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Food waste supply and behaviour towards its alternative uses in Kampala city, Uganda

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Abstract

Solid waste management is a major challenge in sub-Saharan Africa in general and its food waste component is high and increasing with the rapidly increasing population. Survey data (class p1) collected from households, hotels, restaurants, schools and produce markets were analysed using descriptive and logistic regression analyses for insights into the types and amounts of food waste, and respondents' attitudes and practices towards its collection, disposal and alternative uses. Households produce the highest amounts of food waste compared to institutions (hotels, schools and restaurants) and produce markets. In a week, about 96, 72, and 93% of all the respondents in households, institutions and produce markets respectively experienced food waste at least one to three times. On average, with a solid waste collection coverage of 45%, households, institutions and markets in Kampala can respectively supply 680, 80, and 8 t of food waste daily. Moulding, poor food storage, food leftovers, food expiry and excess food produce were the major reasons for condemning food to waste. Over 90% of the respondents recognized food waste as a problem, and as a resource especially for use in livestock feed production, and were willing to consume house crickets raised on feed from food waste. Lower levels of education (none, primary and secondary levels), unemployment, and being divorced at household level were positively associated with recognizing food waste as a resource [X^2 (21, $N=209$) = 137.77, $p = < 0.0001$] and re-use for alternative purposes [X^2 (21, $N=209$) = 47.44, $p = 0.001$] by households and institutions [X^2 (14, $N=92$) = 30.97, $p = < 0.019$]. Majority of the respondents were willing to donate food waste, especially married people and institutions that have been in existence for a period of 5–10 years.

Keywords Food waste, Cricket feed, Edible insects, Attitudes & practices, Logistic regression

1 Introduction

Sub-Saharan Africa (SSA) is currently experiencing the fastest growing and youngest population globally. The annual population growth rate in SSA stands at 2.4%, the fastest in the world, a third of which is below 24 years of age [1–3]. The rapid increase in population translates into a combination of increased demand for nutritious food and generation of food waste. According to Sheahan and Barret [4], the annual per capita food loss/waste ranges between 120 and 170 kg. This ends up in landfills, posing an environmental and health burden to the surrounding population [5, 6]. Consequently, the increasing

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population will result in increased food waste availability, further aggravating the food waste associated challenges.

Food waste refers to the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers [7]. The Waste Framework Directive 2008/98/EC defines waste as "any substance or object which the holder discards or intends or is required to discard" [8]. Hence as food deteriorates along its value chain and it is no longer fit for the intended purpose, it is discarded, compromising food security and promoting malnutrition. In industrialized countries, the majority of food is wasted at the retail and consumer stages, while in low-income countries, food is often lost in the production or processing stages of the supply chain before it even reaches the consumer [9]. Food waste is implicated to lead to a myriad of challenges and lost opportunities to value chain actors and the general population. These include: loss of investment and profit associated with the wasted food, and burdening the environment through emitted leachate; greenhouse gas emission, process, transport and later on dispose food that is ultimately not utilized; and acidified greenhouse gases among others [9, 10]. Food lost through wastage definitely impacts food security negatively.

Despite the above negative connotations, food waste has alternative uses such as animal feed, compost/fertilizer, and energy generation in the form of bio-gas, among others [11, 12]. Makanjuola et al. [13] propose several products from food waste such as dietary fibre, biofuels, colorants, enzymes, livestock feed, food supplements and essential oils among other prospects. Discarded food is only spoiled and unfit for human consumption but not devoid of value. It still carries value and need not be disposed of without extracting this value from it, i.e., value addition. Given that food waste is to be used as the raw material for value addition purposes, it is important to characterize the supply (types, quantity and quality) of the waste in preparation for reliable and sustainable production of the intended value-added products.

In East Africa, Uganda inclusive, it has been documented that biological waste, much of which is food waste from restaurants and markets (fruits, vegetables and tubers) makes up 65–79% of the total solid waste in major cities [14]. Therefore, of the 481 kt of solid waste collected in Kampala [15], food waste could therefore be estimated to range between 312 and 380 kt by 2019. The latter estimations did not quantify the types and amounts of food waste yet this is crucial in food waste value addition, especially for conversion into livestock feed. For the latter, it is important to know which food wastes can contribute to the different key nutrients such as protein in the feed, and how they will be sourced. This study intended and therefore: (i) quantified the types and amounts of the food waste proportion, and (ii) assessed the attitudes and practices of the food waste generators towards its disposal and potential use.

2 Methodology

2.1 Study area and data collection

The research was conducted in Kampala city, the most urbanized area in Uganda. This area is characterized by a high density of households, institutions (hotels, restaurants, schools) and markets. Kampala city consists of five (5) divisions and nine (9) constituencies, the latter being sub-divided into parishes, and local councils. There are five (5) companies contracted by Kampala Capital City Authority (KCCA) to collect and dispose solid waste at Kiteezi landfill. The sample size was estimated using Cochran's sample size formula [16], i.e., sample size, $N=(Z^2pq)/e^2$ where: e is the desired level of precision (i.e. the margin of error), Z is the Z value associated with the confidence interval associated with e, p is the (estimated) proportion of the population which has the attribute in question, q is 1 − p, and 1 is the population size. In this study, the total population and the proportion disposing food waste (p) in Cochran's formula were estimated from the Uganda population census [17] findings as follows:

a. About 97% of the population in Kampala city was comprised of households and women were mostly in charge of preparing and discarding food items. Thus, the population size for use in Cochran's formula was 0.97.
b. Of this total population, (a) 57% of the population of the households were in a marriage (UBOS, 2014), contributing to the 0.57 of the proportion of the key population (women) disposing food; and (b) 13% of the households were widowed and separated persons. Hence, the proportion of the population directly contributing to food waste generation and disposal, i.e., p in Cochran's formula was estimated was estimated as the sum of 0.57 and 0.13, i.e., 0.7 (70%).
c. Given that the persons responsible for trading food in markets and preparing food in the institutions are much smaller in number, and they also belong to the households as well, using the household population to estimate the respondent sample size was adequate and justified.

