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Household Food Waste Management in Rural Communities: A Knowledge, Attitude, and Practice Study

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ABSTRACT

Households are the largest contributors to food waste in Indonesia. Rural communities often lack effective waste management infrastructure, making it essential to promote low-cost, sustainable alternatives like maggot cultivation to reduce organic waste and support local agriculture. A questionnaire survey of 114 householders was performed on Kertajaga residents to assess their knowledge, attitude, and practice (KAP) towards food waste management, including refuse, reduce, reuse, recycle, and participation in the organic waste bank. The study analyzes the association between knowledge, attitude, and practice. The study also covered the relationship between sociodemographic variables and KAP towards household food waste management. The respondents were divided into two categories: waste bank customers and non-customers, whose differences in KAP levels were also assessed in this research. There is a significant difference between customer and non-customer knowledge, but it is not found in attitude and practice. The main finding of this study is that knowledge of food waste management in rural households is generally good and significantly influenced by socialization activities, while attitudes and practices remain moderate with varied associations to sociodemographic factors. A study regarding the content and forms of waste management socialization that are suitable and acceptable for low-income rural communities needs to be carried out to increase the effectiveness of household food waste management in rural areas.

Introduction

Household food waste is a significant global issue with environmental, economic, and social impacts. Approximately 17% of global food production is wasted, with 61% from households, 26% from food services, and 13% from retail [1]. Asia and Southeast Asia contribute 25% of global food waste [2]. Second, in Asia, Indonesia accounts for 41.7% of the 18 million tons of total food waste generated [3]. According to the source, households remain the most significant source, accounting for 40.03%, followed by markets at 19.58% and commerce at 17.29% [3]. To overcome this problem, an alternative management approach that can be implemented in the community is needed, because households, as consumers, are critical actors in reducing food waste. The concept of waste management hierarchy emphasizes that waste reduction is a top priority in waste management. Several studies on the urgency of reducing household food waste have been conducted on various aspects, including the significant influence on improving global environmental sustainability [4], considerable contribution to making more sustainable food systems [5], and reducing emissions effectively [5]. Emission reductions were also emphasized by Slorach et al. [6], who stated that halving food waste by 2030 could save 15 times more greenhouse gas emissions than the best treatment scenario without waste reduction. These urgencies have led to food waste reduction on national and urban food policy agendas, both as waste management issues and sustainable food systems [7]. Miller and Spoolman [8] also highlight the issue of food waste, which is closely related to food security. It is seen in concept 10.5: "We can improve food security by reducing poverty and chronic malnutrition, producing food

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more sustainably, relying more on local food, and reducing food waste" [8]. A simplification of waste reduction is known as the 3Rs (reduce, reuse, recycle). From an environmental point of view, the 3Rs is a crucial approach, as it is an input or waste prevention approach that addresses the issue of waste production upstream [8]. Some of the benefits of the 3Rs include saving material and energy resources, reducing pollution, including greenhouse gas emissions, protecting biodiversity, and saving money [8]. In addition, 3R activities generally carried out in TPS and waste banks are a suitable alternative to realize the concept of zero waste in green cities [9].

The need for more effective and sustainable waste management systems has led to the introduction of various waste reduction initiatives including maggot cultivation. The Black Soldier Fly (*Hermetia illucens*) is particularly effective in breaking down organic waste into high-protein feed for livestock and fish, making this method highly sustainable and suitable for agricultural activities in rural communities. The maggots' ability to reduce waste volume while providing a secondary product, animal feed, makes this method attractive for rural communities, where waste infrastructure may be lacking. This method addresses environmental concerns by reducing the volume of organic waste, and contributes to economic sustainability by providing low-cost animal feed. It supports rural households by integrating waste management with local agricultural activities. Moreover, maggot cultivation reduces methane emissions from organic waste decomposition because traditional waste disposal methods such as landfilling and open dumping often result in harmful greenhouse gas emissions [6].

Research on knowledge, attitudes, and practices in waste management has been carried out, including regarding the level and relationship of knowledge, attitudes, and practices in waste management among urban women [10], research based on gender differences [11], among coastal households [12], food service operators [13], food vendors in universities [14], the effectiveness of face-to-face training and its impact on women's behavior in waste management [10,14], strategic solutions in the waste recycling system with a socialization approach to increase household involvement, government intervention, and support from local communities [15], the relationship between sociodemographics and knowledge, attitudes, and practices of waste management [10,11,14,15], and the relationship between the provision of facilities and infrastructure and waste management behavior [12]. However, there is a need for research on household food waste management's knowledge, attitudes, and practices, especially its utilization through maggot cultivation. In addition, there is still debate on the relationship between knowledge, attitudes, and practices of managing waste, and the relationship between these three variables and sociodemographics.

Several studies on food waste management in rural households have shown that food waste generation in rural areas is generally lower than that in urban areas [16–19]. This difference is due to traditional practices, such as using waste for animal feed and compost [20–22], culture [23–25], religion [25–28], community involvement [24,29], type of food consumed [25,27,30], social norms [31], and proximity to food sources [32]. This study fills the gap that suggests that knowledge and attitudes are related to household practices in managing food waste. Several other studies have explored the efficacy of maggot cultivation for waste management. For instance, research conducted in urban China and the rural Philippines demonstrated significant reductions in household food waste when integrated with maggot farming while providing alternative protein sources for poultry and aquaculture [19–22]. Moreover, a study by Liu et al. [17] on household food waste in China found that maggot cultivation reduced waste volume by 50–70%, significantly reducing environmental pollution [21]. These results underscore the potential of maggot cultivation to enhance waste management, particularly in resource-limited, rural areas.

