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Bread and Bakery Products Waste in Selected Mediterranean Arab Countries

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Abstract Losses and waste of food are high in Arab countries with negative implications in terms of food security and agro-food system sustainability. Cereals are among the most important contributors to caloric energy supply in Arab countries. Despite the fact that Arab countries are net cereal importers they waste considerable amounts of bread. The objective of the paper is to explore the issue of bread and bakery products wastage in selected Mediterranean Arab countries. The paper is based on a literature review as well as an online exploratory survey on household food waste in Mediterranean countries carried out in the period January-May 2015 with 1122 adult consumers in Algeria, Egypt, Lebanon, Morocco and Tunisia. Cereals consumption is high in all concerned countries. Wheat is the most consumed cereal in the region and often as bread. Survey results show that cereals and bakery products, mainly bread, are among the most wasted food groups. Bakery products waste reach up to 20% in some surveyed households. Bread wastage is higher during the fasting month of Ramadan. Subsidized bread is used even as animal or fish feedstuff. Bread waste can be presented as a scandal in the Arab world as bread has a prominent place in Arab culture. Therefore, urgent actions are needed to raise the awareness of Arab consumers about this phenomenon. Cultural background should be exploited in awareness campaigns. Moreover, governments should speed up food support policy reform. In fact, bread waste is also wastage of precious public financial resources.

Keywords: *bread waste, household food waste, subsidies, Arab countries*

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1. Introduction

Food waste has become a global scandal. With nearly one billion people hungry, up to half of food is discarded. That is enough to feed all the world's hungry. Ecosystems are destroyed and greenhouse gas (GHG) emissions are released growing food that is never eaten. But there could be surprisingly remedies for what has become one of the world's most pressing environmental and social problems [1].

Food loss and waste (FLW) are consequences of the way food systems function, technically, culturally and economically [2]. The unsustainability of food systems is the main reason for the existence of food insecurity and malnutrition. For ensuring food security and nutrition all components of food systems should be sustainable, resilient and efficient.

FLW occur in each step of the food chain, from harvesting, transport, storage, packaging, processing, wholesale and retail trade, and where food is consumed [3,4]. FLW occur between the moment when a product is ready to be harvested or harvested and the moment when it is consumed or removed from the food supply chain [5]. FLW vary from one country, commodity and season to another. Losses in the first part of the food chain, which are due to poor harvesting, transport, storage, are more important in developing and low income countries [6,7], while in industrialized, high and middle income countries most food losses occur at the retail and consumer level [4].

A FAO study [4] was the first systematic effort to quantify FLW at global and regional levels. It estimates that around one third of all food produced in the world is lost and/or wasted. The study indicates that up to 68% of FLW occur during production, handling, processing and distribution, and 32% of waste occurs at the consumption stage mostly in urban centres. According to FAO [8], the estimated yearly global FLW by quantity is roughly 30% of cereals. Vanham *et al.* [9] showed that households in EU28 (EU27 and Croatia) waste mostly fresh vegetables and fruits as well as bakery items (cereals product group) such as bread and cakes.

FLW undermine the very foundations of food and nutrition security. They affect all the four components of sustainable food security *i.e.* availability, access, utilization and stability. FLW are seen as an obstacle to achieving food and nutrition security for the millions of undernourished around the world. Its reduction is now presented as essential to improve food security [10,11,12,13]. Even if just one-fourth of the food currently lost or wasted globally could be saved, it would be enough to feed hungry people in the world [14]. FLW reduction is also considered essential to reduce the environmental footprint of food systems [10,11,12,14,15,16]. It amount to major squandering of resources, including water, land, energy, labour and capital [4,14]. FLW inflict a host of impacts, including unnecessary greenhouse gas emissions and inefficiently used water and land, which in turn can lead to diminished natural ecosystems and the services they provide [17].

Economically avoidable food losses have a direct and negative impact on farmer and consumer incomes [4]. FLW represent a wasted investment that can reduce farmers' incomes and increase consumers' expenses [17] as food losses during harvest and in storage translate into lost income for farmers and into higher food prices for consumers [14]. FLW reduction may improve food security due to lower food prices and increased food consumption. Consumers may increase spending from savings on previously wasted food [18].

In the Mediterranean area, food systems are confronted to major sustainability challenges [19]. In fact, food insecurity and malnutrition are still present in some countries of the area. Population is steadily and rapidly increasing in the South as well as food demand all over the region. At the same time, agricultural production in the area has to deal with limited natural resources, principally in the South. Moreover, agriculture is the main water user in a region where water scarcity is the most critical development problem and a main factor limiting agricultural growth [20].

The Mediterranean region is directly concerned with the problem of FLW. The situation is alarming particularly in the southern part of the region since it depends enormously on food imports. The Region as a whole is a net importer of agricultural commodities, animal products and feed [21]. Southern and Eastern Mediterranean region import half of its basic crops. Between 2002 and 2013, imports of agricultural food products have risen by 63% ($69 billion).

FLW in the South and Eastern Mediterranean region are high and contribute to reduced food availability, aggravated water scarcity, adverse environmental impacts and increased food imports in an already highly import dependent region. In view of the region's scarce resource base and low food productivity, high food losses are not only uneconomical, but also ecologically detrimental and possibly even detrimental to food security. In 2013 the region imported wheat for about 29 million tons. It is increasingly dependent on imports for key staples such as grains, sugar and vegetable oil [21].

