li>● textile dye biosorbent</li> <li>● laundry waste adsorbent</li> <li>● oil spill adsorbent</li> </ul>	(Ariyani, 2019; Arlofa, 2016; Hayaati & Ridho, 2020; Legiso et al., 2020; Magnum Ulfa, 2022; Nur Azizah Dwi Ningrum, 2023)
<ul style="list-style-type: none"> <li>● Durian peel extract mixed with garlic &amp; soursop</li> </ul>	<ul style="list-style-type: none"> <li>● Plant-based pesticides</li> <li>● biopesticides</li> </ul>	<ul style="list-style-type: none"> <li>● Pest control (caterpillars, mosquitoes, rats)</li> </ul>	(Ekasari, 2025; Rosmawati, 2016)
<ul style="list-style-type: none"> <li>● Grated &amp; dried durian peel</li> </ul>	<ul style="list-style-type: none"> <li>● Durian peel dacron</li> </ul>	<ul style="list-style-type: none"> <li>● Substitute dacron for pillows and similar uses.</li> </ul>	(Ningsih & Rahayu, 2021)
<ul style="list-style-type: none"> <li>● Processed into flour</li> <li>● Processed into pectin</li> </ul>	<ul style="list-style-type: none"> <li>● Durian peel macaroni</li> <li>● Pectin</li> </ul>	<ul style="list-style-type: none"> <li>● Snack food for consumption or sale</li> <li>● food thickener</li> </ul>	(Amanati, 2021; Nurrohmah et al., 2021)
<ul style="list-style-type: none"> <li>● Extracted</li> </ul>	<ul style="list-style-type: none"> <li>● Durian peel extract (anti-bacterial)</li> </ul>	<ul style="list-style-type: none"> <li>● Anti-bacterial agent in transparent soap formulations</li> </ul>	(Muawanah et al., 2019)
<ul style="list-style-type: none"> <li>● Fermented</li> </ul>	<ul style="list-style-type: none"> <li>● Fertilizer</li> </ul>	<ul style="list-style-type: none"> <li>● Environmentally friendly fertilizer</li> </ul>	(Sari et al., 2025b)

Source: Processed by Researchers (2025)

Referring to the table above, durian peel waste can be converted into various products such as sustainable fuel, bio-adsorbents for wastewater, plant-based pesticides, dacron, antibacterial agents, and even food products like macaroni and pectin. These practices have inspired the community of Alasmalang Village, in collaboration with the CSR program of PT Pertamina Patra Niaga Fuel Terminal Maos, to convert tons of abundant durian peel waste into at least three key products: rodenticides, fertilizers, and, most innovatively, durian peel powder combined with Dry Chemical Powder (DCP) for use in fire extinguishers (APAR).

These three products are certainly feasible to process and produce. The Alasmalang community, under the initiative popularly known as “Bergelimang Program: Berdikari Mengelola Limbah Lingkungan”, has begun developing these unique products. The Alasmalang community group involved in the Bergelimang Program integrates these products with the needs of other local groups in and around Alasmalang Village. For instance, the first innovation involves processing durian peel into powder. The extraction of durian peel into powder is already well-known in certain sectors because durian peel is rich in lignin, cellulose, and starch (Nurrohmah et al., 2021). However, instead of using durian peel powder for products like macaroni or baby biscuits, the community of Alasmalang has successfully transformed it into a mixture for DCP fire extinguishers. This innovation offers an eco-friendly, cost-effective, and safe fire suppression alternative.

These fire extinguishers can be utilized by both the local community in Alasmalang and PT Pertamina Patra Niaga Fuel Terminal Maos for fire safety purposes. According to unpublished preliminary research by the company, a 20% mixture of durian peel powder with monoammonium phosphate (MAP), a common chemical used in fire extinguishers, has been shown to effectively extinguish Class A fires. Class A fires include those involving easily

combustible materials, such as paper or wooden furniture. The DCP from durian peel combined with MAP functions like a protective blanket that removes oxygen and rapidly cools the fuel source. This APAR product can be used by households in Alasmalang and nearby areas to manage domestic fire hazards.

First, a similar integration approach is also applied to other durian peel-derived products, such as fertilizers and rodenticides. Durian peel waste processed into fertilizer is distributed to horticultural groups that maintain dedicated plots for horticultural crops. This initiative is highly beneficial since fertilizers made from durian peel waste are more environmentally friendly (Sari et al., 2025b). Horticultural groups no longer need to rely on expensive or environmentally harmful fertilizers. They also benefit from the fact that their crops are cultivated using natural or organic inputs. As a result, there is no concern when selling their produce to the public, as the products are safe and pose no threat to consumers.