Hence, with $N=0.97$, i.e., ~ 1, $Z=1.96$, $p=0.7$, $q=0.3$, and $e=0.05$, the sample size was estimated at 323 respondents. For a better distribution, 330 respondents were interviewed.

Of the 330 respondents, 150 were allocated to markets and institutions for equal divisibility among the components, while the remainder, 180 respondents, were

allocated to households. For markets, respondents dealing in raw staple food items/fresh produce (matooke, cassava, Irish potatoes, sweet potatoes and vegetables) were interviewed. In each division, the biggest market dealing in fresh produce was visited according to information obtained from division headquarters. These included Nakawa market (Kawempe division), Kalerwe market (Kawempe division), Busega market (Rubaga division), Kibuye Market (Makindye division), and St. Balikuddembe and Nakasero markets (Central division). In each of these selected markets, the market leadership was asked to lead us to three traders dealing in each of the following five staple food items, i.e., Matooke, Cassava, Sweet potatoes, Irish potatoes and green leafy vegetables. Hence, from five produce markets, a total of 75 respondents were selected.

For institutions (hotels, restaurants and schools) in each division, a list of major hotels, restaurants and schools was obtained from the division headquarters and using the random selection method, five of each of the institutions were selected and surveyed from each division. Thus 75 institutions were surveyed. The total number of hotels and restaurants in Kampala (food service centres) was obtained from the Uganda Bureau of Statistics.

For households, 180 respondents were visited in the five divisions. From each of the two constituencies in a division such as Rubaga North and Rubaga South in Rubaga division, a parish (the local council administrative unit at the second level – LC2, which is a combination of several local council units at the first level – LC1) was randomly selected from the each of the constituency parish list. For Kampala central that is one constituency, two parishes were randomly selected. From the 10 parishes selected, 18 residential households were interviewed per parish. When an enumerator reached the selected parish, he/she interviewed every 5^{th} household from the preceding one. The mothers in the households were the target respondents. A team of well-trained enumerators pre-tested the data collection tool and implemented the survey.

2.2 Data management and analysis

Data sets were cleaned to remove unnecessary digital information, re-organized and imported to SPSS software for analysis. Data sets were presented in terms of frequencies and percentages of respondents' response to the parameters under investigation. Logistic regression was performed to gain insights into relationships that can exist between the demographic characteristics of the respondents and their practices and attitudes towards food waste. Findings were presented in the form of tables and figures to aid interpretation and further discussion.

3 Results and discussion

3.1 Social-demographic characteristics of the respondents

In Table 1, we present the descriptive statistics of the information collected from the households, institutions (hotels, restaurants and schools) and markets. Majority of the respondents were youth aged between 18 and 35 years, followed by adults aged between 36–60 years. This is in line with other study findings on food waste, which show similar age bracket patterns. A study in Albania [18], using 185 respondents found youths (18–34 years) to constitute 50.2% of the respondents, while 34.6% were adults in the 35–54 age-group. Charbel et al. [19], in Lebanon had 215 respondents with youths (18–34 years) constituting 63.7%, and 28.9% adults between 35–54 years. This implies that regarding food waste demand and supply, youth and adults are the most important age-groups to be considered for policy planning purposes.

Majority of the respondents had attended either primary or secondary education and therefore attained the minimum literacy level to enable them read and write. Considering food waste as a resource that can lift many stakeholders out of poverty, literacy is therefore a resource to support life-long learning in the fast changing world that now considers waste as a resource [20]. This makes extension services regarding improvement of waste management easily comprehensible by the stakeholders. Majority of the respondents were married, and therefore potentially having more than one person living in a household. This implies increased food waste generation compared to households with single persons that were the second most abundant in the survey.

Women in households, chefs in the institutions, and business owners in markets were the gatekeepers of waste generation and hence management. They are the key to implementing interventions aimed at improved food waste management. However, in the SSA setting, husbands are the household heads and normally control any resource that has financial gains [21]. Likewise, in schools, restaurants and hotels, although the former was identified gatekeepers, business owners are most likely to determine the fate of the food waste once the waste is identified with financial gains. Therefore, alongside the gatekeepers of waste generation and disposal, the final decision makers need to be involved in the waste management improvement interventions if they are to succeed. For households, majority reported having 2–3 meals per day which implies increased food waste generation. Of the five household members, at least two of them earned an income which possibly helps them to currently pay for the disposal of their waste.

Table 1 Demographic characteristics of respondents from households, institutions and produce markets

Variables	Categories	% respondents		
		Households	Institutions	Markets
Sample	Respondents	55.2 (209)	24.3 (92)	20.6 (78)
Designation	Household head	100.0	N/A	N/A
	Chief chef	N/A	48.91	N/A
	Manager/Head teacher	N/A	18.47	19.2
	Business owner/Director	N/A	6.52	80.8
	Other	N/A	26.1	N/A
Gender	Female	95.7		
	Male	4.3		
Age (in years)	Above 61	1.4	2.2	0.0
	36–60	23.9	47.8	50.0
	18–35	66.5	48.9	50.0
	14–17	8.1	1.1	0
Education level	None	12.4	9.8	21.8
	Primary	26.3	16.3	34.6
	Secondary	43.5	40.2	35.9
	Tertiary	17.7	33.7	7.7
Marital status	Divorced/Separated	9.6	10.9	16.7
	Married	45.5	55.4	51.3
	Single	38.8	32.6	26.9
	Widower	6.2	1.1	5.1
Years of existence	0–5	N/A	30.4	33.3
	6–10	N/A	31.5	39.7
	11–15	N/A	25.0	14.1
	16–20	N/A	4.4	5.1
	Above 20 years	N/A	8.7	7.7
Meals/day	1	3.8	N/A	N/A
	2	52.6	N/A	N/A
	3	39.2	N/A	N/A
	4	4.3	N/A	N/A
Number of Income earners in the HH	0	1.4	N/A	N/A
	1	50.7	N/A	N/A
	2	35.9	N/A	N/A
	3	7.2	N/A	N/A
	4	2.9	N/A	N/A
	5	1.9	N/A	N/A
Occupation	Business	35.5	N/A	N/A
	Domestic worker	1.9	N/A	N/A
	Farmer	1.9	N/A	N/A
	House Wife	21.1	N/A	N/A
	Professional	6.2	N/A	N/A
	Student	15.8	N/A	N/A
	Unemployed	17.7	N/A	N/A