The Arab world is characterized by a particularly high level of dependence on agricultural imports. The Middle East-North Africa (MENA) region imports 40% of its needs for agricultural products. This high food dependence is due to a combination of demographic growth and changes in dietary habits. Agricultural imports place a significant burden on Arab state budgets especially Mediterranean ones. Although agricultural production in the region has increased, it has been unable to keep pace with the increase in demand, partly because of limitations in terms of cultivable land, water and climate and partly because of limitations in terms of agricultural policy. Trends in production, consumption and trade of food suggest an increasing dependence of the Near East and North Africa (NENA) region on external sources for its basic food supplies. To close this widening import gap, there is a need to address several challenges such as demographic pressures; sustainably managing the water resources; enhancing crops, livestock and fisheries productivity; reducing food losses; and managing food imports [22]. Between the beginning of the 1960s and the end of the 2000s, the Maghreb and the Middle East saw their levels of import dependence increase from 10% to 54% and from 15% to 50%, respectively. Regional dependence on agricultural imports is likely to continue to escalate in the foreseeable future. Because of the composition of human diets and animal feeding requirements, cereals account for one the largest share of regional agricultural import dependence. As a region, the MENA region has become one of the biggest net importers of cereals in the world, with imported tonnages having increased fifteen fold over the period 1960s-2000s. Wheat is the most imported cereal, with net imports having increased from 5 to 44 million tonnes. This happens despite the fact that cereals continue to occupy a central place in regional agricultural production, accounting for between 65% and 70% of total crop output (in terms of kilocalories), with wheat remaining the most important crop [23].

Food security has become a global concern in recent years following the climate change conditions and global food security challenges and consequently food price volatilities. NENA region still relies on food imports and experiences a food deficit. Reducing food loss and waste is crucial for NENA region that face limited possibilities to increase its food production, and that depends on food imports to meet the food needs of its population [24]. Indeed, food loss and waste reduction is the most feasible and quick win approach to increasing food availability and security in contrast to increasing food production.

The paper aims to shed light on bread and bakery products wastage in Mediterranean Arab countries with a particular focus on Algeria, Egypt, Lebanon, Morocco and Tunisia.

2. Material and Methods

The present paper is based on a review of secondary data from different sources as well as the results of an

online exploratory survey on household food waste in Mediterranean countries carried out by the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM-Bari).

The Department of Sustainable Agriculture, Food and Rural Development of CIHEAM-Bari undertook – in collaboration with many research institutions in Mediterranean and Arab countries - an online survey to assess the knowledge and relative importance of FW in Mediterranean countries. The tool used to conduct the food waste exploratory survey was a self-administered questionnaire [25], [26]. It was designed and developed in English, French and Arabic languages in December 2014 and made available from January till the end of May 2015 through the *Survio* website. The questionnaire was adapted to Mediterranean Arab countries' context from previous questionnaires and studies on FW carried out by the Office of Environment and Heritage in 2011 in the State of New South Wales (NSW), Australia [27], and by the University of Bologna [28].

The questionnaire consisted of 26 questions. It included a combination of one option and multiple choice questions. It was developed into 6 sections: Food purchase behaviour and household food expenditure estimation; knowledge of food labelling information; attitudes towards food waste; extent of household food waste; economic value of household food waste; and willingness and information needs to reduce food waste. In the introductory part of the questionnaire the concept of FLW was introduced to inform the respondents. The first section of the survey dealt also with respondents' demographics.

Using a five-point Likert scale from "*much more than you should*" to "*none*", respondents were asked how much uneaten food was thrown away in their household as well as about attitude towards and final use of food waste (e.g. garbage bins, feed to animals, people in need, compost production). The respondents were asked to estimate the amount of edible food they dispose of in their households per week ranging from throwing away nothing up to more than 2 kg at highest (the specified categories were: nothing, less than 250 gr, 250-500, 500-1000, 1000-2000, and more than 2000 gr per household/week). They were also asked to estimate quantity of purchased food that is thrown away (less than 2%, 3 to 5%, 6 to 10%, 11 to 20%, over 20%) regarding the following food categories: cereals and bakery products, roots and tubers, pulses and oil seeds, fruits, vegetables, meat and meat products, fish and seafood, and milk and dairy products. Another question regarded whether, according to respondents, bread and bakery products waste is higher during the fasting month of Ramadan with respect to the other periods of the year. Last, but not least, question dealt with economic value of household food waste.

Various institutional communication channels were used to disseminate the survey questionnaire in the studied countries as follows:

- Algeria: Institutional websites (e.g. www.inpv.edu.dz, www.univ-chlef.dz, www.conso-algerie.net), Facebook, personal e-mails.
- Egypt: Facebook, mailing lists (e.g. Agricultural Research Centre).
- Morocco: Institutional websites (e.g. National School of Agriculture of Meknes), professional forums (https://fr.groups.yahoo.com/neo/groups/tech_agro/info), Facebook groups (e.g. https://www.facebook.com/groups/aniphop) and mailing lists.
- Lebanon: University and school mailing lists [American University of Beirut (AUB), *Université Saint Joseph* (USJ), *Université Saint Esprit Kaslik*, *Notre Dame Université* (NDU), Balamand, Lebanese University (LU) and American University of Technology], social media (Facebook and WhatsApp group application), private companies networks (*e.g.* Khatib & Alami - Engineering Company), and non-governmental organizations (*e.g.* Lebanese Reforestation Initiative, LRI).
- Tunisia: Institutional websites (e.g. http://www.inrat.agrinet.tn), social media (e.g. Facebook) and emails.

