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Tackling Food Waste in Culinary Education: A Roadmap for Sustainable Change

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Abstract:- Food waste has emerged as a pressing global challenge with significant environmental, economic, and social implications. Educational institutions offering culinary arts and hospitality programs play a crucial role in shaping future professionals' attitudes and practices towards sustainable food management. This study aimed to identify the primary factors contributing to food waste within student culinary laboratories at Takoradi Technical University and develop targeted strategies for mitigation. Through a quantitative research design, data was collected from 232 hospitality students via a structured questionnaire. The findings revealed alarming rates of self-reported food waste during practical sessions, with over-purchasing, lack of awareness, inadequate planning, and inconsistent training identified as key contributing factors. Additionally, opportunities for improvement were highlighted in areas such as planning with supervisors, standardized waste prevention training, and raising awareness about waste reduction policies. Based on these findings, a comprehensive set of recommendations was proposed, including curriculum integration, awareness campaigns, standardized training protocols, policy reforms, monitoring and evaluation mechanisms, collaborative knowledge-sharing, and community engagement initiatives. By implementing these recommendations, Takoradi Technical University can foster a culture of sustainability, equip future hospitality professionals with essential skills and knowledge, and contribute to global efforts towards achieving the United Nations Sustainable Development Goal 12.3 of reducing food waste.

Keywords:- *Food Waste, Culinary Education, Hospitality Industry, Sustainable Food Management, Curriculum Integration, Waste Reduction Strategies.*

I. INTRODUCTION

Food waste has emerged as a pressing global challenge, with significant environmental, economic, and social implications. According to the Food and Agriculture Organization (FAO), approximately one-third of all food produced for human consumption is lost or wasted annually (FAO, 2019). This staggering statistic not only represents a massive waste of resources but also contributes to greenhouse gas emissions, water scarcity, and land degradation. The environmental impact of food waste is substantial, accounting for an estimated 8-10% of global greenhouse gas emissions (Intergovernmental Panel on Climate Change, 2019). Furthermore, the water and land resources utilized in the production of wasted food are immense, exacerbating the strain on our planet's finite resources (Kummu et al., 2012; Elferink & Schierhorn, 2019).

From an economic perspective, food waste translates into significant financial losses for individuals, businesses, and nations. The Food and Agriculture Organization estimates that the global economic cost of food waste amounts to a staggering $1 trillion per year globally (FAO, 2022). This economic burden is particularly significant in developing countries, where food insecurity and poverty are prevalent (Lipinski et al., 2013). Moreover, food waste has profound social implications, as it represents a missed opportunity to address global hunger and malnutrition. With an estimated 811 million people going hungry worldwide (FAO et al., 2022), the potential for redistributing edible surplus food presents a viable solution to alleviate food insecurity and promote social equity (Stenmarck et al., 2016).

Educational institutions, particularly those offering culinary arts and hospitality programs, play a crucial role in shaping future professionals' attitudes and practices towards sustainable food management (Bogomolova et al., 2022; Deale et al., 2015). By integrating sustainability principles into their

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curricula and practical training, these institutions can equip students with the knowledge and skills necessary to address pressing issues such as food waste (Pittman et al., 2015; Stein & Khbudhurian, 2021). Takoradi Technical University, a renowned institution in Ghana, recognizes the importance of addressing food waste within its student food laboratories. These practical learning environments provide invaluable opportunities for students to develop culinary skills and gain hands-on experience in food preparation and service, while fostering a culture of sustainability and resource efficiency (Dyen & Sirieix, 2016; Sarjahani et al., 2009). Student food production laboratories serve as microcosms of professional kitchens, offering a controlled environment where students can learn and practice sustainable food management techniques (Gomes et al., 2021). By actively involving students in food waste reduction initiatives, these laboratories can facilitate the development of practical skills, environmental awareness, and a sense of responsibility towards minimizing food waste (Betz et al., 2015; Falasconi et al., 2019).

Furthermore, addressing food waste in educational settings aligns with national and international efforts to promote sustainable development and combat climate change (Göbel et al., 2015; Papargyropoulou et al., 2019). Ghana, as a signatory to the United Nations Sustainable Development Goals (SDGs), has committed to achieving Goal 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030 (United Nations, 2015).

However, the issue of food waste in student food laboratories remains largely unexplored, and there is a pressing need to understand the extent of the problem, identify contributing factors, and develop effective strategies for reduction. Existing literature suggests that food waste in educational settings can stem from various factors, including improper planning, over-preparation, lack of awareness, and inefficient practices (Painter et al., 2016; Wilkie et al., 2015; Falasconi et al., 2019).

Inadequate meal planning and forecasting of demand can lead to excessive food production, resulting in substantial waste (Pietzak et al., 2017). Over-preparation is another significant contributor, as students and instructors often prioritize ensuring sufficient food availability over minimizing waste (Baldwin et al., 2011). Additionally, a lack of awareness and knowledge about sustainable food management practices among students and staff can perpetuate wasteful behaviors (Ellison et al., 2017). Inefficient practices in food storage, handling, and distribution within student food laboratories can also exacerbate food waste levels (Sarjahani et al., 2009). Factors such as improper temperature control, poor inventory management, and inadequate facilities for storing and repurposing leftovers can contribute to increased waste (Derqui et al., 2018; Pirani & Arafat, 2016).