Second, another valuable durian peel product for horticultural groups and durian nurseries is plant-based pesticides. It is well understood that growing crops organically presents significant challenges, particularly in terms of vulnerability to pests and diseases (Rais & Darwanto, 2016). Nonetheless, this can be mitigated by using natural pesticides derived from durian peel. This presents a unique challenge for horticultural farmers and durian nursery operators, as caring for organic plants is far more demanding compared to using chemical pesticides or fertilizers. However, the results are undeniable: products harvested from organic cultivation are more durable and have a longer shelf life compared to those treated with chemical inputs.

Third, the processed durian skin waste, which is also integrated with other groups, is a rodenticide or rat exterminator. As indicated in the Table of Potential Products from Durian Peel Waste, processed durian peel waste can be utilized to combat not only caterpillars and mosquitoes but also rats, which are common pests that damage crops and invade households. Durian peel contains several compounds with toxic properties, such as flavonoids, polyphenols, and saponins (Ekasari, 2025). Through various extraction processes, durian peel can be converted into pesticides, rodenticides, or insecticides, serving as an effective alternative to synthetic pest control agents that often have harmful side effects on living organisms (Maharani et al., 2024).

These natural products, converted into fertilizers, pesticides, insecticides, and rodenticides, can be utilized by horticultural groups, durian seedling farmers, and even the general public in Alasmalang to combat various pests, including caterpillars, mosquitoes, rats, and mealybugs that affect crops. If, in the future, durian peel waste processing can be implemented on a large scale and the resulting products can be widely adopted, conventional waste sorting facilities such as TPST may no longer be necessary. This is because the comprehensive utilization of durian peel waste aligns with the principles of net-zero waste, particularly in the management of organic waste (Lee et al., 2024). Nevertheless, the task of managing other types of waste, especially non-durian organic waste and inorganic waste, remains a challenge for the Alasmalang community and will require further attention in the future. However, the ongoing efforts toward net-zero waste, specifically in managing high-volume durian peel waste, have already contributed positively in many ways, as elaborated in the following subsections.

### **3. The Contribution of “Bergelimang Program” to Social and Environmental Problem-Solving**

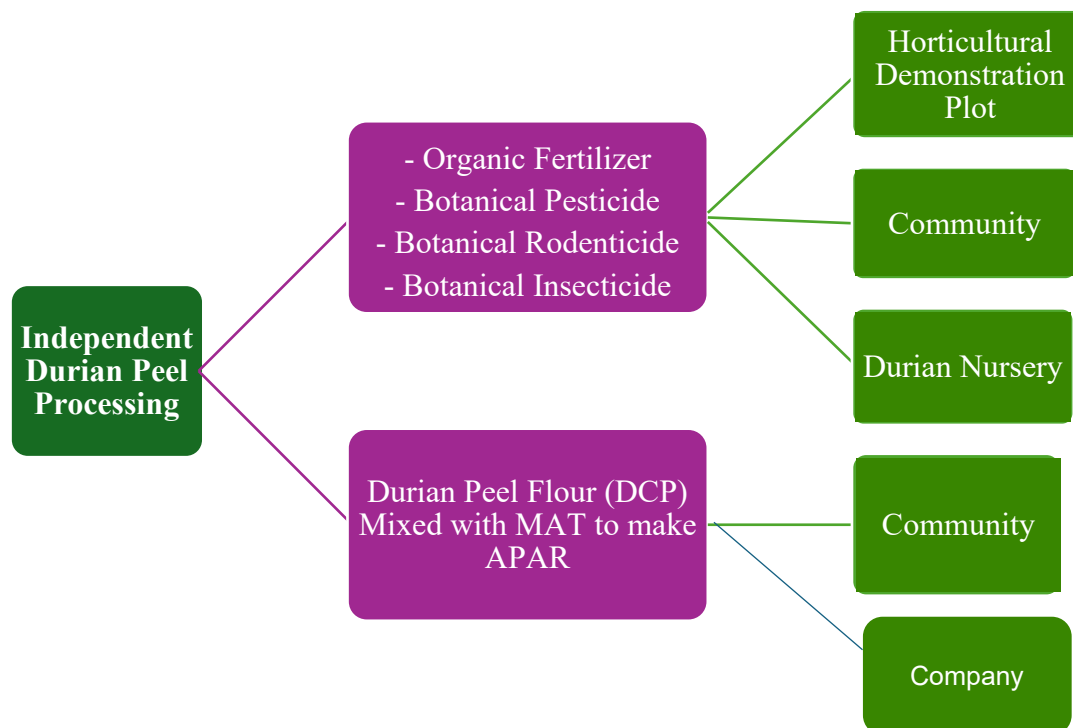
The innovations driven by the community through the “Bergelimang Program”, which involves converting durian peel waste into various products, are not merely creative initiatives but also represent significant contributions to solving economic, social, and environmental