Data were analysed using descriptive statistics (e.g. means, max, min), in order to get a general picture of frequencies of variables, using Microsoft Excel.

Total number of received completed questionnaires was 1122: 323 from Algeria, 181 from Egypt, 215 from Lebanon, 122 from Morocco, and 281 from Tunisia (Table 1). The majority of the respondents were female (61.8%); they were quite young since 63.3% was aged between 18 and 34. About 45% of the respondents were living with parents while just 4.5% was single person household. The respondents presented high level of education with 85.7% having university and PhD degrees. Regarding the household composition, 58.6% of the respondents had 4 to 6 members in the family. Meanwhile the majority of them (62%) were employees (part-time or full-time paid work).

In Algeria, the questionnaire was completed by 323 persons. Respondents were from 43 different cities covering the whole country. More than half (54%) of respondents were females. As for age group, participants in the survey aged from 25 to 24 years accounted for 54% of all interviewed individuals. About two thirds of respondents (67%) had a high education level (masters, doctorates), 25% had graduate university diplomas. Among all interviewed persons, 46% were employed (full time or part time) and 36% were students. The majority of respondents (66%) live with their parents.

As for Egypt, from 207 questionnaires received, 26 were not considered because there were missing data. Therefore, the total number of the sample was 181 adult Egyptians. About two thirds (64.6%) of the respondents were females. Most of the respondents (33.1%) fell within the age category of 35-44 years and 23.8% between 45 and 54. About 44.2% were MSc/PhD holders, and 34.8% hold university degree, 17.1% technical degree. Additionally, 81.8% had paid work (full time or part time). Half of the respondents (53.6%) were married with children. As for household composition, households with 4-6 members represented about 69.1% of the total sample.

In the case of Morocco, out of 129 questionnaires received, 7 were not considered because there were missing data so the total number of the sample was 122. The sample was almost gender-balanced (52% female and 48% male), rather young (80% were less than 44 years old) and most of the respondents (more than 69%) had high education level. More than half of the respondents were married with children (55.7%). As for household composition, half of the respondents lived in households with up to 3 members, while the rest of the sample lived with 4 to 6 members.

As for Lebanon, from 229 questionnaires received, 14 were not considered because of missing data. Therefore, the total number of the sample was 215. The majority of the respondents were female (66.5%); they were quite young since 63.7% was aged between 18 and 34 years old. More than a half of the respondents (55.3%) were living with parents. The respondents presented high level of education with 85.5% having university and PhD degrees. Regarding the household composition, 63.7% of the respondents had 4 to 6 members in the family. About 73% were workers (part-time or full-time paid work).

In the case of Tunisia, from 289 questionnaires received, 8 were not considered so the total number of the sample was 281. The majority of the respondents were female (71.2%); they were quite young since 70.8% were 18-34 years old. About 44% of the respondents were living with parents. The respondents presented high level of education with 95.4% having university and PhD degrees. About a half of the respondents (50.9%) were employees of the government or related organizations and 39.1% were students.