Moreover, the unique challenges faced by student food preparation laboratories, such as limited resources, high turnover of students, and varying levels of experience, can further complicate efforts to minimize food waste (Gomes et al., 2021). Addressing these complex issues requires a comprehensive understanding of the specific factors contributing to food waste within the context of student food laboratories (Falasconi et al., 2019). Addressing food waste in student food preparation laboratories is a crucial step towards achieving the United Nations Sustainable Development Goal 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030 (United Nations, 2015). However, the significance of this initiative extends far beyond numerical targets. It presents a unique opportunity to cultivate sustainable mindsets and practices among future professionals in the hospitality industry, shaping a generation of leaders who will drive positive change towards a more sustainable future.

Recent studies have highlighted the alarming magnitude of food waste across the globe. According to the Food and Agriculture Organization (FAO, 2022), approximately one-third of all food produced for human consumption is lost or wasted annually, amounting to about 1.3 billion tonnes. This staggering figure not only represents a massive waste of resources but also contributes significantly to greenhouse gas emissions, exacerbating the challenges of climate change. By engaging students in food waste reduction strategies within their educational setting, institutions like Takoradi Technical University are equipping them with the knowledge, skills, and experiences necessary to become agents of change in promoting sustainability. These future professionals will carry forward the lessons learned, incorporating sustainable practices into their professional endeavors and contributing to a more environmentally conscious hospitality industry (Pirani & Arafat, 2016).

Moreover, this initiative aligns with the broader objective of fostering a culture of sustainability and environmental stewardship within educational institutions themselves. By leading by example and demonstrating a commitment to reducing food waste, Takoradi Technical University is setting a precedent for other institutions to follow, ultimately contributing to the global effort to mitigate the environmental impact of food waste (Halloran et al., 2014). Furthermore, cultivating sustainable mindsets and practices among students has far-reaching implications beyond the immediate reduction of food waste. It instills a sense of responsibility and ethical decision-making that will permeate various aspects of their personal and professional lives, promoting a more holistic approach to sustainability (Lozano et al., 2017). This research aims to 1) Identify and analyze primary factors leading to food waste within student culinary labs. 2) assess Students' perceptions on Mitigating Food Waste in Student Culinary Labs at Takoradi Technical University.

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II. MATERIALS AND METHODS

The study employed a quantitative research design to investigate frequencies and percentages in order to interpret numerical data related to food waste reduction strategies in student food laboratories. This type of research design is suitable for collecting and analyzing numerical data to understand trends and patterns. The population for the study comprised hospitality students at Takoradi Technical University who participate in practical food laboratory sessions. Specifically, a target population of 600 hospitality department students who engage in practical food laboratory sessions was identified for the study.

To obtain a representative sample from this target population, the researchers used the Krejcie and Morgan (1970) formula to calculate the appropriate sample size. This formula takes into account the population size, desired confidence level, and margin of error to determine the minimum sample size needed for the study to be statistically valid and generalizable.

The population for this study comprised of students at Takoradi Technical University. A target population of six hundred (600) hospitality department students who do practical were used for the study. A sample size of two hundred and thirty-two (232) hospitality students were selected using Krejcie and Morgan formula (1970). The formula state that $n = \frac{X2NP(1-P)}{e2\,(N-1)+X2P\,(1-P)}$ where X^2 =3.841, e (margin of error) = 0.05, N = Population and P (Population Proportion) = 0.5

$$n = \frac{3.841(600)(0.5)[1-0.5\,]}{(0.05)(0.05)[600-1]+3.841(0.5)[1-0.5]}$$

$$n = \frac{1{,}152.3[1-0.5]}{0.0025[600-1]+1.9205[1-0.5]}$$

$$n = \frac{1{,}152.3\,[0.5]}{0.0025[599]+1.9205[0.5]}$$

$$n = \frac{576.15}{1.4975+0.96025}$$

$$n = \frac{576.15}{2.45775}$$

n = 232 Hospitality Management Students

Therefore, based on the Krejcie and Morgan formula, a sample size of 232 hospitality students was determined to be appropriate for the study, given the target population of 600 students and the desired confidence level and margin of error.

Simple random sampling was employed to select participants from the target population of 232 hospitality students at Takoradi Technical University. This sampling technique ensures that each member of the population has an equal and independent chance of being selected for the study, thereby minimizing bias and allowing for generalizability of the findings to the larger population. The primary data for the study was collected through a structured questionnaire, which incorporated both closed-ended and open-ended questions. The questionnaire was designed to gather information on several key aspects related to food waste reduction strategies in student food laboratories.

To ensure data quality and establish rapport with the participants, the researchers personally administered the questionnaires. This approach allowed for clarification of any ambiguities or misunderstandings and encouraged honest and thoughtful responses from the participants. The data collection process was conducted efficiently, with all responses being gathered on the same day, minimizing the risk of attrition or non-response bias. The processed data was then presented in a clear and organized manner using frequency distribution tables, percentages, and charts. These visual representations facilitated the interpretation and communication of the findings, allowing for a better understanding of the trends, patterns, and relationships within the data.

III. RESULTS

- *Primary Factors Leading to Food Waste Within Student Culinary Labs*

Findings presented in Figure 1 reveal an alarmingly high rate of food waste among respondents during culinary lab sessions. A significant 50% openly admitted to regularly wasting food in these practical training environments, indicating a widespread and systemic issue. An additional 40% acknowledged that they sometimes engage in food waste practices, suggesting that even those not consistently wasteful contribute to the problem on occasion.

