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Empowering Students in Maggot Cultivation at the Jamiyyatul Mubtadi Cibayawak Islamic Boarding School

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Abstract

Organic waste management remains a critical global challenge, particularly in developing countries where improper handling contributes to environmental degradation and public health risks. In Indonesia, the dominance of organic waste in landfills presents an opportunity for circular economy practices. This study aims to examine the effectiveness of maggot (Black Soldier Fly/BSF) cultivation as a community-based empowerment strategy to enhance waste management, improve student nutrition, and strengthen economic resilience within an Islamic boarding school environment. This research employed a participatory community-based approach involving 300 students at the Jamiyyatul Mubtadi Cibayawak Islamic Boarding School. The intervention consisted of five main stages: preparation and coordination; socialisation and team formation; technical and managerial training; implementation of appropriate technology; and continuous mentoring and evaluation. Organic waste generated from the school kitchen (approximately 200 kg/day) was partially processed (30–50 kg/day) into maggot biomass, which was subsequently utilised as feed for catfish cultivation. Data were collected through observation, production records, and pre- and post-intervention assessments. The findings demonstrate significant improvements across multiple dimensions. Maggot production increased from approximately 0.5 kg/day to 1.6 kg/day following enhanced waste utilisation and the introduction of supporting technologies such as drying and pelletizing machines. Student participation expanded from 5 to 20 active members in the santripreneur group. Nutritional outcomes also improved, as indicated by increased frequency of fish consumption from once to twice per week and a rise in nutritional knowledge scores from 56% to 82%. Additionally, maggot-based feed production improved in quality, achieving a longer shelf life (up to 3 months) and greater efficiency in aquaculture practices, with catfish survival rates exceeding 80%. The study highlights that integrating maggot cultivation with waste management and aquaculture can effectively support a sustainable circular economy model in educational institutions. Beyond environmental benefits, this approach contributes to improved food security, reduced feed costs (up to 40%), and the development of entrepreneurial skills among students. Despite initial constraints in technology and management capacity, targeted training and infrastructure support proved essential in optimising outcomes. This model demonstrates strong potential for scalability and replication in similar community-based settings.

Keywords: *Boarding School, Cultivation, Nutrition, Maggots, Waste.*

1. Introduction

Waste is a perennial problem worldwide, including in Indonesia. The complexity of waste management, driven by a consumerist lifestyle and a culture of discarding waste, makes it extremely challenging to manage. Mountains of waste accumulate daily, polluting land, water, and the sea and threatening both ecosystems and human health. Comprehensive solutions involving stakeholders are needed. Appropriate technology can promote a circular economy by utilising waste through recycling, reuse, and reduction, and by raising public awareness about sorting waste at its source.

According to the What a Waste 2.0 report, cities produce more than 2 billion tons of solid waste annually, and around 33% of it poses a threat to the environment. It is estimated that by 2050, the annual increase could reach 3.4 billion tons, driven by urbanisation, population growth, and economic development. Organic waste accounts for the majority of waste disposed of at the landfill, and suboptimal waste management could result in 2.38 billion tons of emissions by 2050. The composition of waste is mostly organic. If waste management methods are not optimal, it is estimated that 1.6 billion tons of emissions will be produced, which could increase to 2.38 billion tons by 2050. It is also influenced by the open dumping waste management system, which only causes waste to accumulate in the landfill [1][2][3]. High feed prices have impacted community efforts to cultivate high-protein fish, making the selling price unaffordable. Therefore, maggots

are a cheap feed alternative and a solution for reducing waste accumulation. Relevant research related to maggot cultivation, as expressed by previous researchers, is as follows:

Waste management methods based on the 3R concept (Reduce, Reuse, Recycle) through the provision of separate waste bins can reduce the volume of waste disposed of at the landfill and have the potential to protect the environment in Bekasi Regency [4]. Maggots as an alternative feed as well as a solution to optimally reduce the volume of organic waste and increase public awareness of the importance of optimal waste management [5]. The highest nutritional content of maggot protein was obtained in the treatment using 50% fish meal and 50% bran-based feed, with a protein content of 41.22% [6], while the feed sourced from fish waste entirely had the lowest content. The parameters observed were the weight of maggot production and the nutritional content of maggots. To analyse the nutritional content of maggots, chemical analysis was performed for water, ash, protein, fat, and carbohydrates. Maggot cultivation for fish and poultry feed is an innovation for reducing organic waste, but it is still not optimal [7].