This study aims to fill the research gap in rural food waste management by exploring how knowledge, attitudes, and practices (KAP) in household food waste management, including maggot cultivation, are influenced by sociodemographic factors. This study identifies the relationship between KAP variables that can be used as a comparative study with similar previous studies. In addition, this study identified sociodemographic factors, such as gender, age, number of family members, education, income, attendance at waste management socialization activities, and number of attendances with the level of knowledge, attitudes, and practices. Thus, effective strategies can be developed to change household practices in food waste management. Specifically, this study aims to answer the following questions: 1) How are the levels of household knowledge, attitude, and practice regarding maggot-based food waste management?, 2) How are the relationships among these three variables?, 3) How are they influenced by sociodemographic factors?

Materials and Methods

Study Area

This research was conducted in Kertajaga Sub-village, Sukajaya Village, Pamarican District, and Ciamis Regency, West Java, from October to November 2023. Kertajaga is located in the South Ciamis region, approximately 30 km from the city center. This location was chosen because the Pamarican Sub-district lacks waste management activities even though it is close to the Banjaranyar Landfill. Kertajaga was selected because it coincides with the operation of the Kertajaga Jaya Waste Bank. This waste bank is one of the units still operating, compared to the other 18 maggot cultivation units in Ciamis. Since its establishment, this waste bank has focused on organic waste management and has become a pioneer in utilizing food waste from households in the neighborhood of the waste bank. This waste bank was established due to the manager's concern about environmental pollution because communities still practice burning inorganic waste and disposing of food waste (for those who do not have livestock). Location map of Kertajaga Jaya Waste Bank is shown at this Figure 1.

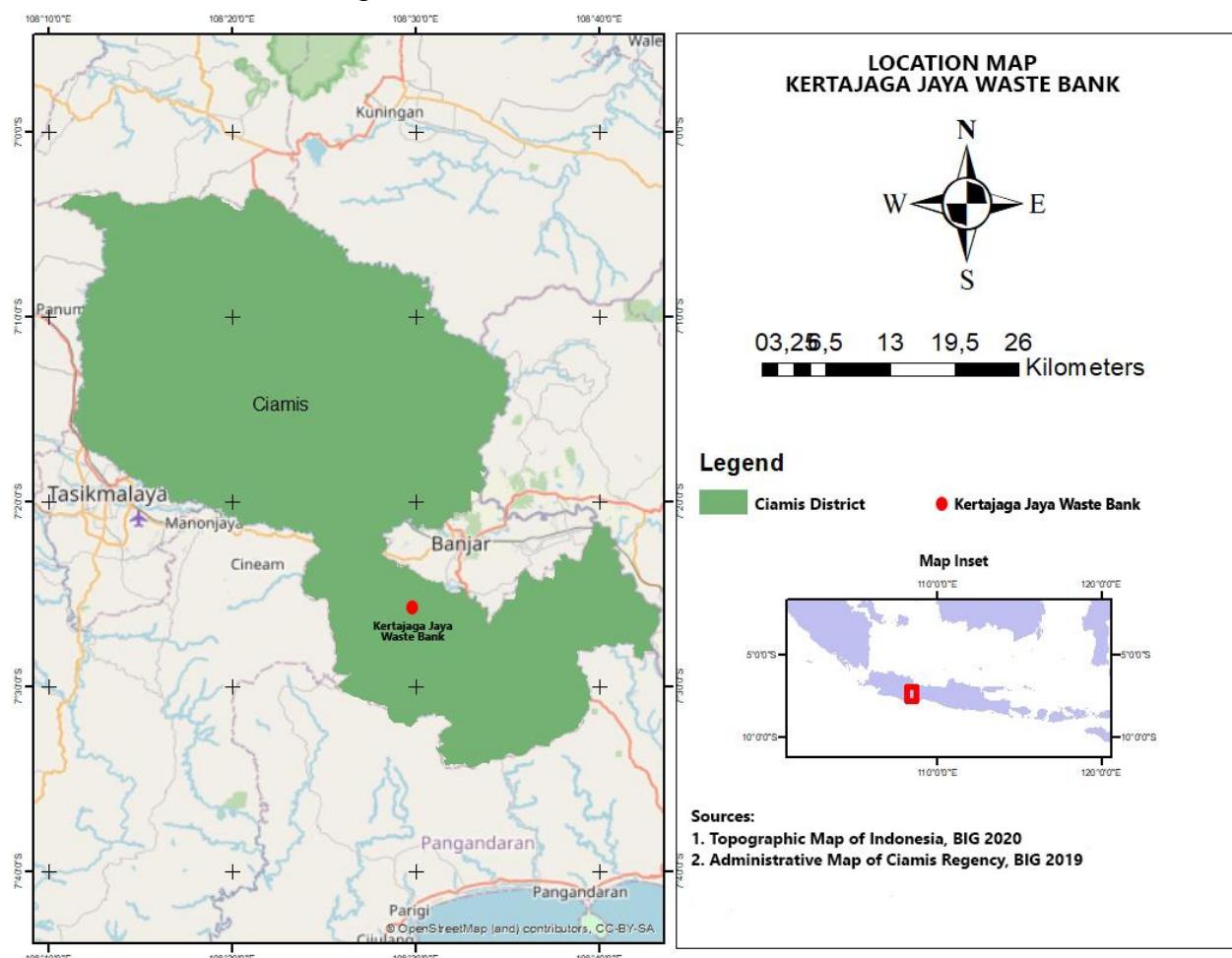


Figure 1. Location map of Kertajaga Jaya Waste Bank.