3.2 Sources and frequency of food waste generation

In Table 2, we present the descriptive statistics for the sources and frequency of food waste generation. Findings show that markets are the major source of food supply to households and institutions, while markets obtain their food items mainly from farmers and whole-sale stores. Farms, farmers' markets and supermarkets are the least suppliers of food items.

Table 2 Food supply and food waste generation from households, institutions and produce markets

Variable	Response	Households (53.6)	Institutions (23.2)	Markets (23.2)
Received food in the previous week	No	0.5	2.2	3.9
	Yes	99.5	97.8	96.2
Source of the food	Directly from farm	4.8	N/A	9.3
	Directly from farmer	N/A	N/A	36.0
	Farmers market	N/A	N/A	9.3
	Wholesale store	N/A	N/A	45.3
	Market	85.2	72.2	N/A
	Shop	9.6	26.7	N/A
	Supermarket	0.5	1.1	N/A
Experienced food waste	No	3.8	27.2	6.4
	Yes	96.2	72.8	93.6
Frequency of food waste	None	3.8	0	0
	Daily	14.4	76.1	13.7
	Once a week	25.8	11.9	23.3
	Twice a week	29.7	8.9	23.3
	Thrice a week	25.4	2.9	17.8
	>Three times a week	0.9	0	21.9
Permission to weigh food waste	No	68.4	25.0	3.9
	Yes	31.6	75.0	96.2

N/A-No data regarding that aspect was available from that sub-group because it was irrelevant

Over 90% of the respondents in markets and households, and 72% in institutions experienced food waste in a week. Institutions experienced/generated food waste most frequently on a daily basis while for households and markets, the frequency of food waste generation averagely ranged between once and three times a week. Across all the categories, 2.9–14.4% of all the respondent categories at least experienced food waste on a daily basis. This information is useful to food waste collection/aggregation for value addition. For example, food waste can be collected on a daily basis from schools, hotels and restaurants while for households and markets, it can be two or three times a week. Over 68% of the households were not willing to grant permission for their waste to be weighed, however, this information was obtained from the 32% who were willing. To the contrary, majority of the respondents from institutions and markets were willing to have their waste weighed, and this information was useful in estimating average quantities of types of food wasted by each category. The willingness by institutions and markets to have their food waste weighed (dealt with) compared to households is possible because waste is generated daily. This willingness combined with daily generation implies that institutions and markets can be consistent sources of daily food waste to its value addition centers. Consistence in raw material supply is critical in value addition [22].

3.3 Food waste supply from households, institutions and produce markets

Table 3 shows the types and average amounts of the types of food waste identified. Banana peels and leftovers contribute 33.3% of the food waste supply followed by cassava peels and left over stems that contribute 27.9%. These are followed by Irish potato peels, left-over foods from cereals and pulses and lastly, leftover foods from animal source foods such as fish and meat. These findings have important implications regarding; (i) the availability, accessibility and affordability of foods in Uganda; (ii) the consumption patterns of these foods, and (iii) the formulation patterns for animal feeds.

In Uganda, matooke and cereals such as maize and rice are the staple foods followed by tubers (cassava, Irish potato, etc.), pulses (beans, ground nuts) and lastly animal source foods (meat, poultry, fish, etc.) [23, 24]. The annual per capita consumption of high quality animal protein and micro-nutrient rich foods is low, i.e., estimated at 13.4 and 33.9 kg cap^{-1} yr^{-1} for meat and milk respectively compared to the world's consumption estimated at 45.3 and 89.5 kg cap^{-1} by 2030 (WHO, 2020). Consequently, Ugandans largely depend on plant based foods and less on animal based foods [25] which is consistent with their food waste behaviour. Plant foods hence make the biggest percentage of food waste, consistent with observations in this study.

Table 3 Types and daily estimates of food waste generated by households, institutions and produce markets

Food waste component	Households (HH)				Institutions (INS)			Produce markets (PM)		
Food Waste	Average (kg d^{-1})	[a]No. of HH	[b]% city Coverage	(t d^{-1})	Average (kg d^{-1})	[c]No. of INS	(t d^{-1})	Average kg d^{-1})	[d]No. of vendors	(t d^{-1})
Matooke peels	0.73	416,094	0.45	136	1.14	10,631	12.12	-	-	-
Cassava peels	0.59	416,094	0.45	110			-			
Matooke cooked	0.62	416,094	0.45	117	1.43	10,631	15.20	1.33	1,182	1.57
Fish	0.08	416,094	0.45	15	0.50	10,631	5.32	-	-	-
Vegetables	0.09	416,094	0.45	17	0.30	10,631	3.19	0.285	1,384	0.39
Irish potatoes	0.03	416,094	0.45	5	0.52	10,631	5.53	3.54	921	3.26
Ground nuts	-	-	-	-	1.72	10,631	18.29	-	-	-
Beans	0.13	416,094	0.45	23	0.07	10,631	0.74	-	-	-
Rice	0.18	416,094	0.45	34	1.19	10,631	12.65	-	-	-
Posho	0.20	416,094	0.45	37	0.35	10,631	3.72	-	-	-
Chicken	0.03	416,094	0.45	5	0.18	10,631	1.91	-	-	-
Beef	0.02	416,094	0.45	4	0.25	10,631	2.66	-	-	-
Potatoes	0.13	416,094	0.45	24	0.18	10,631	1.91	1.835	1,527	2.80
Potato peels	0.06	416,094	0.45	12	-	-	-	-	-	-
Irish peels	0.23	416,094	0.45	42	-	-	-	-	-	-
Pasta	0.10	416,094	0.45	18	-	-	-	-	-	-
Cassava	0.43	416,094	0.45	80	1.42			2.58	1,408	3.63
Total/day				**680**			**83.24**			**8.03**