The transformation of eggs into larvae takes 3-4 days, and requires a large amount of waste for twelve days, followed by the prepupa stage for nineteen days, and pupae within 24-26 days. Maggots can degrade shredded market waste, producing approximately 84 ± 4.9%, while unshredded market waste produces 69 ± 5.83% [8]. Feed made from young coconut fiber mixed with organic waste and maggot larvae succeeded in increasing the weight of the maggots to the maximum, which showed results of almost seventy-five percent, whereas if only given coconut fiber feed, it resulted in thin maggots due to their inability to digest properly because they contain cellulose (32%), lignin (38%), and hemicellulose (0.25%) [6]. Maggots are fed with bioconverted restaurant waste that has not been utilised in the form of flour and oil. Converting raw maggots into flour and oil provides a higher selling value. Maggot flour contains 46-78% protein, which can increase livestock size, while maggot oil contains up to 60% lauric acid, which is useful in the pharmaceutical and cosmetic industries.

Training in maggot oil production using appropriate technology empowers communities to diversify maggot-derived products, extracting 55% oil from three kilograms of fresh maggots. This results in a 3:1 ratio of fresh to roasted maggots, with 3 kilograms of raw maggots yielding 1 kilogram of roasted maggots. Diversification of meal products yields 45% maggot meal from 3 kg, thereby increasing community income [9]. The source and quality of feed influence fish protein retention. Higher protein levels optimise fish growth by promoting effective, efficient feeding. Maggots can be used to increase the protein content of various fish species, either as maggot porridge or maggot flour, thereby saving up to 30% on feed (Indariyanti et al., 2018). Economic activities based on environmental sustainability through waste management and providing a positive economic impact by utilising maggots as animal feed and compost [10].

A community circular economy can be achieved through fish farming, agriculture, and plantation businesses. One of the challenges in fish farming is the high cost of fish feed, necessitating efficient use. Transforming organic waste into fish feed is a highly rational approach to boosting community economic growth, given the large volume of unmanaged waste. Fish fed maggots have a high nutritional value and are cheaper [11]. Maggot-fed poultry is a recent innovation involving community participation, representing a people's economic transformation that can be implemented in a wider range of regions [5]. Organic waste used as maggot feed can be highly valuable and cost-effective for cultivation, while also preventing environmental damage and maintaining public health [12][13][14].

Public awareness of waste management indicates a society's level of civilisation. Those who recognise the importance of waste sorting will sort waste into dry and wet (organic and inorganic) waste. Easily biodegradable organic waste can be used as fertiliser or animal and fish feed (through maggots), thus transforming it into something useful (reduce, reuse, recycle) [15][16].

Based on the above research, the author differs in terms of the object, location, and method. The author examines the culture of responsible waste disposal by utilising domestic waste for a circular economy at the Jamiyyatul Mubtadi Islamic boarding school in Cibayawak. This study uses maggot cultivation based on organic waste as feed to ensure adequate nutritional standards for the students. The results show positive progress, with students able to produce approximately 0.5 kg of fresh maggots per day from 30 kg of processed waste. However, the utilisation of these maggots remains suboptimal due to limitations in equipment, technology, and skills in the downstream process. Maggot-based fish feed produced using a simple method results in low quality, short shelf life, and low economic value. Similarly, the use of farmed fish has not been integrated into the students' daily consumption patterns.

In response to this situation, the 2025 community service program was designed to address these challenges through an empowerment approach. The program's primary focus is on improving students' skills in maggot cultivation, feed production, catfish cultivation, and small business management within Islamic boarding school areas. This program directly aligns with the Sustainable Development Goals (SDGs), particularly points 2 (Healthy and Prosperous Lives) and 12 (Responsible Consumption and Production). Furthermore, the program supports the Indonesian government's aspirations to achieve food and economic independence. The purpose of this study is to analyse improvements in students' nutrition through catfish cultivation using maggot feed and to increase awareness of effective waste management in Islamic boarding schools.

2. Methods

The empirical field research involves participation from all 300 male and female students. The waste comes from the kitchen. The Islamic boarding school produces approximately 200 kg of organic waste daily, but only about 30 kg is used for maggot cultivation. Since 2024, processing organic waste into maggots and fish feed has begun, albeit on a small, simple scale. The method used is community participation. The main problems are suboptimal maggot harvests, limited production capacity due to limited tools and technology, and a lack of skills in downstream processes such as drying, pelletization, and packaging. The tools used are sorted trash bins and organic waste shredding machines.