Data Collection

The total number of respondents in this study was 114, of which 50 were selected through saturated sampling and 64 non-customer respondents were selected through accidental sampling. Saturated sampling was chosen because the number of waste bank customers reached a maximum of 50. Accidental sampling was selected to facilitate the recruitment of households that are ready and willing to participate as respondents. A total of 114 respondents were determined using the Slovin formula from a population of 159 households in Kertajaga, with a 10% margin of error. The result of the calculation was 100 respondents; to prevent biased respondent answers, the sample was enlarged to 114. For this study, the unit of analysis was the household. This means that the primary focus of the research is on the household as a collective entity in terms of its

knowledge, attitudes, and practices (KAP) related to food waste management. The household is the primary decision-making unit that engages in waste management activities, including participation in waste banks and composting programs. The observation unit, however, refers to individual respondents within each household. These respondents were typically responsible for food preparation and waste management (e.g., housewives, housekeepers, or the head of the household). In some cases, male respondents or other household members responded when the primary responsible person was unavailable. The decision to focus on these individuals stems from their pivotal role in managing daily household activities, which are directly related to food waste management practices. The Kertajaga sub-village is covered as a population because the waste bank service currently only reaches one sub-village. This research was conducted with permission from the Secretary of *Dinas Perumahan Rakyat, Kawasan Permukiman, dan Lingkungan Hidup* (DPRKPLH) Ciamis and recommendations from *Tempat Pengolahan Sampah Terpadu* (TPST) Handapherang. The village head and neighborhood association (*Rukun Tetangga/RT* and *Rukun Warga/RW*) sought permission to collect data. Local people guided the respondents through the interview process.

The questionnaire design comprised four sections, as described by Gupta [11]. The first section included the household characteristics of the respondents. The second section included 19 knowledge questions covering the prevention and reduction of food waste generation, sorting and recycling of food waste, and waste bank and maggot cultivation. Responses were scored 1 for "Yes, I know" and 0 for "No." The total score was obtained by summing the scores of all responses. The third section included 13 attitude questions regarding the prevention of food waste generation and disposal, as well as the separation and recycling of waste through waste banks. Scoring is done with a 5-point Likert scale: Strongly Agree=5, Agree=4, Neutral=3, Disagree=2, Strongly Disagree=1. The opposite score was obtained for the negative attitude statements. The total attitude score was calculated by summing the scores of all responses. The fourth section included 11 practice questions on the prevention of food waste generation, the disposal of food waste, and the recycling of food waste. Answers were scored 1 for "Yes, I do" and 0 for "No". The total practice score was calculated by summing the scores of all the answers. A pretest for data collection was conducted with 26 respondents to ensure that the questions were understandable. In the data collection process, respondents were interviewed individually due to the limitations of most respondents in reading and understanding the questionnaire. The Cronbach's Alpha formula was used to analyze the reliability of the questionnaire. The reliability coefficient index is 0.759 (Table 1). Based on this index, the questionnaire was considered reliable (>0.60).

Table 1. Number of items and reliability measurement of knowledge, attitude, and practice questionnaires.

Variable	Number of items	Cronbach's alpha
Knowledge	19	.896
Attitude	13	.742
Practice	11	.638
Total/average	43	.759

The sociodemographic variables included in the analysis were gender, age, number of family members, education level, income, and attendance at waste management socialization activities. These variables were analyzed to understand their relationship with the KAP variables, including knowledge of waste reduction and maggot cultivation, attitudes toward waste management practices, and actual practices implemented by households. Knowledge, attitude, and practice (KAP) variables were the core elements analyzed in this study: 1) Knowledge: Understanding food waste generation, sorting, and recycling, particularly regarding maggot cultivation; 2) Attitudes: Respondents' perspectives on waste reduction, participation in recycling, and willingness to engage in maggot cultivation; 3) Practices: Actual household practices regarding food waste prevention, separation, and recycling, including their involvement in waste bank activities and maggot cultivation.

Data Analysis

Data analysis focused on the association between sociodemographic variables and KAP indicators. The household was the unit of analysis used to derive conclusions about KAP, as it reflects collective actions and decisions within the household. Individual respondents served as the observation unit, providing the necessary data on their knowledge, attitudes, and practices. The respondent's answer score percentage was used to calculate the level of knowledge, attitude, and behavior. The indicators used are excellent if the score is $>90\%$, good $75\text{--}89\%$, average $50\text{--}74\%$, and poor if $<50\%$. This indicator was also used by Gupta [11]. The research type was correlational. Therefore, a t-test with chi-square parameters was used to determine the

differences between customers' and non-customers' knowledge, attitudes, and practices. Spearman's rank correlation analysis with a significance level of $p < 0.05$ was used to see the relationship between knowledge level and attitude, knowledge level and behaviour, and attitude and behaviour because the data were not normally distributed ($p < 0.05$). The relationship between sociodemographic variables and the level of knowledge, attitude, and practice was analyzed using the chi-squared test with a significance level of $p < 0.05$. This test was also conducted by Abidin et al. [13] to explore the relationship between sociodemographics and the level of knowledge and attitudes of food service operators. Microsoft Excel and IBM SPSS Statistics were used as data processing tools. This study was approved by the Ethical Review Committee of the School of Environmental Sciences, University of Indonesia (Number KET-029/UN2.F13.D1.KE1/PPM.00/2023).

Results and Discussion

Results

Respondent Characteristic

Based on respondent characteristics, as shown in Table 2, Kertajaga Jaya Waste Bank customers are dominated by women with 41 customers (82%), with the type of savings dominated by saving for Eid Fitri with 49 customers (98%). The type of work of both customers and non-customers is dominated by housewives (*Ibu Rumah Tangga/IRT*), with 22 respondents (44%) and 38 respondents (59%), respectively. The age of respondents, both customers and non-customers, is dominated by the >50 category, with 19 respondents (38%) and 23 respondents (36%), respectively. The marital status of customers and non-customers was dominated by the married category, with 43 respondents (86%) and 48 respondents (75%), respectively. The number of family members, both customers and non-customers, is dominated by the category of three to four people, with 25 respondents (50%) and 31 respondents (48%), respectively.