[a] The total number of households in Kampala

[b] The coverage collection of solid waste in Kampala

[c] The number of restaurants and hotels in Kampala

[d] The number of produce vendors in Kampala major markets. The tons of food waste per day were obtained by multiplying the average waste collected by the number of HH and the coverage for HH; the number of hotels and restaurants for institutions; and the number of vendors for produce markets

In animal feed, the highest requirement is energy followed by protein and other nutrients [26]. The energy sources in animal feed majorly consist of carbohydrates and fats. Matooke, cassava and cereals in this study are carbohydrate sources and therefore potential sources of energy in animal feed. Pulses normally complement animal proteins as sources of protein and other nutrients in animal feed formulations, with the latter existing in the least amounts. Beans and groundnuts in this study can therefore complement fish, meat and poultry for use in animal feed.

On average, 680 t of food waste are generated daily from households. Households and markets supply a variety of food waste material but collecting the waste often requires considerable investment in labor for collectors, i.e., those who transfer the waste to the skip and the garbage collection company employees; automobiles and their maintenance; fuel and disposal costs at landfills [27, 28]. On the contrary, markets and institutions provide few types of food waste but in large amounts that aid bulk collection. Currently, food waste collection is mainly done by private companies that solicit money from waste generators to dispose of their waste. Therefore, waste generators could find it beneficial and attractive if there is an offer to dispose of their waste at no cost. Similarly, interested parties in food waste value addition can aggregate waste at no fee.

3.4 Reasons for condemning food to waste

Figure 1 depicts the reasons for condemning food to waste. Findings show that moulding, poor food storage, food being leftover, and food expiry were the major reasons by the households and institutions for condemning food to waste.

For produce markets, food being leftover does not apply but presence of food in excess of what could be sold, bad aroma, bad taste, and poor storage were cited as major causes of food waste. Normally, moulding and loss of sensory appeal (bad aroma and bad taste) are signs of food losing its edible quality and subsequent spoilage, becoming unfit for consumption [29, 30]. Poor storage can contribute to molding/spoilage of food. This implies that loss of aesthetic appeal, food expiry and food excess are the major causes of food wastage, and preventing these factors or reducing their occurrence can reduce food wastage. Several measures such as (i) raising awareness, (ii) improving communication along the food supply chain to match demand, and (iii) improving post-harvest handling,

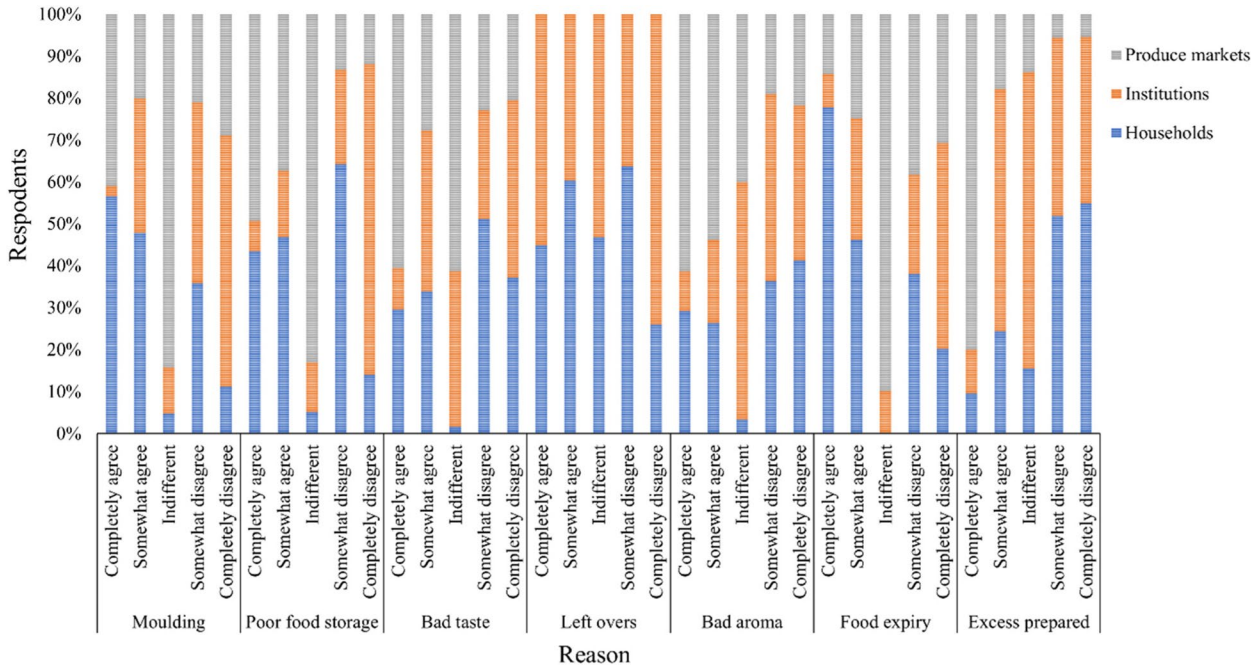

Fig. 1 Reasons for condemning food to waste from a stakeholder perspective

processing, storage, transportation and retailing have been suggested by FAO [31]. Though no strategies exist in many SSA countries to reduce food waste, some regions such as the European Union has have come up with the "farm to fork" strategy to prevent food loss [32]. The United States Department of Agriculture and the Environmental Protection Agency established the U.S. 2030 food loss and waste reduction goal, seeking to cut food loss and waste in half by the year 2030 [33]. The two programs aim at food waste reduction implying that food waste cannot be completely prevented. Therefore strategies to add value to waste highly contribute to the sustainability of food waste management and circularity of the food economy.