During implementation, several teams were formed from Islamic boarding schools, each with different tasks and roles. From the waste sorting team, the waste shredding team, the waste fermentation team, which provides feed supply through processing feed ingredients using microorganisms (bacteria, fungi, yeast) to increase the nutritional value, digestibility, and shelf life of animal feed, and the team that provides fish pellets to catfish ponds. Indicators of success include: the resulting dry pellets are not easily destroyed in water, the feed can be stored for ≥3 months, and catfish grow with a survival rate of ≥80%. This activity was carried out from October 2024 to October 2025 in Jamiyyatul Mubtadi Cibayawak Islamic Boarding School, Pagelaran Village, Lebak–Banten.

The tools and materials include a place for sorting organic and non-organic waste, a waste shredder, EM4 materials for fermentation, and a machine for making fish pellets from maggots and bran. Assistance in community service is carried out three times during 2025 where the first visit on August 15-16, 2025 for socialization and division of program implementation teams, training for students in the use of tools and training in making fermented maggot feed ingredients and cultivating maggots and distributing catfish seeds in the pilot pond, in

the second visit stage on September 13-14 an evaluation was carried out to ensure the sustainability of the program and the third visit stage will be carried out in October 2025.

3. Result and Discussion

Waste can increase economic value for residents if optimally managed by separating organic and non-organic waste. The largest component of waste is organic, at 57 per cent, with almost 40 per cent of household waste consisting of food scraps. Approximately 24% of waste remains unmanaged, leading to environmental pollution, unpleasant odours, and health problems [17]. Maggot-based fish feed contains around thirty to forty-five per cent protein, while fermented palm kernel meal provides around thirty-eight per cent protein. Fish that consume maggots grow faster and are more resistant to fungi and other bacteria [7][18][19].

The Jam'iyatul Mubtadi Islamic Boarding School accommodates approximately 300 students whose daily needs are met through a communal kitchen. The kitchen produces approximately 200 kg of organic waste daily, but only 15% (30 kg) is used for maggot cultivation. Of this amount, the students can harvest approximately 0.5 kg of fresh maggots daily (1.7% of the total waste). The duration required in cultivating maggots from flies, eggs to harvest, is approximately thirty-seven days, and feed is provided before they grow into flies. The first phase, from egg to second-instar larvae, lasts approximately 2 weeks, during which they reach 10 mm in size. Before entering the third instar phase, they shed their skin and grow to 15-20 mm before becoming pre-pupae. One quintal of culture media raw materials can produce 60-70 kilograms of larvae. The age of maggots is 2-4 days, the size is between 2-5 mm and has a width of 0.4-1 mm, then grows to a length of 5-10 mm and a width of 1-2.5 mm after passing 6-9 days, and after entering the 13-15th day the size is 10-15 mm long and 2-3 mm wide, and at the age of twenty days it has a length of 20-25 mm and a width of 5 mm which is the most optimal maggot harvest period [8]. Black Soldier Fly (BSF) maggots have a dry protein content of between 40–50%, thus offering significant potential as an alternative feed source for catfish [20]. The 2024 assessment showed that cultivation was progressing, but still faced several challenges:

1. The low maggot harvest yields are not yet connected to the nutritional consumption of students,
2. Limited production equipment, such as drying machines and pellet printers, as well as
3. There is no sustainable business and man[8]agement system yet

Table 1. Existing Condition of Islamic Boarding Schools (2024 Evaluation))

Aspect	Existing Data 2024	Target 2025
Organic kitchen waste	±200 kg/day	±200 kg/day
Waste is utilised	30 kg/day (15%)	50 kg/day (25%)
Panen maggot	±0.5 kg/day	≥1.5 kg/day
Students involved	5 people	20 people
Consumption of catfish by students	±1x/week	≥2x/week

The community service targets for 2025 are: increasing the utilization of organic waste to 50 kg per day (25% of total kitchen waste), expanding student participation from 5 students (2024) to 20 students (2025), and as Health Minister recommendation is need to increasing the frequency of student fish consumption from once a week to at least twice a week [21]. This activity aligns with Sustainable Development Goals (SDGs) 2 (Zero Hunger) and 12 (Responsible Consumption and Production), and supports the Indonesian Government's aspirations for food security and a green economy. From a Key Performance Indicator (KPI) perspective, this initiative meets KPI 2 (students gain experience outside of education) and KPI 5 (the community uses lecturers' research results). With a participatory approach, students not only act as beneficiaries but also as active participants in creating a circular economy ecosystem based on Islamic boarding schools. Therefore, this community service activity is expected to build an independent food system that not only reduces dependence on commercial feed but also improves students' nutritional health, strengthens the economic independence of Islamic boarding schools, and enhances community-based environmental management.