challenges sustainably. Furthermore, the conversion of durian peel waste into a diverse range of products does not solely focus on outputs but also emphasizes the integration of these products with the needs of other groups in the vicinity of Alasmalang, such as durian seedling farmers and horticultural groups. In this respect, Bergelimang stands out as a unique program compared to other best practices in durian peel processing, which often highlight the end products while overlooking integration and cross-program contributions.

Integration serves as an added value for the Bergelimang Program, as the benefits of the products derived from durian peel waste by the Alasmalang community group are likely to be widely distributed. As discussed in earlier studies, durian peel is rich in beneficial components when properly processed. It contains fibers and compounds that can be converted into products capable of controlling water pollution. For example, durian peel can help address the negative environmental impact of laundry businesses that cause water contamination (Legiso et al., 2020). However, the question arises: to what extent can such initiatives be implemented? Which laundry business operators would be willing to use durian peel-based adsorbents to treat their wastewater?

When similar questions are posed to the Alasmalang community, such uncertainties are unlikely to arise. In collaboration with the CSR program of PT Pertamina Patra Niaga, the community group has not only designed a joint roadmap but also developed an integrated strategy to align durian peel waste products with the needs of other groups, such as seedling and agricultural businesses. This design is not solely oriented toward product outcomes but also ensures that the products have practical utility and functionality, so they are genuinely used and beneficial. With clear and effective utilization, the continuous processing of durian peel waste becomes more viable and sustainable.

The massive accumulation of durian peel waste during the harvest season will gradually be addressed. The Alasmalang community will no longer need to rely on TPST facilities to dispose of durian peel waste. The burden on TPST facilities near Alasmalang Village, which have long struggled with waste from the village, can also be reduced. For example, the waste sludge currently overburdening TPST Sumpiuh and TPST Sumber Rejeki can be gradually mitigated through the independent efforts of the Alasmalang community. In the future, Alasmalang Village may only require TPST facilities for other types of organic and inorganic waste, excluding durian peel waste. The following illustration depicts the integration framework between durian peel waste products and the needs of various local groups surrounding Alasmalang Village.



**Figure 2. Integration of “Bergelimang” with the Needs of Other Groups (Processed by the Researchers, 2025)**

Numerous studies have tested and demonstrated that durian peel waste can be converted into organic fertilizers, botanical pesticides, botanical rodenticides, and botanical insecticides. In Alasmalang Village and its surrounding areas, these processed products from durian peel waste are particularly useful. The CSR division of PT Pertamina Patra Niaga Fuel Terminal Maos, which serves as the primary partner for the Alasmalang community, also supports other community groups engaged in the agricultural sector. The integration between these supported groups is therefore easily established. The people of Alasmalang can supply organic fertilizers and botanical pesticides to other CSR-supported groups. Moreover, nearby districts such as Sumpiuh and Kemranjen, where the population lives close to farmland and rice fields, have active Kelompok Wanita Tani (KWT) such as KWT Subur Makmur and KWT Mergo Tani. These groups can become strategic partners for the Alasmalang community, particularly in the distribution of organic fertilizers and botanical pesticides, which are increasingly expensive and environmentally harmful (Amalia et al., 2025; Gultom & Harianto, 2021).

Given the ease of processing durian waste into these two types of products, combined with the urgent need of the Alasmalang community to address the large volumes of durian peel waste, the resulting value-added products will not be sold at high prices. Affordable and easily distributed durian peel products greatly benefit the Alasmalang community by helping them manage waste effectively. In turn, farmer groups benefit amid the rising cost of non-subsidized fertilizers. Furthermore, residents and TPST operators, who often face rodent infestations that can damage TPST facilities, also benefit from the botanical rodenticide products (Company Social Mapping Report, 2024). Durian peel waste converted into botanical rodenticides is advantageous because it decomposes quickly and is non-toxic to other living organisms (Etik Sundari, 2022). This botanical rodenticide is likely to be highly valuable for residents, extending its utility beyond fertilizer needs for nurseries and farmers.