3.5 Disposal and utilization of food waste material

Figure 2 depicts the disposal and utilization of food waste material. Majority of the respondents in institution and markets, and almost a half of the households indicated that they re-used the food waste.

Food waste from markets and institutions is mainly used for animal feed (excluding poultry) while households use them as snacks during tea breaks. The major use for food waste tends to be animal feed and the wastes are collected daily, majorly at no cost from the persons/institutions from which the food waste is being collected. Food waste is normally used as animal feed [34] implying that it is still laden with nutrients that support animal growth.

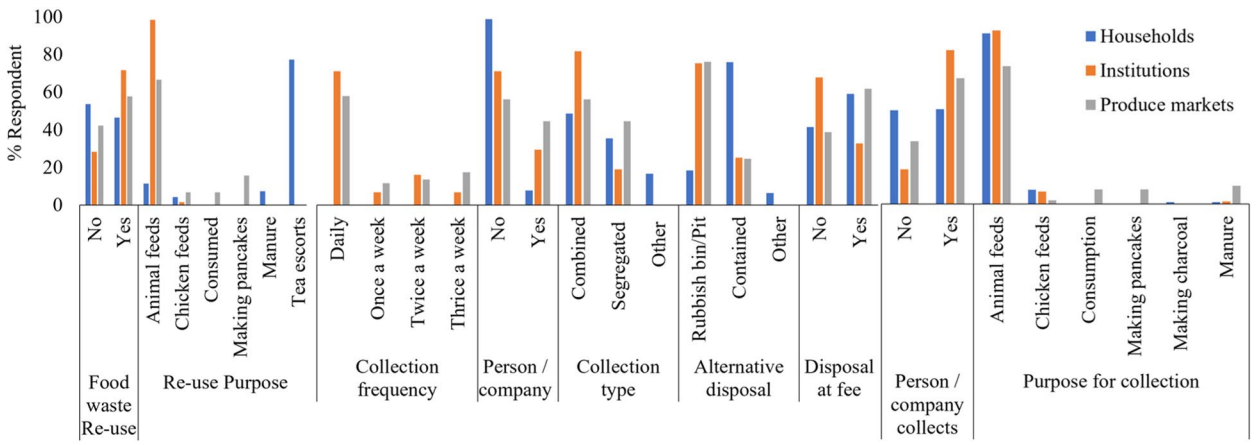

Fig. 2 Disposal and utilization practices of food waste

Given that food waste can potentially transmit (i) diseases such as foot-and-mouth disease and African swine fever to animals [35], and (ii) pathogenic microorganisms that pose a health risks (e.g. zoonotic diseases such as Salmonellosis) to consumers [36], it is important that it is processed for safety and suitability for use as animal feed [37]. Food waste was collected on a daily basis, majorly by a person or company, generally collected together with other kinds of (solid) waste and disposed of in either rubbish pits/waste disposal sites (institutions and markets) or contained in bags/sacks (for households). Majority of the institutions did not pay for disposing of the food waste while majority of the households and produce markets did pay. The lack of food waste segregation/sorting limits its re-utilization because it could be contaminated with materials that do not permit re-use [38]. Therefore, it is important to develop a system that permits segregated/sorted collection of solid waste to enable food waste be allocated for alternative uses. Additionally, protocols to decontaminate food waste and process it into feed and other value added products can encourage sustainable and safe re-use.

3.6 Attitudes and perceptions towards food waste collection, disposal and use

Majority of the respondents recognized food waste as a serious problem to worry about especially by the households and the institutions, and impossible to eliminate (Fig. 3).

However, they were satisfied with the collection systems. This implies that the population is currently seeking for increased efficiency with the current collection systems. Adapting the latter to segregated/sorted food waste can already support its value addition endeavors and eliminates the need to establish another system. Although the current collection system offers convenience, collection is only at 45% coverage in Kampala [39], implying that majority (55%) of the population suffer from inadequate waste disposal of the uncollected (food/solid) waste. Such collection systems can be modified to involve sorting and delivery of food waste to value addition centers instead of landfills. Increased utilization of food waste can result in increased collection coverage because of its demand for value addition purposes.

Most of this waste, especially from unlicensed collectors and poor informal households that cannot afford disposal fees dump their garbage in un-gazetted places such as roadsides, illegally constituted dumpsites and the drainage channels which affects the sanitary, hygienic, and environmental health of the surrounding population [14, 27]. Majority of the respondents were aware of the benefits of food waste and willing to donate it for alternative uses. The collected food waste was majorly used for animal feed (Fig. 2) and majority of the respondents were willing to consume livestock raised on food waste. This is an indication of the positive attitude towards innovative value added products from food waste. Positive attitudes towards utilization of innovations is important if such innovations are to be impactful to the intended beneficiaries [38].