The education level of customers and non-customers was dominated by the elementary school category, with 24 of respondents (48%) and 36 respondents (56%), respectively. The income of customer respondents was higher in the category from Rp1,000,001–Rp2,000,000, with the number of respondents being 18 (36%), compared to non-customer respondents in the category from Rp500,001–Rp1,000,000, with 17% and 27% of respondents, respectively. In the attendance category of waste management socialization/training activities, customer and non-customer respondents were dominated by never attending, with 28 respondents (56%) and 57 respondents (89%), respectively. However, the number of customer respondents was higher than that of non-customer respondents, with four attendances or 24%, and the private sector dominated the implementation of socialization. In the category of waste separation practices, non-customer respondents practiced separation but did not deposit it into the waste bank; instead, they used it to feed their livestock.

Table 2. Characteristics of customer and non-customer household respondents of Kertajaga Jaya Waste Bank.

Categories	Sub-categories	Customer		Non-Customer	
		n	%	n	%
Gender	Male	9	18	7	11
	Female	41	82	57	89
Type of savings	Volunteer	1	2	0	0
	Saving for eid al-Fitr	49	98	0	0
Age	18–30	2	4	5	8
	31–40	16	32	16	25
	41–50	13	26	20	31
	>50	19	38	23	36
Number of family members	1–2	15	30	20	31
	3–4	25	50	31	48
	5–6	10	20	13	20
Education level	Elementary school	24	48	36	56
	Junior high school	10	20	9	14
	Senior high school	12	24	11	17
	Diploma	2	4	0	0
	Undergraduate	1	2	8	13
	Graduate	1	2	0	0

Categories	Sub-categories	Customer		Non-Customer	
		n	%	n	%
Monthly income	<Rp500,000	8	16	13	20
	Rp500,001–Rp1,000,000	8	16	17	27
	Rp1,000,001–Rp2,000,000	18	36	9	14
	Rp2,000,001–Rp3,000,000	10	20	11	17
	>Rp3,000,000	6	12	14	22
Attendance at waste management socialization/training	Yes	22	44	7	11
	No	28	56	57	89
Total attendance at waste management socialization/training	0	28	56	57	89
	1	4	8	3	5
	2	2	4	0	0
	3	4	8	1	2
	4	12	24	3	5
Waste separation practice	Separating and depositing	50	100	0	0
	Separating but no deposit	0	0	57	89
	Not sorting	0	0	7	11
Food waste disposal	Deposited to the waste bank	50	100	0	0
	Given to the livestock (fish)	0	0	8	13
	Given to the livestock (chicken)	4	8	48	75
	Thrown away	0	0	8	13

Knowledge of Household Food Waste Management through Maggot Cultivation among Customer and Non-Customer Respondents

Based on Table 3, respondents have good knowledge about "Reducing food waste can reduce environmental hazards" with 88% and 89.1% of customers and non-customer respondents, respectively. These percentages indicate that respondents have good knowledge about food waste prevention when associated with environmental consequences, and this finding is in line with Attiq et al. [33], which states that awareness of implications and ecological knowledge are significant predictors of reducing food waste at the prevention level. Excellent prevention knowledge with the highest score was in question five on the urgency of determining the expiry date to prevent food waste, with a score of 100% and 96.9% in customer and non-customer respondents, respectively. Other prevention indicators yielded mixed scores, but indicator point two had the lowest scores of 58% and 42.2% among the customer and non-customer respondents, respectively. This indicates that respondents needed to gain the knowledge that wasting food is equivalent to wasting energy, water, and nutrients used to grow, process, and transport food.

The indicator of knowledge about sorting food waste indicates that respondents have excellent expertise, with a high score of 100% and 98.4% for customer and non-customer respondents, respectively. An exceptional level of knowledge was also found regarding the waste recycling indicator of food waste used as animal feed and compost material. This result is suspected to be related to rural communities being accustomed to using food waste as feed for private livestock. This indicates that rural communities have voluntarily segregated their waste and do not need to be informed about segregation using a command-and-control approach, as studied by Lin and Guan [34] in Beijing, Shanghai, Shenzhen, and Guangzhou, regarding mandatory source separation.

The level of knowledge of waste banks and maggot cultivation resulted in various scores. However, some customer respondents need to learn about the types of household food waste that can be used as feed for maggots. There are also customer respondents who need to know that maggots can eat food waste and are a source of protein for livestock, even though waste bank employees always pick up food waste. Knowledge about "recycling or depositing waste in waste banks to reduce the volume of food waste disposed/dumped in landfills" is poor. This is because most respondents need to learn what a landfill is. The knowledge indicator that much maggot cultivation in Ciamis has stopped due to a lack of feed also needs to show more knowledge. This study tried to add knowledge questions about the problem of maggot cultivation in Ciamis, which many stopped due to a lack of feed. The results showed that both customers (34%) and non-customers (93.8%) needed to learn.

Table 3. Knowledge level of household food waste management through maggot cultivation among customers and non-customer respondents.