Strikingly, only a small minority of 10% expressed uncertainty about their food waste habits in the culinary labs, implying a general awareness and recognition of the issue among most respondents. However, in a concerning revelation, not a single respondent claimed to never waste food during these sessions, underscoring the pervasiveness of the problem across the entire sample.

These findings align with existing literature on food waste in culinary training facilities, which have been identified as significant contributors to the overall food waste problem (Wilkie et al., 2015). Several factors have been cited as potential causes, including overproduction due to recipe requirements, inefficient food preparation techniques, lack of awareness or training on minimizing waste, and a general lack of emphasis on sustainable practices in culinary curricula.

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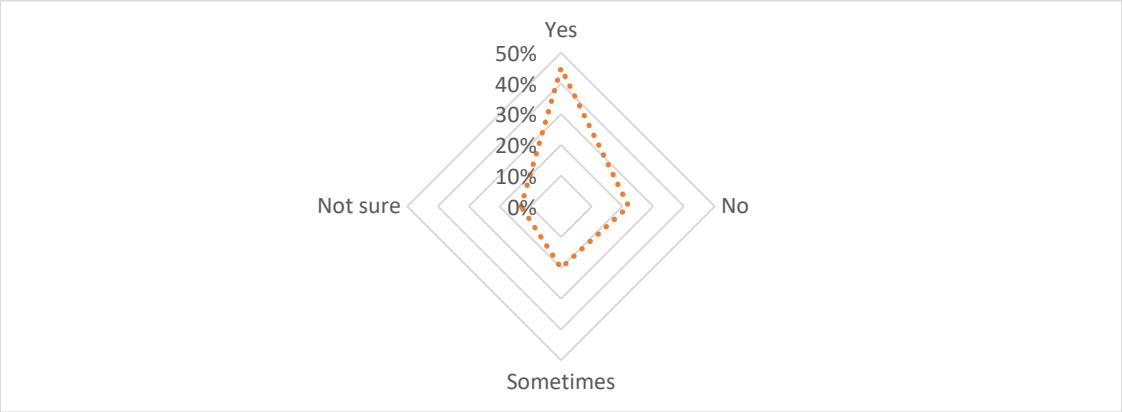

Fig.1 The Tendency of Students to Waste Ingredients at Culinary Lab Sessions
Fieldwork, 2023

A study by Principato et al. (2020) found that food waste is a significant issue in university canteens, with over 30% of food being wasted on average. The researchers attributed this to factors such as overproduction, poor menu planning, and lack of student awareness. The high percentage of students in the current document admitting to wasting ingredients (up to 50%) aligns with these broader findings on food waste in educational food service environments.

Additionally, a review by Papargyropoulou et al. (2016) highlighted the role of student behavior and attitudes as key drivers of food waste in university settings. They noted that factors such as lack of awareness, convenience-oriented habits, and disconnection from food production processes can contribute to wasteful practices. The presence of "Not sure" and "Sometimes" responses in the current document may reflect these underlying behavioral and attitudinal factors that influence ingredient waste.

Interestingly, a study by Setti et al. (2018) found that student engagement and hands-on experience in food production can help reduce waste. The researchers suggested that direct involvement in food preparation and an understanding of the production process can foster more conscious waste-reducing behaviors. The high levels of self-reported ingredient waste in the current document, despite the setting being a food production lab, may indicate that additional interventions are needed to translate hands-on experience into more sustainable practices.

Table 1: Factors Contributing to Ingredient Waste in Food Preparation Laboratory Sessions

Statement	SD	D	N	A	SA	Mean	Rank
	(%)	(%)	(%)	(%)	(%)		
Improper storage is a major cause of ingredients wastage among students.	15.9	10.7	11.6	28.4	33.1	3.49	4th
Due to lack of awareness and information, students do not properly utilize ingredients which leads to wastage.	9.4	14.2	16.3	30.1	29.7	3.56	2nd
Over purchasing of ingredients make students to misuse and mishandle the ingredients for cooking.	9.1	12.9	17.6	21.9	38.4	3.67	1st
Failure to plan properly in the usage of ingredients is as a result to properly determine how and when cuisine will be prepared for consumption.	8.2	12.9	21.9	30.6	26.3	3.54	3rd
Overbuying is said to be one of the major causes of restaurant businesses collapsing in Ghana.	12.9	13.3	25	26.7	21.9	3.31	6th
Insufficient monitoring and supervision during food production practical contribute to ingredients wastage.	9.1	15.9	19.8	27.1	28.0	3.49	4th
Insufficient knowledge about portion sizes lead to unnecessary ingredients wastage.	10.8	14.2	22.4	23.7	28.9	3.46	5th
Limited access to appropriate tools and equipment hampers ingredients utilization.	10.3	17.6	24.1	28.0	19.8	3.29	7th
Students' lack of awareness about the cost implications of ingredients wastage leads to careless usage.	11.2	11.6	17.7	31.0	28.4	3.54	3rd

Scale: 0-1.49 = SD (Strongly disagree), 1.5-2.49 = D (Disagree), 2.5-3.49 = N (Neutral), 3.5-4.49 =A (Agree), 4.5-5 = SA (Strongly agree)
Source: Fieldwork, 2023

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Table 1 presents data on the causes of ingredients wastage, particularly among students. The data is based on a survey where respondents were asked to rate various statements on a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." The mean scores and rankings of the statements are provided, giving insights into the perceived importance of each factor contributing to ingredients wastage.