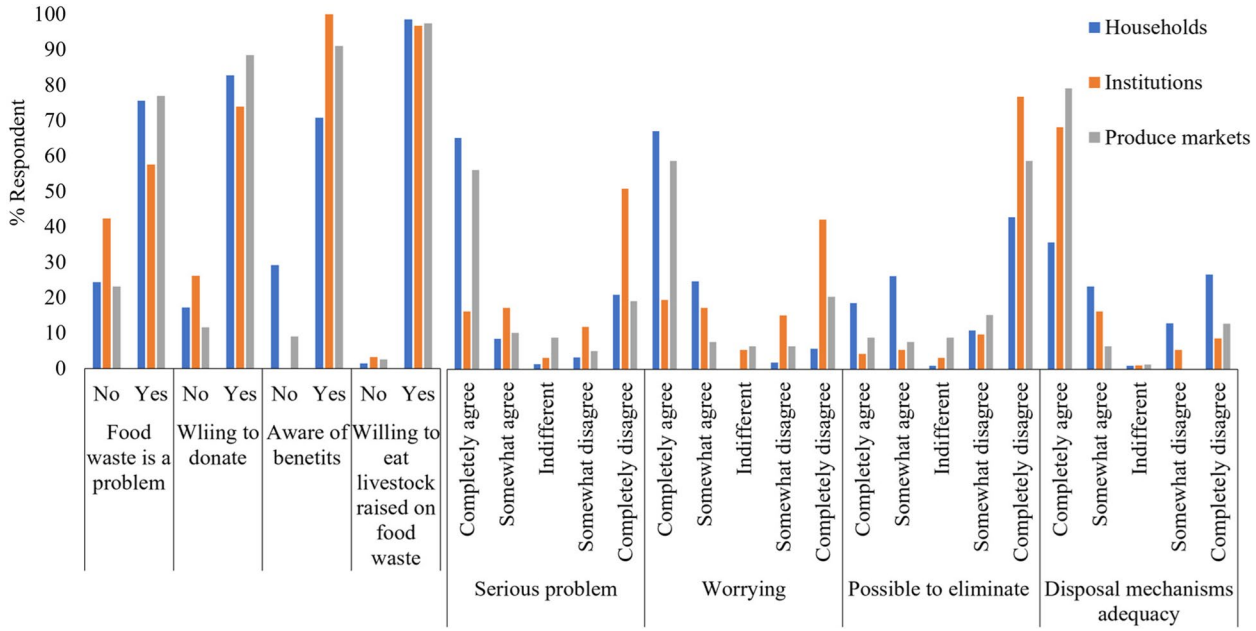

Fig. 3 Attitudes of respondents towards food waste collection, use and disposal

3.7 Effect of demographics on respondents' behaviour towards food waste collection, disposal and use

Logistic regressions were performed to ascertain the effect of demographic characteristics on selected practices towards food waste (Table 4).

The demographic characteristics included age, gender, marital status, education level, years of complete schooling, number of rooms in a household, persons earning an income in the household, and occupation.

Table 4 Predicted probability of occurrence of changes in waste disposal/use behavior due to changes in respondent demographic characteristics

Dependent Variable	Independent Variables	Logit Statistics						
		B	S.E	Wald χ^2	df	Sig ($P=0.05$)	Odds ratio	Model evaluation
Households								
Re-use of food waste	Marital status (Divorced)	-2.33	1.01	5.27	1.00	0.02	0.10	• X^2 (21, $N=209$) = 47.44, $p=0.001$ • Nagelkerke $R^2=27.1$ • Correct cases (%) = 68.40
	Earning an income	-0.59	0.22	7.37	1.00	0.01	0.56	
	Main occupation (Business)	-2.76	1.31	4.41	1.00	0.04	0.06	
	Main occupation (Unemployed)	-3.00	1.37	4.79	1.00	0.03	0.05	
Disposal at a fee	Rooms house	0.29	0.11	7.08	1.00	0.01	1.33	• X^2 (21, $N=209$) = 35.21, $p=0.027$ • Nagelkerke $R^2=20.9$ • Correct cases (%) = 58.90
Food waste is a problem	Education level (None)	5.57	1.75	10.08	1.00	0.00	262.54	X^2 (21, $N=209$) = 75.47, $p=<0.0001$ • Nagelkerke $R^2=45.2$ • Correct cases (%) = 80.90
	Education level (Primary)	2.76	1.06	6.79	1.00	0.01	15.72	
	Education level (Secondary)	2.14	0.90	5.67	1.00	0.02	8.53	
	Number of schooling years	0.23	0.08	8.91	1.00	0.00	1.26	
Willingness to give away Food waste at no charge	Marital status (married)	-1.86	0.91	4.18	1.00	0.04	0.16	• X^2 (21, $N=209$) = 33.67, $p=<0.039$ • Nagelkerke $R^2=45.2$ • Correct cases (%) = 24.80
Thinking that food waste has benefits	Education level (None)	8.86	2.54	12.18	1.00	0.00	7027.67	• X^2 (21, $N=209$) = 137.77, $p=<0.0001$ • Nagelkerke $R^2=68.90$ • Correct cases (%) = 70.80
	Education level (Primary)	6.02	1.66	13.10	1.00	0.00	411.38	
	Education level (Secondary)	4.89	1.51	10.46	1.00	0.00	132.81	
	Marital status (Married)	5.09	1.84	7.67	1.00	0.01	162.98	
	Marital status (Single)	5.63	1.93	8.54	1.00	0.00	278.01	
	Marital status (Divorced)	4.02	1.83	4.80	1.00	0.03	55.45	
	Number of schooling years	0.27	0.10	6.63	1.00	0.01	1.31	
	Main occupation (Unemployed)	3.38	1.45	5.42	1.00	0.02	29.26	
Institutions								
Willingness to give away Food waste at no charge	Existence period (5–10 years)	-4.15	1.72	5.86	1.00	0.02	0.02	• X^2 (14, $N=92$) = 26.45, $p=<0.023$ • Nagelkerke $R^2=36.6$ • Correct cases (%) = 73.90
Disposal at a fee	Education level (None)	11.25	3.23	12.15	1.00	0.00	76,611.71	• X^2 (14, $N=92$) = 30.97, $p=<0.006$ • Nagelkerke $R^2=38.5$ • Correct cases (%) = 77.20
	Education level (Primary)	5.11	1.81	7.97	1.00	0.01	164.82	
	Education level (Secondary)	3.74	1.14	10.78	1.00	0.00	42.20	
	Number of schooling years	0.47	0.16	8.78	1.00	0.00	1.60	
Re-use of food waste	Education level (None)	-5.88	2.71	4.73	1.00	0.03	0.00	• X^2 (14, $N=92$) = 30.97, $p=<0.019$ • Nagelkerke $R^2=25.6$ • Correct cases (%) = 71.7
	Education level (Primary)	-4.43	1.77	6.27	1.00	0.01	0.01	
	Education level (Secondary)	-2.44	0.99	6.06	1.00	0.01	0.09	