No.	Question	Customer, n (%)		Non-customers, n (%)	
		Yes	No	Yes	No
Knowledge of food waste generation, prevention and reduction					
1	Reducing food waste can reduce pollution and danger to the environment.	44 (88)*	6 (12)	57 (89.1)*	7 (10.9)
2	The energy, water and nutrients that are used to grow, process and transport food are wasted if food is purchased but not eaten.	29 (58)*	21 (42)	27 (42.2)*	37 (57.8)
3	Dry food storage stores should be free from any moisture to prevent foods from being easily damaged.	45 (90)*	4 (10)	54 (84.4)*	10 (15.6)
4	Food (meat, fruits, and vegetables) bought at reduced prices is already not fresh.	39 (78)*	11 (22)	49 (76.6)*	15 (23.4)
5	Specifying the expiry date on food products is important to avoid food poisoning and getting sick.	50 (100)*	0 (0)	62 (96.9)*	2 (3.1)
6	As long as cooked food items remain frozen they can be stored for one month or more in the freezer.	42 (84)*	8 (16)	51 (79.7)*	13 (20.3)
7	Leftovers from cooked dishes that have been kept in the refrigerator for two or more days are unsafe to eat.	38 (76)*	12 (24)	37 (57.8)*	27 (42.2)
8	Throwing away trash is the same as throwing away money.	37 (74)*	13 (26)	48 (75.0)*	16 (25.0)
Knowledge of food waste separation and recycling					
9	Food waste must be separated from other waste and it helps in identifying materials that can still be recycled and reused.	50 (100)*	0 (0)	63 (98.4)*	1 (1.6)
10	Food that could have been eaten by people is not wasted if it is fed to the pets or composted.	50 (100)*	0 (0)	63 (98.4)*	1 (1.6)
11	Food waste can be composted and used as plant fertilizer.	45 (90)*	5 (10)	58 (90.6)*	6 (9.4)
Knowledge about waste bank and maggot cultivation					
12	Recycling or depositing waste to the waste bank reduces the volume of food waste disposed/dumped in landfills.	34 (68)*	16 (32)	34 (53.1)*	30 (46.9)
13	Food waste recycling reduces the release of harmful gasses, such as methane that can cause extreme weather events.	38 (76)*	12 (24)	60 (93.8)*	4 (6.3)
14	Depositing food waste to the waste bank can become a source of livelihood.	50 (100)*	0 (0)	41 (64.1)*	23 (35.9)
15	In Kertajaga, there is a maggot cultivation unit.	50 (100)*	0 (0)	61 (95.3)*	2 (3.1)
16	Maggots can function as food waste bioconversion and used as animal feed.	42 (84)*	6 (16)	46 (71.9)*	18 (28.1)
17	Maggot has rich protein for animal feed.	38 (76)*	12 (24)	41 (64.1)*	23 (35.9)
18	The types of household food waste that can be used as maggot feed are rice, vegetables, fruits, and proteins such as meat.	44 (88)*	6 (12)	42 (65.6)*	22 (34.4)
19	Maggot cultivation in Ciamis is widely stopped operationally due to lack of feed.	33 (66)*	17 (34)	4 (6.3)*	60 (93.8)

*Correct answer.

Attitudes of Household Food Waste Management through Maggot Cultivation among Customer and Non-Customer Respondents

Based on Table 4, most customer and non-customer respondents disagreed that "Food wastage is not anything that I ever consider", and one customer respondent who answered agree was a high-income respondent with around Rp5,000,000. On the point "I am discouraged to participate in recycling food waste because I only produce a small amount of food waste", 56% of the customer respondents disagreed. This result suggests that customer respondents have livestock, and not all food waste is deposited in the waste bank. By contrast, some non-customer respondents (26.6%) agreed to deposit a small amount. The waste bank director can consider this attitude to add more customers. On the prevention of food waste from the shopping stage, points 4 and 6 resulted in good levels in both customer and non-customer respondents (>70%), as well as at the cooking stage in point 5, "I estimate how much food to prepare to reduce food waste" resulted in a good level in customer respondents (78%), but in non-customer respondents resulted in average level (60.9%). Respondents who answered disagree were mostly of the opinion that it is necessary to overcook for any guest's needs. The indicator of attitude towards sorting and recycling through waste banks resulted in a good score, except for point 12, which resulted in an average score (<75%): "If I deposit my waste at the waste bank, I expect to get paid". This result shows that some villagers consider incentives unnecessary, even though the average income of respondents was around Rp500,001 to Rp1,000,000.

Table 4. Attitude level of household food waste management through maggot cultivation on customer and non-customer respondents.

No.	Question	Customer, n (%)			Non-customer, n (%)		
		SA/A	N	D/SD	SA/A	N	D/SD
Attitude towards food waste generation prevention and disposal							
1	Food wastage is not anything that I ever consider.	1 (2)	2 (4)	47 (94)*	6 (9.4)	5 (7.8)	53 (82.8)*
2	I am discouraged from participating in recycling food waste because I only produce a small amount of food waste.	20 (40)	2 (4)	28 (56)*	17 (26.6)	18 (28.1)	29 (45.3)*
3	I cook leftovers from yesterday's meal.	29 (58)*	6 (12)	15 (30)	35 (54.7)*	11 (17.2)	18 (28.1)
4	I believe that a grocery list is important when shopping for food.	36 (72)*	8 (16)	6 (12)	46 (71.9)*	13 (20.3)	5 (7.8)
5	I estimate how much food to prepare in order to reduce food waste.	39 (78)*	6 (12)	5 (10)	39 (60.9)*	10 (15.6)	15 (23.4)
6	I refer to the labels "best before" and "expiration date" when buying food products.	50 (100)*	0 (0)	0 (0)	63 (98.4)*	0 (0)	1 (1.6)
7	I throw away a fruit or vegetable if it is slightly damaged.	10 (20)	5 (10)	35 (70)*	11 (17.2)	1 (1.6)	52 (81.3)*
8	I immediately throw excess food into the trashcan after every meal.	42 (84)	2 (4)	6 (12)*	57 (89.1)	1 (1.6)	6 (9.4)*
Attitude towards food waste separating and recycling through waste banks							
9	If there is a waste bank in our village, then I will participate to become a customer.	46 (92)*	2 (4)	2 (4)	53 (82.8)*	8 (12.5)	3 (4.7)
10	I agree if my food waste is deposited into the maggot cultivation unit.	47 (94)*	2 (4)	1 (2)	49 (76.6)*	10 (15.6)	5 (7.8)
11	If I am instructed to separate food waste, I'm ready to follow it.	47 (94)*	3 (6)	0 (0)	50 (78.1)*	8 (12.5)	6 (9.4)
12	If I deposit my waste into the waste bank, I expect to get paid.	29 (58)*	5 (10)	16 (32)	40 (62.5)*	10 (15.6)	14 (21.9)
13	I agree that the payment for sorting and depositing waste is money in the form of savings.	40 (80)*	8 (16)	2 (4)	54 (84.4)*	10 (15.6)	0 (0)