The processed durian peel waste converted into flour also offers significant potential. Durian peel flour can be utilized by micro, small, and medium enterprises (MSMEs) as a raw material for unique food products. Numerous studies have noted that durian peel flour can be

processed into snacks such as macaroni, while its extract can yield *pectin*, a natural food thickener. Other food-related derivatives include organic vinegar (Irhamni et al., 2019). At this point, the list of benefits derived from processed durian peel waste is extensive. However, beyond its tangible benefits, the utilization and proper management of durian peel waste also carry important messages of social and environmental sustainability. Properly processed waste need not be destined solely for disposal.

#### **4. Reflection on Organic Waste Management of Durian Peel for Future Generations**

Building on the ongoing debates among social scientists, environmentalists, and climate advocates, there is an increasing urgency to mainstream environmental sustainability for the sake of future generations. Many discursive and practical efforts have been undertaken across sectors to emphasize the critical importance of this issue. The initiatives of the Alasmalang community, in collaboration with PT Pertamina Patra Niaga Fuel Terminal Maos, reflect these efforts, albeit implicitly and with room for further development. The community's efforts to integrate durian peel waste products with the needs of other groups, such as KWT, residents, and TPST operators, represent a remarkable achievement.

However, upon closer reflection, this integration is only the starting point of a broader movement to raise awareness that waste can be transformed into valuable resources when managed properly. Once this perspective is disseminated to a broader community, the potential for converting durian peel waste into various products will expand significantly. In the coming years, durian peel processing will no longer be limited to the production of botanical pesticides or flour alone. Given the proven economic value and functional benefits of many durian peel derivatives, it is highly likely that the demand for biofuels derived from durian peel waste, for instance, will become a reality.

Various forms of biofuel, such as bioethanol, biogas, briquettes, and biodiesel, represent just some of the sustainable energy products derived from durian peel waste. Although initially these fuels may not be produced or utilized on a large scale, their application at the community level, for operating specific machinery, for example, would provide both economic and environmental benefits. The current global trend toward "energy transition", shifting from fossil fuels to renewable and sustainable energy sources, is gaining momentum (Sovacool, 2016). Such transitions often do not require large-scale transformative changes, which are difficult to achieve. Instead, gradual and socio-technical approaches to energy transition, such as utilizing biofuels derived from durian peel waste, can be implemented effectively (Andrews-Speed, 2016).

In addition to its potential for biofuel production, the ongoing processing of durian peel waste can also contribute to the net-zero-waste movement. The conversion of durian peel waste into organic fertilizers, botanical rodenticides, APAR (fire extinguisher) powder, and other useful products represents a shift toward a "zero-burial" waste management paradigm. This approach is far more sustainable than conventional landfill practices, which are considered the worst-case scenario for waste management (Iqbal et al., 2023). Experts recommend at least minimal interventions, such as composting, to accelerate the decomposition of organic waste with human intervention (Wibisono et al., 2016). This reinforces the notion that waste need not become an environmental disaster when processed appropriately.

Another development related to the pursuit of net-zero waste is the potential use of durian peel-based, environmentally friendly packaging (Sinuhaji et al., 2014; Suryaningsih et al., 2025). The cellulose contained in durian peel can indeed be isolated and subsequently processed into pulp, paper, and biofoam. Such conversion holds strong potential for the general public and MSME groups around Alasmalang that require eco-friendly packaging products to reduce plastic waste. Waste typically becomes a socio-environmental disaster when it is merely

left unattended or disposed of in improper places, such as rivers and other waterways. While such behavior may remove waste from households or business premises, indiscriminate disposal creates new problems, including resistance to decomposition or uncontrolled putrefaction. Uncontrolled decomposition can generate harmful microorganisms that contaminate soil and flow into residential areas via rivers or groundwater. Hence, human intervention, no matter how small, must be undertaken to address mounting waste.

Reflecting again on the structural issue, namely, the drastic decline in the number of TPSTs in Banyumas Regency in 2024. This situation also opens the possibility of increased littering. A limited number of TPSTs will inevitably receive enormous volumes of waste, only a small fraction of which can be sorted. The remainder, in the form of waste slurry, is left to accumulate at TPSTs because it is difficult to distribute. Such piles of waste slurry can, over time, produce foul odors, hazardous substances, and even become sources of disease. Therefore, localized efforts by the Alasmalang community to process their massive durian peel waste will yield structural benefits. Faced with limited waste disposal facilities, the Alasmalang community can independently manage its own waste, thereby reducing the burden on other TPSTs. The TPST load attributable to Alasmalang's waste will thus lie primarily in inorganic waste, which this paper has not discussed in depth. Nevertheless, in the future, if eco-friendly packaging or durian peel-based biofoam can be adopted, inorganic (e.g., plastic) waste could likewise be substantially reduced.