One of the major causes identified is over purchasing of ingredients (mean score: 3.67, ranked 1st). This finding aligns with the literature, which suggests that over-purchasing or over-stocking of ingredients can lead to spoilage, mishandling, and ultimately, wastage (Lipinski et al., 2013; Papargyropoulou et al., 2014). Students may be tempted to purchase more ingredients than necessary, leading to misuse and mishandling, as stated in the corresponding statement. Another prominent cause is the lack of awareness and information (mean score: 3.56, ranked 2nd). This factor is often cited in the literature as a significant contributor to food waste, including ingredients wastage (Graham-Rowe et al., 2014; Stancu et al., 2016). Students may not have adequate knowledge or awareness about proper ingredient utilization, storage, and handling techniques, leading to unnecessary wastage.

Failure to plan properly in the usage of ingredients (mean score: 3.54, ranked 3rd) and students' lack of awareness about the cost implications of ingredients wastage (mean score: 3.54, ranked 3rd) are also identified as crucial factors. Proper planning and awareness of the economic impacts of wastage can help reduce unnecessary losses (Grandhi & Singh, 2015; Thyberg & Tonjes, 2016). The data also highlights the role of improper storage (mean score: 3.49, ranked 4th) and insufficient monitoring and supervision during food production (mean score: 3.49, ranked 4th) as contributing factors. These factors are widely recognized in the literature as leading causes of food and ingredients waste (Halloran et al., 2014; Principato et al., 2015). Insufficient knowledge about portion sizes (mean score: 3.46, ranked 5th) and limited access to appropriate tools and equipment (mean score: 3.29, ranked 7th) are also identified as potential contributors to ingredients wastage, albeit with relatively lower mean scores compared to the top-ranked factors.

- *Students' Perceptions on Mitigating Food Waste in Student Culinary Labs at Takoradi Technical University*

The importance of planning recipes with guidance from instructors or supervisors is well-documented in culinary literature. Many culinary experts emphasize the value of proper planning and organization before beginning any cooking or food preparation process (Labensky et al., 2015; Gisslen, 2018). The survey data in Figure 2 aligns with this perspective from the literature. The majority of respondents (66.38%) reported that they see the need to plan their recipes with supervisors before cooking or preparing dishes. This finding suggests that students in the Hospitality Management program recognize the benefits of seeking guidance and oversight during the planning stage, which can help prevent issues such as improper ingredient usage, food waste, or other challenges during the actual cooking process (Gisslen, 2018).

However, a notable portion of respondents (17.2%) only "sometimes" see the need to plan their recipes with supervisors, while another 12.93% do not see the need to plan with supervisors at all. This lack of consistent planning and oversight could potentially contribute to inefficiencies or errors, as emphasized by culinary experts (Labensky et al., 2015). Only a small percentage (3.44%) were unsure about whether there is the need to plan their recipes with supervisors, suggesting that most students have a defined approach, albeit with room for improvement in ensuring consistent planning with instructor guidance across all students.

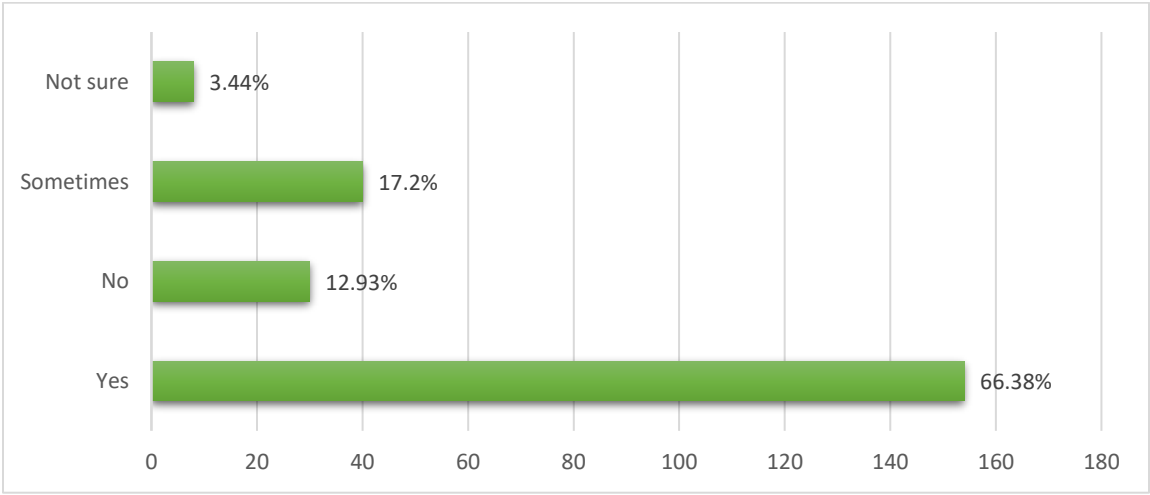

Fig 2. The Importance of Planning Menus with Supervisors
Fieldwork, 2023

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Overall, while the majority follow best practices by planning with supervisors, the data indicates an opportunity to further emphasize the importance of this crucial planning stage to the subset of students who do not consistently apply this approach. Robust planning aligned with expert guidance can help set students up for success in the kitchen (Gisslen, 2018; Labensky et al., 2015).