B – Estimated Logit Coefficient

S.E. – Standard Error of the Coefficient

Wald χ^{2--} [B/S.E.]^2

Sig. – Level of significance ($P=0.05$)

Results indicate that being divorced among the household respondents and having attained lower levels of education (none – secondary) among the respondents in the institutions has a positive effect on the re-use of food waste. Low literacy levels and divorce (especially among women, the major respondents in this study) in Africa increases vulnerability to poor livelihood [20]. It is possibly because of the increased vulnerability that re-use of food waste becomes an important consideration. Having more rooms in a household, and the number of schooling years and low levels of education (none-secondary) among respondents in the institution were positively related to disposing of food waste at a fee. Respondents with no education had higher odds of paying for food waste (76,611) compared to the educated ones. This is possibly resulting from these respondents producing higher volumes of food waste and their ability/mandatory requirement to pay for food waste collection services. Education level positively affected the attitude towards food waste as a problem that should be solved. The odds of respondent who are un-educated seeing food waste as a problem were higher (262) than those for respondents with primary level education, which were in turn higher than the ones with secondary level of education. This could be because, either the persons with lower levels of education have limited ability to pay for waste collection services, or they live in areas with limited garbage collection services due to limited support infrastructure such as roads and ability to pay for waste collection [38]. It also implies that awareness should be created among the more educated population about problems associated with food waste even when they don't find it a serious problem.

Being married for household respondents and existence for 5–10 years positively influenced respondents willingness to freely give away (donate) food waste. This is possibly because disposing of waste would be an additional chore to the married women that they would like off their activity schedule while institutions could be in a phase of growth where they have accumulated the food waste but have not built the capacity to dispose of it, unlike younger institutions that accumulate low amounts of waste or older institutions that have already built the capacity to dispose of it. Marital status (being married and single), educational level (none-secondary level), number of years of schooling, and occupation (being unemployed) positively affected the attitude that food waste has benefits. However, higher odds of a thinking that food waste is valuable were associated with the non-educated (7027), being single (278) and un-employed (29). This could be associated with higher vulnerability that then enables them to seek for new perspectives/opportunities out of the vulnerability. Such members of the community therefore can be important drivers of food waste value addition.

4 Conclusions and recommendations

Food waste is recognized as a problem and as a resource with benefits across the three major categories of respondents. Households, institutions (hotels, schools and restaurants), and business owners in produce markets were the gatekeepers of food waste, and therefore the drivers for food waste interventions. However, involvement of key decision makers in households, institutions and markets shall be critical for the success of such interventions. Persons with lower levels of education were positively associated with recognizing food waste as a resource, and paying for its disposal, and hence their sensitization and involvement in food waste value addition chains is key. The respondents recognized the use of food waste for alternative uses such as livestock/cricket feed, manure and break tea escorts among others. Women, especially married; single individuals, and divorced persons were willing to consume livestock such as edible insects raised on feed from food waste. Use of products from food waste can create market and stimulate development and actualization of more interventions towards food waste valorization. Although addressing spoilage, poor storage and excess produce in markets can potentially reduce the amounts of food waste generated, the increasing population may not make this intervention a reality, but recycling/adding value to food waste can.

Supplementary Information

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Additional file 1.

Additional file 2.

Additional file 3.

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Authors' contributions

Geoffrey conceived the study. Geoffrey, Elsie and Moses were involved in study design, data collection, analysis, and writing. All authors contributed to the article and approved the submitted version.

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Availability of data and materials

The raw data sets on which the conclusion in this paper are based are available as supporting information.