Table 1. Respondents' profile

Items		**Algeria** (n=323)	**Egypt** (n=181)	**Lebanon** (n=215)	**Morocco** (n=122)	**Tunisia** (n=281)
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)
Gender	Male	148 (45.8)	64 (35.4)	72 (33.5)	64 (52.5)	81 (28.8)
	Female	175 (54.2)	117 (64.6)	143 (66.5)	58 (47.5)	200 (71.2)
Age	18-24	79 (24.4)	6 (3.3)	56 (26.1)	20 (16.4	88 (31.3)
	25-34	176 (54.5)	41 (22.7)	81 (37.7)	52 (42.6)	111 (39.5)
	35-44	45 (13.9)	60 (33.1)	43 (20.0)	25 (20.5)	52 (18.5)
	45-54	14 (4.3)	43 (23.8)	21 (9.8)	14 (11.5)	14 (5.0)
	55 and over	9 (2.8)	31 (17.1)	14 (6.5)	11 (9.0)	16 (5.7)
Family status	Single person household	14 (4.3)	3 (1.7)	13 (6.1)	13 (10.7)	8 (2.8)
	Living with parents	213 (65.9)	29 (16.0)	119 (55.7)	23 (18.9)	123 (43.8)
	Partnered	18 (5.6)	34 (18.8)	6 (2.8)	13 (10.7)	21 (7.5)
	Married with children	66 (20.4)	97 (53.6)	39 (18.1)	68 (55.7)	93 (33.1)
	Shared household, non-related	7 (2.2)	7 (3.9)	5 (2.3)	2 (1.6)	32 (11.4)
	Other	5 (1.5)	11 (6.1)	33 (15.4)	3 (2.5)	4 (1.4)
Level of education	Primary school	4 (1.2)	3 (1.7)	6 (2.8)	0 (0)	1 (0.4)
	Secondary school	5 (1.5)	1 (0.6)	17 (7.9)	3 (2.5)	2 (0.7)
	Technical qualification	7 (2.2)	3 (1.7)	8 (3.7)	5 (4.1)	9 (3.2)
	University degree	83 (25.7)	31 (17.1)	122 (56.7)	30 (24.6)	136 (48.4)
	Higher degree (MSc, PhD)	218 (67.5)	63 (34.8)	62 (28.8)	84 (68.9)	132 (47.0)
	No formal schooling	6 (1.8)	80 (44.2)	0 (0)	0 (0)	1 (0.4)
Household composition (number of members)	1 to 3	54 (16.7)	44 (24.3)	69 (32.1)	51 (41.8)	91 (32.3)
	4 to 6	173 (53.6)	125 (69.1)	137 (63.7)	62 (50.8)	161 (57.4)
	7 to 10	85 (26.3)	0 (0)	9 (4.2)	9 (7.4)	29 (10.3)
	> 10	11 (3.4)	12 (6.6)	0 (0)	0 (0)	0 (0)
Occupation	In paid work (full time or part time)	151 (46.7)	148 (81.8)	156 (72.6)	91 (74.6)	143 (50.9)
	Student	118 (36.5)	3 (1.7)	41 (19.1)	20 (16.4)	110 (39.1)
	Unemployed and looking for work	43 (13.3)	7 (3.9)	3 (1.4)	3 (2.5)	23 (8.2)
	Home duties	7 (2.2)	11 (6.1)	12 (5.6)	3 (2.5)	2 (0.7)
	Retired/ Age pensioner	4 (1.2)	12 (6.6)	3 (1.4)	5 (4.1)	3 (1.1)

Source: Authors' survey.

3. Results and Discussion

3.1. Food Loss and Waste in Mediterranean Arab Countries

Accurate estimations of the magnitude of FLW in Mediterranean Arab countries are lacking. Nevertheless, there is no doubt that it remains unacceptably high. Per capita FLW is about 215 kg/year in North Africa, West & Central Asia (NAWCA) [4]. Such levels of FLW are unexpected in a region that is so dependent on the international markets to meet its food needs. Quantitative FLW in NENA are estimated to be 14 to 19% of grains, 26% of roots and tubers, 16% of oilseeds and pulses, 45% of fruits and vegetables, 13% of meats, 28% of fish and sea foods, and 18% of dairy products. For fruits and vegetables, which have the highest proportion of losses and waste, country-specific data indicates a substantial part of these losses occur at the post-harvest stage [29]. The percentages of FLW of the edible parts of seven food commodity groups in Arab countries are shown in Table 2.

Table 2. Weight percentages of FLW (in percentage of what enters each step of the food supply chain) in Arab countries (NAWCA region) and Turkey

Commodity groups	Steps of the food supply chain				
	Agricultural production (%)	Postharvest handling and storage (%)	Processing and packaging (%)	Distribution: Supermarket retail (%)	Consumption (%)
Cereals	6	8	2.7	4	12
Roots & tubers	6	10	12	4	6
Oilseeds & pulses	15	6	8	2	2
Fruits & vegetables	17	10	20	15	12
Meat	6.6	0.2	5	5	8
Fish & seafood	6.6	5	9	10	4
Milk	3.5	6	2	8	2

Source: Adapted from Gustavsson et al. [4]

Losses and waste severely affect the availability of food in the Near East region. It is estimated that 10-15% of non-perishables (e.g. grains) and up to 60% of perishables are lost during the whole production chain in the Near East region. In addition, post-cooking losses are also significant. The very significant post-harvest losses are due to many reasons such as extreme environmental conditions, inadequate storage, transport and packaging infrastructure, etc. [30].

In Egypt annual losses of wheat (both locally produced and imported) are valued at 6.6 billion Egyptian Pounds (over $1 billion), while the value of maize losses is estimated to be 1.5 billion Egyptian Pounds. If wheat and maize losses are reduced by half, this would lead to savings of some 4.0 billion Egyptian Pounds annually. An estimate of average total food waste ranged from 3 to 19% across supermarkets; while the amount of loss directly associated with handling damage was approximately 2%. Egypt loses 13-15% of the available cereals between harvesting and final consumption [8]. Losses of horticultural products in Egypt are presented in Table 3. FAO alerted about increased rate of food losses and waste in Egypt which reaches about 50% in vegetables and fruits, 40% in fish, 30% in milk and the amount of wheat losses and waste reaches 1.5 million tons/per annum. Additionally, wheat, tomato and orange losses and waste cost the government about 11 million EGP/annually, and about 650,000 tons of maize besides 350,000 tons of beet are wasted annually [31].

According to FAO [8], causes of FLW in NENA region are: lack of appropriate policy and regulatory framework; institutional weaknesses; and inadequate and weak infrastructural base. The region suffers from very low cold chain capacity. Poor maintenance and management practices are another major factor concerning the infrastructure in the region. Wholesale and retail markets in the region are often small, overcrowded, unsanitary and lacking cooling equipment, and adequate facilities for loading, unloading, ripening, consumer packaging and temporary storage.