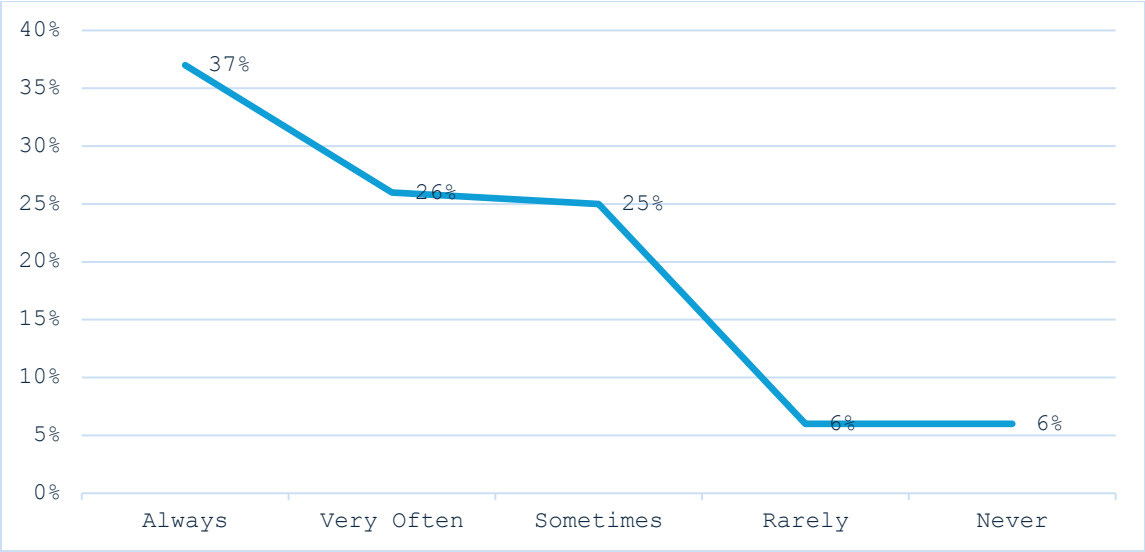

Fig. 3 Provision of Training by Supervisors on Preventing Ingredient Waste

The data shows that a significant portion of respondents (37%) reported that their supervisors "always" provide training on preventing ingredient waste. This aligns with best practices in the culinary industry, as reducing food waste is not only environmentally sustainable but also crucial for controlling food costs and maintaining profitability in foodservice operations (Pirani & Arafat, 2016; Papargyropoulou et al., 2019). Additionally, 26% indicated that their supervisors provide such training "very often," further reinforcing the emphasis on waste prevention measures. Together, the "always" and "very often" responses account for 63% of the sample, suggesting that a majority of supervisors prioritize this aspect of training.

However, a notable 25% reported receiving training "sometimes," implying inconsistency in the delivery of this crucial guidance. Infrequent or irregular training on waste prevention could lead to knowledge gaps and suboptimal practices among foodservice staff (Pirani & Arafat, 2016). Furthermore, a combined 12% reported either "rarely" or "never" receiving such training from their supervisors. This lack of guidance on ingredient waste prevention is concerning, as it could contribute to significant food waste, increased costs, and negative environmental impacts (Papargyropoulou et al., 2019; Pirani & Arafat, 2016).

While a majority of supervisors provide consistent training on preventing ingredient waste, the data highlights opportunities for improvement in ensuring that all students receive comprehensive and regular guidance on this critical aspect of culinary operations. Implementing standardized training protocols and reinforcing the importance of waste reduction could further strengthen sustainable practices and cost control measures across the industry (Papargyropoulou et al., 2019; Pirani & Arafat, 2016).

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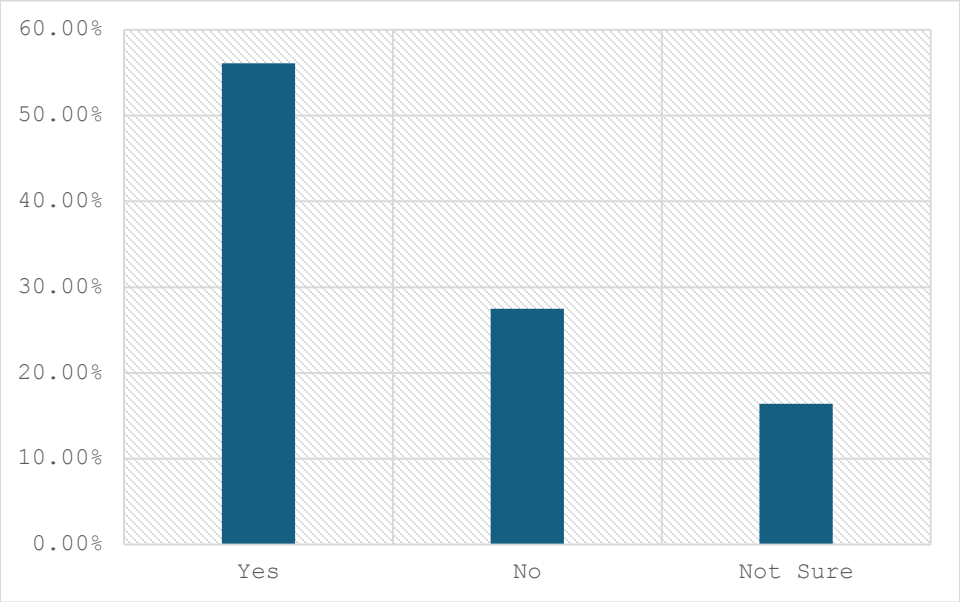