Declarations

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Statista. Sub-Saharan Africa: Population Growth from 2011 to 2021. New York: Statista; 2023. https://www.statista.com/statistics/805619/population-growth-in-sub-saharan-africa (Accessed 15 Sep 2023).
2. UNFPA. Status Report Adolescents and Young People in Sub-Saharan Africa: Opportunities and Challenges. Johannesburg: United Nations Population Fund. 2012.
3. Word Population Review. Sub-Saharan Africa Population 2023. 2023. https://worldpopulationreview.com/continents/sub--saharan-africa-population (Accessed 15 Sep 2023).
4. Sheahan M, Barrett CB. Review: Food loss and waste in Sub-Saharan Africa. Food Policy. 2017;70:1–12.
5. Sarpong D, Oduro-Kwarteng S, Gyasi SF, Buamah R, Donkor E, Awuah E, et al. Biodegradation by composting of municipal organic solid waste into organic fertilizer using the black soldier fly (Hermetia illucens) (Diptera: Stratiomyidae) larvae. Int J Recycl Org Waste Agric. 2019;8:45–54.
6. EJAtlas. Dandora landfill in Nairobi, Kenya. Nairobi: Environmental Justice Atlas; 2015. https://ejatlas.org/conflict/dandora-landfill-in-nairobi-kenya (Accessed 11 Sep 2023).
7. FAO. Technical Platform on the Measurement and Reduction of Food Loss and Waste. Rome: Food and Agriculture Organization of the United Nations.
8. The European Parliament and The Council Of The European Union. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). 2008.
9. Kennard NJ. Food waste management. In: Leal Filho W, Azul AM, Brandli L, Ozuyar PG, Wall T, editors. Zero Hunger. Cham: Springer; 2020, p. 355–70.
10. Al-Madbouh S, Al-Khatib IA, Al-Sari MI, Salahat JI, Jararaa BYA, Ribbe L. Socioeconomic, agricultural, and individual factors influencing farmers' perceptions and willingness of compost production and use: an evidence from Wadi al-Far'a Watershed-Palestine. Environ Monit Assess. 2019;191:209.
11. Al-Sari MI, Sarhan MAA, Al-Khatib IA. Assessment of compost quality and usage for agricultural use: a case study of Hebron, Palestine. Environ Monit Assess. 2018;190:223.
12. Al-Khatib IA, Anayah FM, Al-Sari MI, Al-Madbouh S, Salahat JI, Jararaa BYA. Assessing physiochemical characteristics of agricultural waste and ready compost at Wadi Al-Far'a Watershed of Palestine. J Environ Public Health. 2023;2023:6147506.
13. Makanjuola O, Arowosola T, Chenyu D. The utilization of food waste: Challenges and opportunities. J Food Chem Nanotechnol. 2020;6:182–8.
14. James OO. Solid waste management in African cities – East Africa. In: Luis Fernando Marmolejo R, editor. Waste Management. Rijeka: IntechOpen; 2012, 3–20.
15. Aryampa S, Maheshwari B, Sabiiti E, Bateganya NL, Bukenya B. Status of waste management in the East African cities: understanding the drivers of waste generation, collection and disposal and their impacts on Kampala city's sustainability. Sustainability. 2019;11:5523.
16. Uakarn C, Chaokromthong K, Sintao N. Sample size estimation using Yamane and Cochran and Krejcie and Morgan and Green formulas and Cohen statistical power analysis by G*power and comparisons. Apheit Int J. 2021;10:76–88.
17. UBOS. National Population and Housing Census 2014 – Main Report. Kampala: Uganda Bureau of Statistics; 2016. https://www.ubos.org/wp-content/uploads/publications/03_20182014_National_Census_Main_Report.pdf (Accessed 12 Sep 2023).
18. Preka R, Berjan S, Capone R, El Bilali H, Allahyari MS, Debs P, et al. Household food wastage in Albania: causes, extent and implications. Future Food J Food Agric Soc. 2020;8:29–48.
19. Udomkun P, Romuli S, Schock S, Mahayothee B, Sartas M, Wossen T, et al. Review of solar dryers for agricultural products in Asia and Africa: An innovation landscape approach. J Environ Manage. 2020;268:110730.
20. Concern. Six benefits of literacy in the fight against poverty. New York: Concern Worldwide US. 2020.
21. Stotsky JG, Kolovich L, Kebhaj S. Sub-Saharan Africa: a survey of gender budgeting efforts. IMF Working Paper. 2016;2016:152.
22. NPA. Scaling up Value Addition in Agriculture Products. Kampala: National Planning Authority; 2013. http://www.npa.go.ug/wp-content/uploads/2018/04/NPA-PEC-PAPER-Scaling-up-Value-Addition-in-Agriculture.pdf (Accessed 15 Sep 2023).
23. FEWS NET. Uganda: Staple Food Market Fundamentals. Washington, DC: Famine Early Warning Systems Network; 2017.
24. Marocco I, Mukiibi E, Nsenga R, Sardo P, Wanyu J. Uganda from Earth to Table. Traditional Products and Dishes. 2nd ed. Mukono: Slow Food Uganda; 2018.
25. FAO. Nutrition Country Profile: The Republic of Uganda 2010. Rome: Food and Agriculture Organization of the United Nations; 2010.
26. Gachuiri C, Lukuyu B. Feed Formulation and Mixing for Small-Scale Feed Producers. ILRI Manual 45. Nairobi: International Livestock Research Institute; 2021.
27. WaterAid. Solid Waste Management Arrangements and its Challenges in Kampala: A case Study of Bwaise II Parish, Kawempe Division, October 2011. Kampala: WaterAid Uganda; 2011.
28. Katusiimeh MW. Public and Private Service Provision of Solid Waste Management in Kampala, Uganda [Ph.D. Dissertation]. Wageningen: Wageningen Univ; 2012.
29. FAO. Toolkit - Reducing the Food Wastage Footprint. Rome: Food and Agriculture Organization of the United Nations; 2013.
30. EC. Farm to Fork Strategy. Brussels: European Commission.
31. USEPA. United States 2030 Food Loss and Waste Reduction Goal. Washington, DC: United States Environmental Protection Agency; 2023.
32. Katongole CB, Sabiiti E, Bareeba F, Ledin I. Utilization of market crop wastes as animal feed in urban and peri-urban livestock production in Uganda. J Sustain Agr. 2011;35:329–42.
33. Salemdeeb R, zu Ermgassen EKHJ, Kim MH, Balmford A, Al-Tabbaa A. Environmental and health impacts of using food waste as animal feed: a comparative analysis of food waste management options. J Clean Prod. 2017;140:871–80.
34. Shurson GC. "What a waste"—Can we improve sustainability of food animal production systems by recycling food waste streams into animal feed in an era of health, climate, and economic crises? Sustainability. 2020;12:7071.
35. FAO. Utilization of Food Loss and Waste as well as Non-Food Parts as Livestock Feed. Rome: Food and Agriculture Organization of the United Nations; 2015.
36. Mugambe RK, Nuwematsiko R, Ssekamatte T, Nkurunziza AG, Wagaba B, Isunju JB, et al. Drivers of solid waste segregation and recycling in Kampala slums, Uganda: a qualitative exploration using the behavior centered design model. Int J Env Res Pub He. 2022;19:10947.
37. Kinobe JR, Bosona T, Gebresenbet G, Niwagaba CB, Vinneras B. Optimization of waste collection and disposal in Kampala city. Habitat Int. 2015;49:126–37.
38. Sauchelli S, Pickles T, Voinescu A, Choi H, Sherlock B, Zhang J, et al. Public attitudes towards the use of novel technologies in their future healthcare: a UK survey. BMC Med Inform Decis. 2023;23:38.

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