*Correct answer; SA/A = Strongly Agree or Agree, N = Neutral, D/SD = Disagree or Strongly Disagree.

Practices of Household Food Waste Management through Maggot Cultivation among Customer and Non-Customer Respondents

Based on Table 5, regarding the indicator of food waste prevention practices, most respondents scored at the average level (50–75%), especially on points 3, 4, and 5. At point 3, "Every time there are leftover side dishes, I always pack them to take back or give them to a neighbor", respondents who agreed usually gave their leftover dishes to helpers or close family members. In contrast, respondents who answered disagree were worried that their neighbours would be offended by being given leftover side dishes. In the prevention indicator, the score needs to be improved at point 7, "I don't plan meals for the day". Most respondents explained that they decide what to cook when shopping, and do not plan for each day. On point 6, "I read the storage instructions", and non-customer respondents scored poorly. At point 9, 40% of customer respondents and 42.25% of non-customer respondents answered yes to "I have leftovers in every meal mainly because of too many foods cooked", even though most respondents answered yes to the statement "The amount of food cooked is only according to the needs and demands of the family member at a certain time". This result indicates the inaccuracy in estimating the amount or measure of cooking.

Table 5. Percentage score results of household food waste management practices through maggot cultivation on customer and non-customer respondents.

No.	Question	Customer, n (%)		Non-customers, n (%)	
		Yes	No	Yes	No
Food waste generation prevention practices					
1	The cooking ingredients are separated by type to prevent them from mixing in a long time and becoming spoiled.	48 (96)*	2 (4)	59 (92.2)*	5 (7.8)
2	The amount of food cooked is only according to the needs and demands of the family member at a certain time.	40 (80)*	10 (20)	43 (67.2)*	21 (32.8)
3	Whenever there are side dish leftovers, I always pack to take them back or give them to neighbor.	31 (62)*	19 (38)	43 (67.2)*	21 (32.8)
4	When I go shopping, I buy in small amounts regularly.	28 (56)*	22 (44)	33 (51.6)*	31 (48.4)

No.	Question	Customer, n (%)		Non-customers, n (%)	
		Yes	No	Yes	No
Food waste generation prevention practices					
5	I save leftovers in the refrigerator and consume them afterwards.	25 (50)*	25 (50)	43 (67.2)*	21 (32.8)
6	I read the storage instructions.	26 (52)*	24 (48)	3 (4.7)*	61 (95.3)
7	I don't plan meals for the day.	23 (46)*	27 (54)	28 (43.8)*	36 (56.3)
Food waste disposal practices					
8	I save leftovers in the refrigerator and throw them out later.	26 (52)	24 (48)*	31 (48.4)	33 (51.6)*
9	I have leftovers in every meal mainly because of too many foods cooked.	20 (40)	30 (60)*	27 (42.2)	37 (57.8)*
Food waste recycling practice					
10	I have recycled food waste into compost.	14 (28)*	36 (72)	22 (34.4)*	42 (65.6)
11	I have storage containers for foodstuff and leftovers.	47 (94)*	3 (6)	41 (64.1)*	24 (37.5)

*Correct answer.

Differences in Knowledge Level, Attitude, and Food Waste Management Practices among Customer and Non-Customer Respondents

Based on the level of knowledge in Table 6, 39% of the respondents had a level of knowledge, and their scores ranged from 75% to 89%. This indicates that most respondents had good knowledge of household food waste management. Of the customer respondents, 38% had an excellent level of knowledge, with a score >90%. The t-test with a chi-square parameter of 0.005 showed a significant difference between customer and non-customer respondents regarding household food waste management knowledge.

Table 6. Differences in knowledge level of household food waste management through maggot cultivation among customer and non-customer respondents (n (%)).

Category	Indicator	Customer	Non-customers	p-Value	Total
Excellent	>90%	19 (38)	7 (11)		26 (23)
Good	75%–89%	18 (36)	27 (42)		45 (39)
Average	50%–74%	10 (20)	25 (39)	0.005	35 (31)
Poor	<50%	3 (6)	5 (8)		8 (7)

Based on the attitude level in Table 7, 78% of the respondents had an attitude level of 50–74%. This indicates that most respondents have an average attitude toward household food waste management in the customer (70%) and non-customer (84%) categories. The t-test with a chi-square parameter of 0.054 revealed no significant difference between customer and non-customer respondents in their attitudes toward household food waste management.

Table 7. Differences in the level of attitude of household food waste management through maggot cultivation among customer and non-customer respondents (n (%)).

Category	Indicator	Customer	Non-customers	p-Value	Total
Excellent	>90%	0 (0)	0 (0)		0 (0)
Good	75%–89%	15 (30)	10 (16)		25 (22)
Average	50%–74%	35 (70)	54 (84)	0.054	89 (78)
Poor	<50%	0 (0)	0 (0)		0 (0)

Based on the level of practice in Table 8, 51% of the respondents had a level of training at a score of 50–74%. This indicates that most respondents had an average level of practice regarding household food waste management in the customer (50%) and non-customer (52%) categories. The t-test with a chi-square parameter of 0.500 revealed no significant difference between customer and non-customer respondents in their attitudes towards household food waste management.