Fig. 4 Awareness of Students Regarding Policies to Reduce Ingredient Waste
Fieldwork, 2024

Fig.4 shows that a significant majority of respondents (130 or 56%) are aware of policies to reduce ingredient waste. This is an encouraging finding, as awareness is a crucial first step towards adopting sustainable practices and minimizing food waste, which has significant environmental and economic implications (Papargyropoulou et al., 2019; Pirani & Arafat, 2016).

However, a notable portion of respondents (64 or 27.5%) indicated that they are not aware of such policies. This lack of awareness could potentially lead to suboptimal practices, resulting in higher levels of food waste and associated costs (Papargyropoulou et al., 2019). Ensuring that all students are adequately informed about waste reduction policies should be a priority for hospitality management programs. Furthermore, 38 respondents (approximately 16%) indicated that they are "not sure" about the existence of such policies. This uncertainty suggests a need for clearer communication and education efforts to raise awareness among this subset of students. Papargyropoulou et al. (2019) emphasize the importance of awareness and education in fostering sustainable practices and reducing food waste in the hospitality sector. They recommend implementing comprehensive training programs and awareness campaigns to ensure that all employees, including students, are well-informed about waste reduction policies and practices. Similarly, Pirani and Arafat (2016) stress the need for a holistic approach to reducing food waste, which includes not only operational strategies but also educational components. They suggest that hospitality management programs should prioritize educating students on the environmental and economic impacts of food waste, as well as equipping them with the knowledge and skills to implement effective waste reduction strategies.

While the majority of students are aware of policies to reduce ingredient waste, the findings highlight opportunities for improvement in terms of increasing awareness and understanding among the remaining students who are unaware or unsure of such policies. By addressing the awareness gap identified in the data and incorporating best practices from the literature, hospitality management programs can better prepare future industry professionals to contribute to sustainable and cost-effective operations.

IV. DISCUSSION

The present study aimed to identify the primary factors contributing to food waste within student culinary laboratories and develop targeted strategies to mitigate this issue at Takoradi Technical University. The findings reveal several crucial insights and underscore the significance of addressing food waste in educational settings.

One of the most striking revelations is the alarmingly high rate of self-reported food waste among students during culinary lab sessions. A staggering 50% of respondents admitted to regularly wasting ingredients, while an additional 40% acknowledged occasional wasteful practices (Figure 1). This finding aligns with existing literature, which has identified culinary training facilities as significant contributors to the broader food waste problem (Wilkie et al., 2015; Principato et al., 2020).

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The data presented in Table 1 sheds light on the primary causes of ingredient wastage among students. Over-purchasing of ingredients emerges as the top-ranked factor, corroborating the literature's emphasis on the detrimental impacts of overstocking and excessive procurement (Lipinski et al., 2013; Papargyropoulou et al., 2014). Lack of awareness and information, as well as failure to plan properly, are also identified as significant contributors to wasteful practices. These findings resonate with previous research highlighting the role of knowledge gaps, inadequate planning, and disconnection from sustainable practices in driving food waste (Graham-Rowe et al., 2014; Grandhi & Singh, 2015; Stancu et al., 2016).

Interestingly, the data reveals that while a majority of students (66.38%) recognize the importance of planning recipes with supervisors (Figure 2), a notable portion (17.2%) only "sometimes" engages in this practice, and 12.93% do not plan with supervisors at all. This inconsistency in adherence to best practices aligns with culinary literature emphasizing the crucial role of guidance and oversight during the planning stage to prevent waste and inefficiencies (Labensky et al., 2015; Gisslen, 2018).

The study also explored students' perceptions of supervisors' efforts in providing training on ingredient waste prevention (Figure 3). While a majority of supervisors (63%) consistently offer such training, a significant portion (25%) only provide it "sometimes," and 12% rarely or never offer such guidance. This finding underscores the need for more comprehensive and standardized training protocols to ensure that all students receive consistent education on sustainable practices and waste reduction strategies (Pirani & Arafat, 2016; Papargyropoulou et al., 2019).

Furthermore, the data reveals an awareness gap among students regarding policies to reduce ingredient waste (Figure 4). While 56% of respondents are aware of such policies, a notable 27.5% are unaware, and 16% are uncertain. This lack of awareness or understanding can potentially lead to suboptimal practices and higher levels of waste, as highlighted by previous research (Papargyropoulou et al., 2019; Pirani & Arafat, 2016).

The findings of this study underscore the pressing need for comprehensive interventions to address food waste within student culinary laboratories. By identifying the primary contributing factors, such as over-purchasing, lack of awareness, inadequate planning, and inconsistent training, targeted strategies can be developed to mitigate these issues. Implementing educational campaigns and awareness programs can help bridge the knowledge gap and foster a culture of sustainability among students. Integrating sustainable food management practices into the curriculum, with a particular emphasis on proper planning, ingredient utilization, and waste reduction techniques, can equip future professionals with the necessary skills and mindset to drive positive change.