Table 3. Horticultural products losses in Egypt

Commodity	Estimated mean losses (%)
Fresh fruit	19
Fresh vegetables	29
Oranges	14
Tomatoes	15

Source: [8].

3.2. Household Cereals and Bakery Products Waste in Target Arab Countries: Survey Results

Results of the survey show that household food waste is widespread in all countries. Only few respondents declare that they do not waste any food (Table 4).

Table 4. Level of household food waste (% of respondents)

	Much more than it should	More than it should	A reasonable amount	Very little	Almost nothing
Algeria (n=323)	4.6	6.5	29.4	47.4	12.1
Egypt (n=181)	1.1	2.8	29.3	53.0	13.8
Lebanon (n=215)	0.5	5.1	30.6	48.6	15.3
Morocco (n=122)	6.6	13.1	25.4	51.6	3.3
Tunisia (n=281)	3.9	9.6	31.7	48.8	6.0

Source: Authors' survey.

The survey provided some interesting information about the amounts of uneaten food wasted. The quantity of thrown food per week depends on different factors including household composition. In Algeria, 47% of respondents declare that they are wasting a very small amount of food, and 29% say they waste a reasonable amount, but 4% admit they are throwing away much more than they should. Unfortunately, only 1% of respondents said that they waste no food in their homes. About 21% of surveyed people say they throw less than 250 gr per week, while 13% throws between 250 gr and 500 gr. Those that throw away larger quantities are a minority, for example only 2% of respondents throw 2kg per week.

In Egypt, about 53% of respondents indicated that they dispose "very little" amount of uneaten food, as they try to minimize household food waste since they are worried and aware about food waste impacts, and about 29.3% throw reasonable amount of uneaten food. As for the extent of food waste, about 17.7% throw less than 250 gr while16.6% throw between 250 and 500 gr.

In Lebanon, the amount of uneaten food thrown out by respondents' households was not perceived to be particularly excessive; 49% indicated they throw out "very little" and 30% indicated they threw out "*a reasonable amount*". Only 5% of respondents indicated they throw out "*more food than they should*". Additionally, 15% reported that they do not throw out food at all. Regarding the quantity of food thrown away, around 18.6% throw less than 250 gr of food in a week and 23 % throw more than 250 gr per week.

In Morocco, 50% of the respondents estimated that a very small amount of food is wasted in their households in comparison with 20% of them who consider that they waste much more than it should not. A quarter of them assume that the food waste quantity at the household is reasonable. Only 3% of them considered that no food is wasted in their household. About 39% of respondents affirm that their households throw away at least 250gr of still consumable food each week. It is worth highlighting that according to the survey results, 55% of respondents waste food even if the quantity wasted is generally small.

As for Tunisia, the survey revealed that the generation of food waste per capita per week is higher than 250gr for 37.1% of respondents and less than 250gr for 23.5% of respondents. More than 39% percent of the respondents stated that they do not throw away any edible food, whereas only 1.8% household conceded that they dispose of more than 2 kg. It should be highlighted that the food waste generated by the respondents out of home in hotels, restaurants, canteens, take away, coffee shops, etc. was not subject of the survey. The average value of food waste is 606 gr per person/week. A simple extrapolation of these figures to the entire population of the country results in 292,000 tons of food wasted per year in Tunisia. Food waste amount changes from a *period of the year* to another. Attitudes may change according to periods especially in Ramadan. Most of respondents declared that FW is higher during this fasting month in all targeted Mediterranean Arab countries (i.e. Algeria, Egypt, Lebanon, Morocco and Tunisia), due to the high quantity of food purchased and prepared but never eaten.

A high share of Algerian respondents (88 %) admit that food waste significantly increases; food waste during Ramadan reaches its peak, even though many weeks before the holy month the government and different NGOs launch several campaigns to fight against this negative phenomenon. The National Union of Algerian Traders and Artisans (UGCAA) gave alarming details such that out of 4.1 billion of bread sticks bought during Ramadan, 120 million go in the trash; 12 million of the 150 million litres of milk purchased during the holy month are discarded; Algerians throw 500,000 quintals of vegetables over 10 million quintals purchased during the fasting period. The absence of an appropriate consumption culture is behind the 20% increase of the purchase of highly consumed products during Ramadan. According to UGCAA the cost of food waste is expected to exceed 5 billion dinars (about 50 million Euros) during the month of Ramadan of 2015. The Algerian Ministry of Commerce addresses this problem at Ramadan eve, through a formal ad broadcast by the media to the public.

In Egypt, respondents indicated that food waste increase in the Holy Month of Ramadan as mentioned by 75.7% of the respondents. It is evident that Egyptians' food purchases during Ramadan soar beyond all other monthly consumer averages, straining the efforts of ministers concerned with supply and domestic trade to keep up with demand. According to a recent study carried out by the National Centre for Social and Criminal Research (NCSCR), at least 60% of food on an average Egyptian family, and more than 75% of food in a banquet, goes to waste, which is to say tossed into the rubbish bin, during this month.