Table 8. Differences in the level of household food waste management practices through maggot cultivation among customer and non-customer respondents (n (%)).

Category	Indicator	Customer	Non-customers	p-Value	Total
Excellent	>90%	6 (12)	3 (5)		9 (8)
Good	75%–89%	3 (6)	6 (9)		9 (8)
Average	50%–74%	25 (50)	33 (52)	0.500	58 (51)
Poor	<50%	16 (32)	22 (34)		38 (53)

Relationship between Knowledge, Attitude, and Practice of Food Waste Management

Based on Table 9, there was a significant but weak positive relationship between knowledge, attitude, and practice in the category of all respondents. Among the customer respondents, there was a significant but weak relationship between knowledge, attitude, and practice. However, attitude and practice showed no significant relationship ($r = 0.186$, $p > 0.05$). This shows that good knowledge indicates good practices, but a good attitude only sometimes makes customer respondents follow good practices in managing household food waste. In non-customer respondents, there was a significant but weak relationship between knowledge and practice and attitude and practice. However, knowledge and attitude showed no significant relationship ($r = 0.239$, $p > 0.05$). This shows that good knowledge only gives non-customer respondents a good attitude. However, good knowledge and attitude can indicate that non-customer respondents need better practices for managing household food waste.

Table 9. The relationship between knowledge, attitude, and practice of household food waste management through maggot cultivation.

Parameters	Customer		Non-customers		Overall	
	r-value	p-value	r-value	p-value	r-value	p-value
Knowledge and attitude	0.306*	0.030	0.239	0.057	0.294**	0.001
Attitude and practice	0.186	0.196	0.344**	0.005	0.355**	0.000
Knowledge and practice	0.336*	0.017	0.420**	0.001	0.263**	0.005

*Significant at $p < 0.05$; ** Significant at $p < 0.01$.

Relationship Between Sociodemographic Variables and Knowledge, Attitudes, and Practice of Food Waste Management

The relationship between sociodemographic variables and knowledge level in Table 10 shows that age, income, and attendance at waste management socialization activities have a significant relationship with knowledge level, with p-values of 0.021, 0.032, and 0.023, respectively, and there was no significant relationship between other sociodemographic variables and knowledge level ($p > 0.05$). There were four age categories: 18–30, 31–40, 41–50, and >50; and five income categories: <Rp500,000; Rp500,001–Rp1,000,000; Rp1,000,001–Rp2,000,000; Rp2,000,001–Rp3,000,000; and >Rp3,000,000, while in the categories of attendance: ever-present or never present in waste management socialization activities.

Table 10. The relationship between sociodemographic factors and knowledge, attitudes, and management of household food waste through maggot cultivation.

Variables	Knowledge	Attitude	Practices
Gender	0.104	0.101	0.278
Age	0.021*	0.401	0.004*
Number of family members	0.889	0.237	0.001*
Education	0.086	0.276	0.343
Revenue	0.032*	0.301	0.657
Attendance at waste management socialization activities	0.023*	0.005*	0.022*
Total attendance	0.074	0.028*	0.004*

*Significant at $p < 0.05$.

The relationship between sociodemographic variables and the level of attitude, as shown in Table 10, indicates that attendance at waste management socialization activities and the number of attendances have a significant relationship with the level of attitude, with p-values of 0.005 and 0.028, respectively. There was no significant relationship between the other sociodemographic variables and attitude level ($p > 0.05$). The attendance category was either ever or never attended, while the number of attendances was zero, one, two, three, and four times, respectively, for the waste management socialization activities. Age, number of family members, attendance at waste management socialization activities, and the number of attendances had a significant relationship with the level of practices, with p-values of 0.004, 0.001, 0.022, and 0.004, respectively; there was no significant relationship between other sociodemographic variables and the level of practices ($p > 0.05$).

Discussion

The results showed that good knowledge of food waste reduction could reduce environmental hazards by 88% and 89.1% for customer and non-customer respondents, respectively. This indicates that respondents have good food waste prevention knowledge when associated with environmental consequences, and this finding is in line with Attiq et al. [33] that awareness of the implications and environmental knowledge are significant predictors of reducing food waste at the prevention level. However, the respondents needed to learn that wasting food equalled wasting energy, water, and nutrients used to grow, process, and transport food. This finding is noteworthy because energy waste contradicts the concept of reducing the use of material and energy resources in the sustainable resource-use hierarchy concept introduced by Miller and Spoolman [8].

An excellent level of knowledge was also found regarding the waste recycling indicator that food waste can be used as animal feed and compost material. This result is suspected to be related to the practice of rural communities that are accustomed to using food waste as feed for livestock. This indicates that rural communities have voluntarily segregated their waste and do not need to be informed about segregation with a command-and-control approach, as studied by Lin and Guan [34] in Beijing, Shanghai, Shenzhen, and Guangzhou regarding mandatory source separation.

The Urgency of Waste Management Socialization

The approach to socialization and training in waste management has been examined in many previous studies. The results of this study show a relationship between community attendance at socialization activities and the level of knowledge, attitude, and practice, which is in line with previous research results by Zand et al. [10]. However, the difference is in the emphasis by Zand et al. [10] that training needs to be done face-to-face, while this study only examined attendance at socialization activities. This result aligns with Naim and Rahman [14], but the difference is that the research by Naim and Rahman [14] is only related to attitudes, not knowledge and practices. The intervention of organizing socialization and training on waste management is also found in the Food Waste Recycling System (FWRS) strategy to address the problem of household food waste [15]. Thus, conducting household waste management socialization and training can improve food waste management knowledge, attitudes, and practices.