Such efforts are highly advantageous for the Alasmalang community itself. For instance, the attempt to convert durian peel waste into DCP flour to be blended with MAP for APAR use is, in principle, not overly complex. The process involves several stages: preparation, soaking, chemical hydrolysis (acid and base), bleaching, drying, and milling into fine flour. This fine flour (DCP) is then blended with MAP via a grafting method, resulting in a stable and homogeneous combination of the organic component (DCP) and the inorganic compound (MAP). In the initial phase of this process, supported by research facilities, economic resources, and guidance from PT Pertamina Patra Niaga Fuel Terminal Maos, the Alasmalang community can continue to develop APAR products from durian peel DCP flour.

Overall, durian peel, once regarded merely as waste, can gradually be converted into a multifunctional raw material and high-value-added products that contribute to sustainable, safe, and environmentally sound waste management. If these potentials are realized, the processing of durian peel waste could become a truly comprehensive praxis, complementing earlier sustainability contributions through the use of botanical rodenticides, organic fertilizers, and botanical pesticides. The use of these organic and natural agents not only reduces contamination associated with more hazardous synthetic pesticides but also mitigates side effects ranging from irritation to mortality caused by synthetic toxins (Nimas Ayu Nurdian Ningsih, 2022).

#### **D. CONCLUSION**

Waste management remains a critical issue in Indonesia, particularly in Banyumas Regency, Central Java. In Banyumas Regency, of the 350,814 m<sup>3</sup> of waste generated in 2024, only 14.9% was successfully sorted at the landfill, underscoring the need for heightened attention. This problem is exacerbated by structural factors, such as the drastic decline in the number of Integrated Waste Disposal Sites (TPST) in Banyumas Regency from 39 in 2023 to just 11 in 2024. This reduction has resulted in large, poorly distributed waste accumulations, especially at TPSTs near Alasmalang Village, such as TPST Sumber Rejeki and TPST Sumpiuh. Specifically, in Alasmalang Village, the challenge is compounded by the significant accumulation of durian peel waste, approximately 26 tons per harvest season, categorized as an “instrumental problem” due to the absence of specific management instruments for durian

peel waste. To address these layered issues, the Alasmalang community, supported by the Corporate Social Responsibility (CSR) program of PT Pertamina Patra Niaga Fuel Terminal Maos, has implemented the “Bergelimang Program: Berdikari Mengelola Limbah Lingkungan”.

Bergelimang Program is distinguished by its innovative conversion of durian peel waste into high-value-added products that go beyond conventional waste management methods. Key innovations include the development of durian peel flour blended with Dry Chemical Powder (DCP) and *monoammonium phosphate* (MAP) to produce environmentally friendly, economical, and safe Class A fire extinguishers (APAR), capable of extinguishing fires involving combustibles such as paper and wood. Additionally, durian peel is processed into organic fertilizers, which are integrated into the needs of local horticultural groups, thereby reducing dependence on expensive and environmentally harmful chemical fertilizers. Leveraging natural compounds such as flavonoids, polyphenols, and saponins, the program also produces plant-based rodenticides effective against pests such as rats, caterpillars, and mosquitoes, providing a safer alternative to synthetic pesticides. The program further promotes the development of durian peel cellulose into biofoam as an eco-friendly packaging alternative to plastics. Its uniqueness lies in its integrated approach, in which product development is linked to the specific needs of various community groups, such as horticultural farmers and durian nurseries, thereby enhancing practical functionality and environmental sustainability.

The innovations of the Bergelimang Program significantly contribute to environmental sustainability by transforming large volumes of organic waste, reducing pollution, and advancing toward a net-zero-waste model that is superior to waste landfilling. The shift toward natural pesticides and fertilizers also reduces chemical contamination and associated health risks. From an economic empowerment perspective, the program creates economic value from previously unused waste, provides affordable natural alternatives to costly chemical agricultural inputs, and potentially stimulates new entrepreneurial activities within the community. Furthermore, it strengthens social resilience and autonomy by enabling the community to manage its waste and reduce the burden on limited TPST facilities. Although additional development opportunities remain, such as conversion into sustainable fuels (e.g., biogas, biodiesel, briquettes) to support the energy transition, the Bergelimang Program already serves as a comprehensive and forward-looking model of community-based organic waste management. It offers a compelling illustration of sustainable waste governance, demonstrating that waste, when approached with strategy and collaboration, can indeed be transformed into a blessing.

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