In Morocco, according to 87 % of respondents FW increases during the fasting month of Ramadan. This is due to increased difficulty of planning meals during this month. In fact, many households in Morocco use to cook more than what they can eat for fast breaking. Therefore, this highlights the importance of organizing awareness raising campaigns before and during the month of Ramadan in order to reduce FW.

In the Islamic culture food is a bestowed, proliferating gift (i.e. Baraka) from Allah Almighty, and misuse or overuse of it is not accepted morally. Moreover, the period of Ramadan stands for Muslims for abstinence and sobriety. Yet there is a paradoxical phenomenon: the holy month is also the time when food wastage highs up to folds compared to the rest of the year. Households tend to borrow too much during the holy month to buy agro-food products they, often, do not need and cannot consume.

The uneaten food is managed in different ways by respondents' households. Sometimes, the same household uses different uneaten food management strategies. In Algeria, 46% confirmed that they end up in the trash, while 47 % said that the remaining food is given to animals, 13% donate it to the needy people, and 6% transform it into compost. Meanwhile 41.4% of the Egyptian respondents give the remained food to animals, but this happens in rural areas, as well as some urban districts were people raise mainly poultry. About 35% said they dispose it in the garbage. In Lebanon, a high percentage of participants discard uneaten food in garbage bins (50%), whereas around 30% of respondents feed uneaten food to animals. About 15% of participants donate uneaten food for people in need, and 5% use uneaten food for compost production. In Morocco, the survey showed that, unfortunately, 69% of respondents throw the uneaten food in the trash. However, an important part of respondents (24%) manage uneaten food in good way by giving it as donation. Meanwhile, some respondents use uneaten food to feed animals (24%) or to produce compost (2.5%). While, these two last uneaten food management strategies are clearly better than throwing it in the trash, they do not represent anyway good strategies for FW reduction as also food fed to animals or used to produce compost is to be considered as wasted food.

The extent of FW varies from a food group to another. The most wasted product groups are cereals and bakery products, fruits and vegetables (Table 5). In general, perishable products are the most wasted food. In Algeria, cereals and bakery products are the most wasted products. Actually 20% of cereals and derivatives are thrown, followed by vegetables and dairy products. In Egypt, the survey results showed that 16.5% of the respondents waste more than 6% of purchased cereals and bakery products. As for cereals and bakery products, 18% of Lebanese

respondents throw away more than 6% of the purchased quantity of these foodstuffs.

In Morocco, the survey showed that the most wasted food group in the Moroccan context is cereals and the bakery products, followed by fruits, vegetables. The high percentage of cereal and bakery products that is wasted is a big environmental and economic problem considering the high amount of these products, especially bread, are consumed by Moroccans. This is also a political issue in Morocco, as bread is subsidized in the kingdom, so bread waste is considered also as a waste of public budget and, consequently tax payers' money. It is interesting to notice that, not only *perishability*, but also price is an important factor in determining the extent FW. In fact, meat and meat products, and fish and sea food that are also perishable products, but quite expensive, are among the least wasted foods.

In all Tunisian locations the highest percentage (more than 30%) of foods that are thrown away sometimes or often relates to fruit, vegetables, cereals, legumes/seeds, milk, bread, fish and roots and tubercles. Survey data revealed that cereal and bakery products such as bread, rice and pasta followed by vegetables, milk and milk products are the largest contributors to food waste. As for bread, 81.5% of the Tunisian respondents declare that they throw bread when they do not finish eating it.

Table 5. Estimated quantity (in %) of purchased food thrown away in Mediterranean Arab countries (n=1122)

Food categories	Less than 2%	3 to 5%	6 to 10%	11 to 20%	Over 20%
Cereals and bakery products	46.4	17.2	12.4	9.5	14.4
Roots and tubers	66.4	19.4	7.0	3.5	3.7
Pulses and oil seeds	77.3	12.8	5.2	2.9	1.8
Fruits	66.7	17.9	8.6	4.0	2.9
Vegetables	53.2	26.4	11.2	4.2	5.0
Meat and meat products	81.8	8.6	5.5	2.6	1.4
Fish and seafood	85.5	8.9	3.1	1.6	0.9
Milk and dairy products	65.4	18.4	8.1	4.5	3.6

Source: Authors' survey.

The economic value of food waste generated each month is more than 6US$ mainly in Lebanon (Table 6). Economic value of household wasted food depends not only on wasted amount (so also on household composition), and the composition of FW, but also on household food habits and consumption patterns. The survey found that only 52% of Algerian respondents are wasting less than 5 US$ per month in terms of food, while 40% waste between 6 and 20 US$ monthly, those whose economic value of food wasted in their home exceeds 51 US$ are only 2.2%. In Egypt, it was revealed that for about 78.5% of the respondents the economic value of wasted food is less than 35 EGP (less than 5$), while for 14.9% of the respondents economic value of wasted food is between 42 and 140 EGP (6 - 20$). Meanwhile 54% of the Lebanese respondents mentioned that it is between 6 and 20 US$. About 20% said that the value is less than 5 US$ while 7% declared to throw food at a value higher than 51 US$ per month. In Morocco, the value of household FW generated each month is more than 60 Moroccan Dirhams (10 MAD = 1US$) for 54% of respondents' households. The weighted average economic value of the monthly FW generated by each responding Moroccan household is about 100 MAD. This value represents around 13% of the weighted food budget for the considered sample. In Tunisia, while the economic value of food wasted is less than 5 US$ per month for more than a half of respondents, it is more than 21 US$ for 6.4% of the sample.