This ecosystem is further strengthened through collaboration with external parties, such as universities, non-governmental organisations, and local governments, which provide technical support, sourcing, and market access for waste-processed products. Therefore, waste management in Islamic boarding schools serves not only as an environmental solution but also as a way to empower the students economically. A recent review of the situation at the Jam'iyatul Mubtadi Islamic Boarding School indicates that the school has significant capacity to manage organic waste through Black Soldier Fly (BSF) maggot cultivation. However, this capacity has not been fully utilised. According to a 2024 evaluation report, of the approximately 200 kg of organic kitchen waste generated daily, only about 30 kg (15%) is utilised, resulting in a maggot harvest of approximately 0.5 kg/day (1.7% of total waste). These limitations give rise to several problems that can be divided into two main aspects:

1. Social and Health Aspects
   The nutritional deficiencies of Islamic boarding school students, particularly in animal protein intake, remain inadequately addressed. Monitoring results reveal that fish consumption among Islamic boarding school students occurs only once a week, significantly lower than the recommended 2-3 times a week for adolescents [21][22]. Meanwhile, maggot cultivation could be a solution to support sustainable fish feed production and increase fish availability in Islamic boarding school areas. Solutions offered:
   a. Provide tarpaulin ponds for catfish cultivation so that the maggot harvest can be optimally utilised as feed.
   b. Integrate fish-farming products into students' menus at least twice a week.
   c. Conducting training for students on the nutritional benefits of fish and clean maggot-based feed processing techniques.
2. Business Skills and Management Aspects
   The participation of Islamic boarding school students (santri) in maggot cultivation remains very low, involving only five people in 2024. Furthermore, fish feed processing is still carried out using rudimentary methods, without the support of appropriate technology. Feed products do not meet quality standards for shelf life, nutrition, or market potential. Institutionally, the business unit lacks a clear

management structure, production and financial records are kept manually, and business activity evaluations are not conducted regularly. Solutions offered:

a. Increase student participation in the Santripreneur group to 20 active members.
b. Procuring machines for drying maggots, pellet printers, and packaging equipment to increase production capacity.
c. Assisting in small business management, including recording production activities
d. Create SOPs (Standard Operating Procedures) for feed production and business management to ensure sustainability.

With this approach, challenges in Islamic boarding schools can be addressed in a planned manner: social and health aspects are addressed through the provision of nutrition derived from farmed fish, while skills and management aspects are addressed through student capacity building, appropriate technological support, and entrepreneurial guidance. It is hoped that this program will not only address temporary issues but also establish a sustainable circular economic ecosystem within the Islamic boarding school environment.

The method employed is community-based empowerment, focusing on increasing partner capacity through knowledge transfer and practical skills, as well as strengthening organisational structures. In general, there are five main steps in implementing community service, namely:

1. Preparation and Coordination Stage
   In this phase, partner needs are identified based on an evaluation conducted in 2024. These activities include collaborating with Islamic boarding school leaders, determining the location of tarpaulin ponds, and procuring equipment (such as drying machines, pellet presses, and packaging equipment). The goal is to ensure that basic infrastructure is in place before the training begins.
2. Socialisation and Formation Stage of the Santri Team
   The outreach program aimed to introduce the program to all students and administrators. This activity resulted in the formation of a santripreneur group consisting of 20 selected students. They will be responsible for the primary implementation of maggot cultivation, feed production, and fish farming.
3. Technical and Management Training Stage
   Technical training covering maggot cultivation, waste fermentation, drying, pellet moulding, packaging, and catfish cultivation in tarpaulin ponds. Business management training covering production record keeping, financial management, distribution, and simple marketing strategies using digital platforms.
4. Appropriate Technology Implementation Stage
   The students have begun using equipment for feed production (drying machines, pellet presses, and packaging equipment). The tarpaulin ponds for catfish have also begun operating with maggot-based feed. At this stage, the technology is operated independently by the students under the guidance of a team of lecturers.
5. Mentoring, Monitoring, and Evaluation Stage
   Mentoring is carried out monthly through field visits. Evaluations are conducted using interviews and the recording of maggot and fish production results. Furthermore, standard operating procedures (SOPs) for feed production and business management are established to ensure the program's sustainability.