Furthermore, strengthening collaboration between students and supervisors during the planning and execution stages of culinary lab sessions can enhance oversight, guidance, and adherence to best practices. Establishing standardized training protocols and ensuring consistent delivery of waste prevention education can further reinforce sustainable behaviors and practices among students. It is also crucial to address systemic issues, such as over-purchasing and inventory management practices, through policy reforms and operational adjustments within the culinary laboratories. Engaging students in the development and implementation of these initiatives can foster a sense of ownership and responsibility, further reinforcing the desired behavioral changes.

By addressing food waste in student culinary laboratories, Takoradi Technical University can not only contribute to environmental sustainability and resource efficiency but also cultivate a generation of hospitality professionals who are equipped with the knowledge, skills, and ethical principles necessary to drive positive change in the industry. This initiative aligns with the broader goals of the United Nations Sustainable Development Goals, particularly Goal 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030 (United Nations, 2015).

Ultimately, the findings of this study emphasize the urgency and significance of tackling food waste in educational settings, as these environments serve as crucibles for shaping the attitudes, behaviors, and practices of future professionals. By addressing the root causes of food waste within student culinary laboratories, Takoradi Technical University can pioneer a transformative shift towards a more sustainable and responsible hospitality industry.

V. CONCLUSION

The findings reveal a pervasive problem, with a staggering 50% of respondents admitting to regularly wasting ingredients during practical sessions. This alarming statistic underscores the urgent need for comprehensive interventions to address this challenge. Through an in-depth analysis of the data, several key factors contributing to food waste have been identified, including over-purchasing of ingredients, lack of awareness and information, failure to properly plan, improper storage practices, and inadequate supervision. These findings align with existing literature on food waste in educational settings and highlight the multifaceted nature of the problem.

Moreover, the study has revealed opportunities for improvement in areas such as consistent planning with supervisors, standardized training on waste prevention, and raising awareness about policies aimed at reducing ingredient

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waste. While a majority of students recognize the importance of planning with guidance and a significant portion of supervisors provide regular training, there remains room for enhancing these practices and ensuring consistency across the entire student population. By addressing these critical issues, Takoradi Technical University can take a proactive step towards fostering a culture of sustainability and resource efficiency within its culinary arts program. Implementing targeted strategies, such as educational campaigns, curriculum integration, and policy reforms, can equip future hospitality professionals with the knowledge, skills, and mindset necessary to drive positive change in the industry.

Furthermore, this initiative aligns with broader global efforts to combat food waste and promote sustainable development. The United Nations Sustainable Development Goal 12.3 aims to halve per capita global food waste at the retail and consumer levels by 2030 (United Nations, 2015). By tackling food waste within its educational setting, Takoradi Technical University can contribute to this ambitious goal and position itself as a leader in sustainable culinary education. Ultimately, the significance of this study extends beyond numerical targets or institutional boundaries. It presents a unique opportunity to cultivate a generation of hospitality professionals who are deeply committed to environmental stewardship, ethical decision-making, and sustainable practices. By addressing food waste in student culinary laboratories, Takoradi Technical University can play a pivotal role in shaping a more responsible and sustainable future for the industry.

As the world grapples with the pressing challenges of climate change, resource scarcity, and food insecurity, the importance of minimizing food waste cannot be overstated. This study serves as a catalyst for action, highlighting the urgency of addressing this issue within educational settings and empowering future professionals to lead the charge towards a more sustainable and equitable food system.

VI. RECOMMENDATIONS

The issue of food waste within student culinary laboratories has emerged as a pressing concern, with alarming statistics revealing the pervasiveness of this problem. However, by implementing a comprehensive set of recommendations, educational institutions have the power to catalyze positive change and foster a culture of sustainability among future hospitality professionals.

At the heart of this endeavor lies the integration of sustainable food management practices into the culinary arts curriculum. By equipping students with knowledge on waste reduction techniques, proper ingredient utilization, and meal planning strategies, institutions can instill a foundational understanding of the importance of minimizing food waste. Hands-on training and practical exercises should reinforce these lessons, ensuring that students not only grasp the theoretical concepts but also develop the practical skills necessary to translate them into action.

Complementing this curricular overhaul is the need for comprehensive awareness and education campaigns. Through workshops, seminars, and collaborative efforts with industry experts and environmental organizations, institutions can heighten students' awareness of the environmental, economic, and social impacts of food waste. By fostering a deep understanding of these consequences, educators can inspire a sense of responsibility and commitment to sustainable practices among their students.

However, education alone is not sufficient; ensuring consistent guidance and supervision is paramount. Standardized training protocols for instructors and supervisors should be established, equipping them with the knowledge and tools to effectively guide students throughout the cooking process. Enhanced supervision during culinary lab sessions will reinforce proper planning, ingredient utilization, and adherence to best practices, fostering a collaborative learning environment where students and instructors work together to identify and address potential sources of waste.

Institutional policies and operational procedures must also be reviewed and revised to address systemic issues contributing to food waste. This may involve implementing guidelines for meal planning, forecasting, and ingredient procurement to prevent excessive stocking and minimize waste. Additionally, investing in appropriate infrastructure, tools, and equipment can facilitate efficient food preparation, storage, and repurposing of leftovers, further reducing waste generation.