Sociodemographic Factors in Food Waste Management

Research on knowledge, attitudes, and waste management practices is often associated with socio-demographic variables. This study found no relationship between education level and knowledge, attitudes, and practices. This result differs from research by Zand et al. [10], which suggests a relationship between the level of education and knowledge, attitudes, and practices. The difference with this study lies in the object of the research. Zand et al. [10] specifically examined the responses of female respondents. Differences were also found in the characteristics of respondents' education levels. In the study by Zand et al. [10], many respondents (59.5%) had a high level of education (bachelor's and postgraduate), while in this study, the majority of respondents were at the elementary level (53%). However, the absence of a relationship between education and the level of knowledge, attitudes, and practices is consistent with research by Suci et al., Naim and Rahman, and Limon and Villarino [12,14,15]. Respondents were specific to households in Sabang [12], the Philippines [15], and food vendors in Malaysia [14]. Most education levels in this study were at the elementary level (53%); in research by Zand et al. [10], the majority were at the undergraduate level (31.2%); and in research by Limon and Villarino [15], the majority were at the junior high school level (50%). This discussion shows different relationships between household respondents and food vendors.

The number of family members is associated with waste management practices that align with research results by Limon and Villarino [15]. The average number of family members in this study ranged from three to four, whereas the study by Limon and Villarino [15] included households in Ilocos Norte Province, Philippines, and had five people per household. Most respondents in this study who had more family members, especially young children, tended to oversupply food and often produced leftovers for their children. However, the number of family members and the level of knowledge and attitude remained the same. Income level may allow respondents to have a good level of knowledge, but it has no relationship with their attitude toward and practice of managing waste. This finding aligns with the findings of Suci et al. [12], who surveyed households in Sukajaya Sabang Village, and with those of Gupta [11], who specifically examined the level of knowledge, attitudes, and behavior of women in India. However, this contradicts the findings by Limon and Villarino [15], who state that there is a relationship between income level and household practices in managing waste. Limon and Villarino [15] stated that adulthood enables respondents to assess their

knowledge, attitudes, and good practices. This study demonstrates that age is associated with attitudes and practices regarding waste management. However, it is still unknown whether the findings align with Naim and Rahman [14], who state that age is significantly related to managing waste. The highest level of practice is in the age range of 40–50 years. The gender variable has no relationship with the level of knowledge, attitudes, and practices regarding waste management, which aligns with the findings by Limon and Villarino [15].

The study sample shows that female respondents constituted the majority, with 82% of waste bank customers being women, while male respondents comprised only 18%. This reflects that household food waste management is often considered a woman's responsibility, particularly in rural settings, where women typically handle daily tasks, such as cooking, waste sorting, and food storage. The low percentage of male respondents may have limited the ability to detect meaningful differences in the relationship between gender and KAP. Given that only 10% of the respondents were male, this small subset may have provided insufficient variation to explore potential gender-based distinctions in food waste management practices. The overrepresentation of women among the respondents is consistent with the traditional gender roles in rural communities, where food preparation and waste management are predominantly seen as the responsibility of women. In this context, women's involvement in the waste bank is much higher than that of men, with 82% of female customers. This finding aligns with previous studies that emphasize women's role in household sustainability practices, including food waste reduction [4]. Given these gendered responsibilities, it is reasonable that the differences in KAP between male and female respondents are less apparent. As the primary individuals responsible for managing household food waste, women are likely to have more direct involvement and knowledge about the processes, leading to higher or more uniform levels of KAP across the female population. In contrast, male respondents may be less involved in daily household waste management tasks, which could explain why their responses did not differ significantly in the analysis.

Knowledge, Attitude, and Practice Research Comparison in Waste Management

Some findings indicate that good knowledge sometimes leads to good waste management attitudes and practices among food vendors or operators [14]. However, the conclusions of this study indicate that there is a positive but weakly significant relationship between knowledge and attitude, knowledge and practice, and attitude and practice among the respondents overall. This finding aligns with the study by Abidin et al. [13]; the only difference is that the relationship between attitude and practice is negative in his research, whereas the relationship is positive in this study. The significant relationship between knowledge and practice is also in line with the findings by Suci et al. [12]. Although the relationship is positive but weak, it indicates that good knowledge leads to positive attitudes and practices in rural households. This uniqueness can be a suggestion for future research to analyze the comparison of knowledge, attitudes, and practices that consider differences in the geographical conditions of the region.

Conclusions

This study found that rural households had good knowledge of food waste management, and their attitudes and practice levels were average. The classification of customer and non-customer respondents showed an average level, except for customer knowledge, which showed an excellent level. T-test results showed significant differences in knowledge between customer and non-customer respondents, but no significant differences in attitudes and practices. This is because customer respondents regularly receive socialization from waste bank directors. The results of this study also show that attendance at waste management socialization activities is related to respondents' knowledge, in addition to other sociodemographic factors, such as age and income. This study also found a relationship between knowledge and attitude, knowledge and practice, and attitude and practice among all respondents. However, there was no relationship between attitude and practice among customer respondents, and no relationship between knowledge and attitude among non-customer respondents. Analysis of the relationship between sociodemographic variables and knowledge, attitude, and practice levels showed that attendance at waste management socialization activities was related to knowledge, attitude, and practice. In contrast, the amount of attendance was related to attitude and practice. Age is related to knowledge and practice, the number of family members is only associated with practice, and income is also related to knowledge.

Author Contributions

SMS: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; **SST:** Conceptualization, Writing - Review & Editing, Supervision; **HH:** Conceptualization, Writing - Review & Editing, Supervision.

Conflicts of Interest

There are no conflicts to declare.

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