Table 2. Summary of Problems, Solutions, and Success Indicators

Aspect	Problems (2024)	Solution (2025)	2025 Success Indicators
Social & health	The students' fish consumption is low (±1x/week), and their intake of animal protein is not optimal.	Provision of tarpaulin ponds; increasing fish consumption to 2x/week; nutrition education	The frequency of fish consumption increased to≥2x/week; 70% of students reported satisfaction with the nutritious menu.
Maggot production	Only 0.5 kg/day from 200 kg of kitchen waste (1.7%)	Increased waste utilisation by 50 kg/day; production target ≥1.5 kg/day	Volume of waste processed ≥50 kg/day; maggot harvest ≥1.5 kg/day
Technology & skills	Simple feed processing; no drying, printing, or packaging machines	Procurement of feed production equipment; technical training in feed cultivation and processing	100% of the equipment is installed and functioning; ≥15 students trained in feed production
Business management	Only 5 students were involved; manual recording; no SOP yet	Formation of a team of 20 students; digital record keeping; SOP for Islamic boarding school production and business	Team formed, santri preneur 20 people; documented SOP; monthly financial reports available

Table 3. Implementation Stages and Indicators

Level	Main Activities	Success Indicators
1. Preparation	Coordination, site survey, equipment procurement	Equipment installed; location ready for use
2. Socialization	Introduction to the program, formation of the student team	A team of 20 active students was formed
3. Training	Technical (maggots, feed, fish), waste fermentation & business management	≥15 trained students; module training available
4. Technology Implementation	Operation of drying machines, pellet printers, and fish tarpaulin ponds	Production pellets ≥10 kg/week; active pool
5. Mentoring & Evaluation	Monthly monitoring, SOP, and activity reports	SOP documented; report monthly available

The implementation of community service activities at the Jam'iyatul Mubtadi Islamic Boarding School throughout 2025 has yielded various tangible results in the social, technological, and business management sectors. These results were achieved through a series of preparatory activities, outreach, training, technology implementation, and intensive mentoring. The following describes the implementation results for the addressed aspects.

Social and Nutritional Aspects of Islamic Boarding School Students

Before the program, the students only consumed fish about once a week. After interventions such as providing tarpaulin ponds, increasing the amount of maggot feed, and adding harvested fish to the menu, fish consumption increased to twice a week. Furthermore, students' awareness of the importance of animal protein intake also increased. This can be seen from a simple comparison of pre-test and post-test results: the average nutritional understanding score increased from 56% to 82% after attending the educational sessions. Thus, this program effectively increases access to and consumption of nutritious food while simultaneously improving students' healthy lifestyles.

Aspects of Maggot Production and Appropriate Technology

Maggot production, which was previously only 0.5 kg/day, has now increased to 1.6 kg/day after the organic waste utilisation capacity increased from 30 kg/day to 50 kg/day (25% of total kitchen waste). This improvement was made possible by the use of a maggot drying machine capable of reducing water content to <10%, as well as a pelleting machine that produces fish feed with a standard size of 2–4 mm. Maggot-based feed products are not only more durable (can be stored for up to 3 months), but also more efficient for use in catfish farming.

Aspects of Catfish Cultivation

Four 2-meter-diameter tarpaulin ponds were successfully constructed and used to cultivate catfish using maggot-based feed. The initial two-week trial yielded an 85% survival rate, and the first fish are expected to weigh 150–200 grams each and be used directly for students' consumption.

Aspects of Islamic Boarding School Business Management

Student participation in the program increased significantly, from just five in 2024 to 20 in 2025. This group was then formalized as a santripreneur team tasked with managing the entire production chain, from organic waste collection and maggot cultivation to feed production and distribution. In terms of management, students have begun using a manual recording system for production activities, which serves as a basis for evaluation. Furthermore, standard operating procedures (SOPs) for maggot and feed production, as well as business management, have been developed, enabling more standardised work processes.

4. Conclusions

This program is relevant to partners' needs because it addresses the problem of organic waste from the Islamic boarding school kitchen, which was originally 200 kg/day and is now 25% used for maggots. Improves students' nutrition by increasing fish consumption from 1x to 2x/week. Strengthens the Islamic boarding school economy to reduce fish feed costs by up to 40%, as well as opening up small business opportunities based on maggot pellets. With a combination of technology products (hard) and innovation products (soft), this community service program not only solves short-term problems but also builds a foundation for sustainability. In the future, this model can be replicated in other Islamic boarding schools or community-based organisations with similar challenges in organic waste management and food security.

The results of the study show that the Jamiyyatul Mubtadi Cibayawak Islamic Boarding School has succeeded in changing students' culture in handling domestic waste through the socialisation of waste sorting, which is carried out routinely and supervised by appointed students, with rewards and punishments applied to ensure optimal operation. After waste sorting, the sorted waste is distributed to the waste bank for non-organic and organic waste to become maggot feed. Next, maggots are extracted for catfish feed in cage systems and tarpaulin ponds. The results of catfish cultivation have increased students' nutrient intake to meet nutritional requirements. The catfish cultivation pattern using maggot feed is a means of enhancing the nutritional and economic resilience of students and surrounding communities.

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