Monitoring and evaluation mechanisms are crucial for tracking progress, measuring the effectiveness of interventions, and identifying areas for improvement. Regular audits and assessments of food waste levels, ingredient utilization, and adherence to sustainable practices should be conducted, engaging students and staff in the process to foster a sense of ownership and accountability.

Collaboration and knowledge-sharing are equally vital components of this journey. Educational institutions should actively participate in regional, national, and international networks focused on sustainable food systems and waste reduction initiatives. By exchanging best practices and innovative solutions with industry partners and research organizations, institutions can contribute to the growing body of knowledge in this field and accelerate progress towards a more sustainable future.

Finally, community engagement and outreach efforts are essential for raising awareness and fostering a broader understanding of the importance of reducing food waste.

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Partnerships with local communities, non-governmental organizations (NGOs), and government agencies can facilitate the redistribution of edible surplus food to those in need, contributing to food security efforts. Encouraging students to participate in community outreach programs and volunteer initiatives related to food waste reduction and environmental sustainability can further reinforce the significance of this endeavor.

By embracing this comprehensive roadmap, educational institutions have the power to transform their culinary laboratories into incubators of sustainable practices, shaping a generation of hospitality professionals who are equipped with the knowledge, skills, and ethical principles necessary to drive positive change within the industry. As the world grapples with the pressing challenges of climate change, resource scarcity, and food insecurity, this proactive approach to addressing food waste represents a pivotal step towards a more sustainable, socially responsible, and economically viable future for the hospitality sector and the broader global community.

VII. IMPLICATIONS OF THE STUDY

The findings of this study have far-reaching implications that extend beyond the confines of Takoradi Technical University's culinary laboratories. By identifying the primary factors contributing to food waste and proposing targeted strategies for mitigation, this research has the potential to catalyze positive change within the broader hospitality industry and contribute to global efforts towards environmental sustainability and food security.

- *Educational Implications:*

The study highlights the critical role of culinary education programs in shaping sustainable practices and mindsets among future hospitality professionals. By integrating waste reduction strategies, proper planning techniques, and awareness campaigns into the curriculum, educational institutions can equip students with the knowledge and skills necessary to minimize food waste throughout their careers. Secondly, fostering collaboration between students and instructors during the planning and execution stages of culinary lab sessions can enhance oversight, guidance, and adherence to best practices, ultimately reducing waste and promoting resource efficiency. Also, implementing standardized training protocols and ensuring consistent delivery of waste prevention education can reinforce sustainable behaviors and practices among students, creating a lasting impact on their future endeavors.

- *Industry Implications:*

The findings underscore the importance of addressing food waste within the hospitality industry, as it contributes significantly to economic losses, environmental degradation, and food insecurity. By adopting the strategies and recommendations outlined in this study, industry professionals can mitigate waste, reduce operational costs, and enhance their sustainability credentials. Equally, empowering employees with knowledge and training on proper ingredient utilization, inventory management, and waste reduction techniques can foster a culture of sustainability within hospitality establishments, leading to tangible benefits for both the environment and the bottom line. Furthermore, Implementing robust policies and operational adjustments to address systemic issues such as over-purchasing and inefficient storage practices can drive significant reductions in food waste across the industry.

- *Environmental and Social Implications:*

By minimizing food waste, the hospitality industry can contribute to the global effort to combat climate change and mitigate its environmental impact. Reducing food waste translates to lower greenhouse gas emissions, decreased strain on natural resources, and a reduction in the ecological footprint of the industry. Secondly, addressing food waste aligns with the United Nations Sustainable Development Goal 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030 (United Nations, 2015). This study can serve as a catalyst for educational institutions and the hospitality industry to actively participate in achieving this ambitious target. Also, reducing food waste has profound social implications, as it can contribute to alleviating food insecurity and malnutrition globally. By maximizing the utilization of available resources and minimizing waste, the industry can play a role in promoting food security and social equity.

- *Research Implications:*

This study contributes to the existing body of literature on food waste in educational settings and the hospitality industry, providing valuable insights and data that can inform future research endeavors. The methodological approach and survey instruments employed in this study can serve as a framework for researchers investigating similar issues in other educational institutions or industry contexts, facilitating comparative analyses and cross-cultural studies. The findings can stimulate further research into the development and evaluation of targeted interventions, educational programs, and policy initiatives aimed at reducing food waste within the hospitality sector.

The implications of this study extend beyond the walls of Takoradi Technical University, offering valuable insights and actionable recommendations for educational institutions, the hospitality industry, and society as a whole. By addressing the root causes of food waste and promoting sustainable practices, this research can contribute to a more environmentally conscious, socially responsible, and economically viable future for the hospitality sector and the broader global community.

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➢ *Conflict of Interest*

The authors declare no conflicts of interest in relation to this research study and publication. There was no financial support received from any organization that could have influenced the outcome of the work. The study was conducted independently by the authors, free from undue influence or competing interests from funders, institutions, companies, or other entities. The authors have no financial or personal relationships that could potentially bias the results and findings presented in this manuscript. Additionally, the authors confirm that the research was carried out objectively and ethically, upholding the principles of scientific integrity and transparent reporting practices throughout the entire process.

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