Table 6. Value of food waste generated per month (in percentage of respondents)

Items	Less than 5 US$	6-20 US$	21-50 US$	More than 51 US$
Algeria (n=323)	52.0	40.2	5.6	2.2
Egypt (n=181)	78.5	14.9	5.5	1.1
Lebanon (n=215)	19.9	54.2	19.0	6.9
Morocco (n=122)	45.9	42.6	10.7	0.8
Tunisia (n=281)	57.3	36.3	5.3	1.1

Source: Authors' survey.

3.3. Some Initiatives for Reducing Food Waste: Focus on Bread Waste

The reports of the Arab Forum for Environment and Development (AFED) have repeatedly emphasized the importance of promoting better efficiency and fair access to food while reducing waste, as there are limits to what ecosystems can provide [32]. For achieving sustainable food consumption in the Arab world, policymakers should reduce or eliminate perverse agricultural subsidies that encourage unsustainable food production or that adversely affect food security; apply tax incentives that make foods with negative nutritional impacts or adverse environmental effects relatively more expensive; launch public awareness campaigns on sustainable food consumption; regulate marketing and advertising for unhealthy and unsustainably produced foods; invest in agricultural technologies and infrastructure to reduce food losses and waste; and support public procurement reforms in favour of more sustainable food consumption patterns [33].

Strategies to improve food security in NENA region have traditionally focused on increasing food production while putting relatively much less emphasis on measures to reduce FLW. If implemented in an appropriate way, measures to reduce FLW offer the opportunity to increase food security while at the same time reducing further stress on scarce natural resources such as land and water [8]. The challenge of addressing food waste needs to take into consideration the whole supply chain from food production, through to food processing and retail. Understanding and preventing FLW requires a deep understanding of regional, domestic and local food systems [34,35]. For that, research is needed regarding the theme of FLW.

As the causes of FLW are not the same in all countries also potential solutions to food waste and loss reduction are quite different across countries and even across different socio-economic groups in the same country. HLPE [2] distinguished three levels of FLW causes: micro-, meso- and macro-levels. Integrating FLW concerns in policies can take two ways, which are complementary: (i) integrate FLW concerns in all policies which can have an impact on them; (ii) devise a specific FLW reduction policy to address the interdependencies of actions that end up creating FLW. Often the efficiency of FLW reduction depends on broader interventions involving private actors all along the food chain and/or public actors [2]. Reduction of FLW implies also new supply chains governance and organisation [36]. Several studies (*e.g.* [37]) have detailed measures that consumers could implement to reduce their own food waste. These include:

- Better planning of purchases to avoid buying more than is needed.
- Avoid impulsive or advance purchasing of food that is not required immediately.
- Better understanding of the distinction between "best before" and "use by" label dates.
- Better storage practices and stock management in the home.
- Better evaluation of the portions that need to be prepared.
- Better knowledge on how to use the leftovers on other recipes instead of discarding them.

Reducing FLW is a multi-sectorial, multi-disciplinary and multi-factorial task. It requires networking and coordination between public institutions and private sector agencies in agro-industries, food quality and safety, NGOs, etc. Policies and regulations are key drivers for all actions aiming at reducing FLW but along with an effective participation and collaboration of all previous actors [29]. According to the Expert Consultation meeting on FLW reduction in the Near East Region held in Egypt in 2012 [8], lack of appropriate policy and regulatory framework and institutional weaknesses are the two main points to focus on in order to reduce FLW.

Mediterranean Arab countries have now begun to address institutional priorities and to act consequently to encourage FLW reduction at different levels. FAO is implementing a Regional Program in Egypt, Lebanon and Jordan aiming at building capacities for food loss reduction in the Near East region (2014-2016). The regional program envisages also institutional and legislative aspects. On 24-28 February 2014, the 32nd Session of FAO Regional Conference for the Near East on Reducing Food Losses and Waste in the Near East & North Africa Region took place in Rome. The conference endorsed the "*Strategic framework for the reduction of Food Losses and Waste in the Near East and North Africa*" whose objective is reducing the FLW in the NENA region by 50% during the next 10 years.

In Morocco, some recent initiatives have been promoted by some public institutions to address this important issue in the kingdom. For instance, on June 11th 2015, the Moroccan Ministry of Agriculture and Fisheries in partnership with FAO launched a strategic project in order "*to develop a national strategy and an action plan to reduce FLW in Morocco*". The main activity consists on a study on FLW in the country for a selected key food supply chains. The study aims to develop a vision and strategic directions that will conduct into an action plan to reduce FLW by 50 % by 2024 [38].

The actions of the National Union of Algerian Traders and Artisans, the national consumer protection association, its local representations, ministries of agriculture, trade, health and all government and nongovernmental organizations related to the topic of food waste are limited to raising the awareness of consumers, producers and traders on the quality of food products on the market (storage, expiry date, packaging). Even these campaigns are launched at the beginning of each summer, because of the heat that characterizes the country during this season and which causes the loss of big quantities of food due to inappropriate cold chain management.

Though subsidies are generally considered a crucial element of the social safety nets, AFED found that indiscriminate subsidies of water, energy and food in the Arab region promote wasteful consumption, and do not necessarily ease the burden on the poor – over 90% of the subsidies go to the rich [39]. A large part of food subsidies is diverted away from their intended use [40]. A study by the World Bank [41] showed that for food subsidies in rural Upper Egypt, the richest quintile received about 48% more in per capita benefits than the poorest group. There is tremendous waste along the supply chain of subsidized food. For instance, subsidized bread is used as animal or fish feed. It is estimated that 28% of food subsidies in Egypt never reach their intended target [40]. On search for reversing these trends, different Arab countries have a variety of price reforms experiences [32].

In Algeria the main foodstuffs such as cereals, milk, cooking oil, sugar, etc. are subsidized by the state, therefore available on the market at low prices. These prices accessible by almost all of the Algerians make waste of bread, milk and all products prepared with these subsidized foods a marginal issue.

Egypt has two main sub-systems for food subsidy, first wheat flour and bread subsidy, second ration card program which provides fixed monthly quota of some commodities. This subsidy system suffers from increasing budget and waste, as waste occurs at different stages of bread supply chain starting from pre-post wheat harvest, storage, transportation, conversion of wheat to flour until consumption. The government of Egypt started implementing several reforms and strategies, for both food and fuel subsidies, in order to improve the subsidy system efficiency and reduce losses and budget deficit. The ration card system was replaced by a smart card system [42]. In

fact, last April 2015 the Egyptian Government was phasing in a smartcard system that aims to modernise the country's long-established tradition of bread subsidies. Around 70 million of Egypt's 90 million people are eligible for the smartcard system, which permits five loaves of bread per family member per day. Such reform would enable the government to reduce wastage and leakage [41]. Bread demand, meanwhile, has reportedly dropped by between 15%–20% as consumers rationalise their consumption. Jordan is among other regional governments interested in adopting a similar approach.

Few Egyptian NGOs initiated their own programs that care about food waste i.e. *Egyptian Food Bank* (EFB) provides some schemes to feed poor people and at the same time urged hotels and restaurants to re-use all food waste (leftovers) and re-pack it in order to be distributed to those who suffer from food insecurity. EFP signed a protocol with the Egyptian Hotel Association in order to save the excess untouched food from hotel events' buffets and restaurants by packing it in foil trays to be distributed to the nearest NGO, elderly residence or orphanage in the area instead of throwing it away. EFP also raises awareness by directing campaigns to individuals at their homes, to distribute the excess untouched food to the nearest needy [43].

In Lebanon, due to lack of governmental commitment to household food waste management, local institutions and non-governmental organizations have developed specific actions. *Food Establishments Recycling Nutrients* (FERN), *Food Blessed* and *Lebanese Food Bank* [44] are among local organizations dealing with food loss and waste.

Sustainable food consumption can be achieved by considering sustainable production and consumption simultaneously, and adopting public policies (agricultural subsidies, tax incentives, awareness campaigns, marketing regulations, investment in agricultural technologies and infrastructure, and public procurement) that discourage food losses and waste and that support sustainable food consumption. This should be accompanied by revisiting the region's food-based dietary guidelines to promote sustainable diets in Arab countries, thus making sustainable food choices the easy choice [33].

4. Conclusions

Food losses and waste have a direct and indirect incidence on both food security and food systems sustainability. Therefore, it is clear that the reduction of food losses and food waste is necessary to bring about the multifaceted long-term benefits that the region needs in order to ensure its sustainable development. Reduced FLW generation can ease pressure on natural resources and free up water resources and land for other development purposes, societal needs and economic sectors. Food waste exacerbates the inefficiency of the food chain in the region.

Cereals and bakery products are among the most wasted foods in all targeted Mediterranean Arab countries. This fact is alarming taking into consideration that these are the most consumed products in the region. In order to reduce household FW, effort should be directed towards changing consumer behaviours and habits especially household management practices, by providing consumers with knowledge and information to deal with their food-related actions, while fully considering economic and environmental impacts of FW.

Addressing this multifaceted problem requires a comprehensive regional research agenda supported by integrated and multi-sectoral policy interventions and instruments. Research and policy activities must be well coordinated if sustainable results are to be achieved. The improvement of the management and governance of the whole food system, through the introduction of appropriate technical and soft (organisational/social) innovations, is crucial for reducing food waste. To address and reduce food loss and waste, a strategic approach is required that emphasizes coordination between all relevant actors, including public institutions and private sector agencies, food producers and handlers, consumers, and civil society institutions, through responsible and sustainable policies and effective compliance mechanisms. It is also of paramount importance to alert consumers of the environmental implications of their food-related behaviour (*e.g.* diets, overeating, and wasting food). It is also important to rethink food subsidies in the region to discourage all forms of wasteful consumption.

The recent initiatives carried out by public institutions and the civil society are a step in the right direction, but it is not sufficient. There is high need for more initiatives (targeting not only FW reduction, but also FW prevention) especially awareness raising campaigns. For that a multi-stakeholder approach and active involvement of all key actors of the food chain is highly recommended in the future. This should be put high on the agenda of the regional governments taking into consideration the environment and economic implication of FLW.

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