



FOOD LOSS AND WASTE IN PALESTINE

A PILOT STUDY
OF THE FAO METHODOLOGY



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**FOOD LOSS AND WASTE
IN PALESTINE:
A PILOT STUDY OF THE
FAO METHODOLOGY**

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The field work was implemented
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Photo credit - cover page

Simona Bencivenni,
Tulkarem, 2017

Executive summary

Food loss and waste (FLW) refers to the quantity spoiled and/or left unused along the supply chains and in households. FAO developed a methodology to quantify FLW in small-scale farmers and local supply chains in developing countries. It has never been applied to Palestine, and very limited data are available.

In May-June 2017 Politecnico di Milano, in partnership with Cesvi and with FAO support, tested the application of the FAO methodology to Palestine and identified recommendations for a larger-scale study. Data at the West Bank level were collected from various stakeholders (Screening), while a pilot study took place in Tulkarem (Survey and Sampling). The analysis focused on the post-harvest handling and storage, and distribution stages of tomatoes and cucumbers.

A *FLW rate* of 11% at both these stages – resulting in an overall compound rate of 21% *from harvest to retail* – was estimated for both the products. It means that 5,610 and 2,915 tons of cucumber and tomatoes produced in the Tulkarem Governorate, respectively, are wasted every year. Therefore FLW per capita per year is estimated to about 13.4 and 8.3 kg, respectively. These rates are in line with those in North Africa, West and Central Asia. However, the uncertainty is high due to little data available and seasonality. A FLW range of 7-15% is likely for both the products at post-harvest and storage, while seasonal peaks of 25% and 30% are possible at the retailer level for tomatoes and cucumbers, respectively. *No relevant activities of processing and packaging* were identified, while *FLW in agricultural production and consumption was not assessed*.

The study identified the following main challenges:

- **Post-harvest handling and storage** (farmers): 1) presence of *pest and diseases* causing direct spoilage; 2) *lack of knowledge on post-harvest treatments* with bad operational practices, resulting in food spoilage and quality deterioration; 3) *lack of cold storage*, resulting in large quantity of FLW, especially during summer; and 4) *lack of proper and up-to-date irrigation system*, often resulting in over-irrigation and affecting the shelf life of products.
- **Distribution** (traders, wholesalers and retailers): 1) *lack of cold transportation and storage*, resulting in large quantity of food spoilage and quality reduction; and 2) *lack of proper marketing system and by-contract agreements* due to limited predictability on sales, resulting in poor production planning and frequent overproduction.

According to the current situation, the following recommendations are suggested:

- **Improvement of operational and managerial aspects:** 1) *improvement or installation of irrigation plants and devices*, like tensiometers and modern pipes; 2) *introduction and use of cooling facilities*, possibly shared by groups of farmers; and 3) *training of farmers* regarding the introduction and use of new practices and technologies.
- **Improvement of marketing of products:** 1) *introduction of by-contract agreements* between farmers and buyers; and 2) combination of improved practices, technologies – including cold storage solutions – and policies resulting in an extended shelf life and profitable selling period, thus a *more favorable price management* of products.
- **New policies:** 1) *promotion of composting and use of locally-produced compost*; and 2) *establishment of local Food Banks* to redirect safe and good loss to people in need.

Finally, the study proved that FAO methodology is applicable in the Palestinian context with little adaptation. A larger-scale study is required to measure and analyze FLW, including all the stages of the supply chain, considering at least another product with different perishability characteristics and using the Sampling tool more extensively.

Food Loss and Waste in Palestine: A pilot study of the FAO methodology¹

The topic of Food Loss and Waste (FLW) has been gaining more and more importance in the last years due to critical links with a few intertwining challenges, such as food security, environment conservation (including mitigation of climatic changes) and efficiency in resources management. Still, most countries lack reliable data about the amount of food that is lost or wasted along the supply chains and in households, the causes behind the spoilage and possible options to alleviate the problem.

The present document aims at contributing to fill this gap by summarizing the results of a pilot study of the methodology that the Food and Agriculture Organization (FAO) of the United Nations has developed to quantify FLW in small-scale farmers and local supply chains of developing countries (FAO-Save Food, 2016).²

The present work adjusted the FAO methodology in a few respects, with the purpose of undertaking a smaller-scale pilot study of FLW in Palestine. The goal of the pilot study is twofold: collecting and analysing information on horticultural FLW in the West Bank; testing some main components of the FAO methodology and providing suggestions for a larger-scale study.

Most of the empirical data have been collected during a fieldwork in the West Bank (May and June 2017). The mission in Jerusalem, Ramallah and Tulkarem was framed in an emerging cooperation on FLW reduction between Cesvi Fondazione Onlus (Cooperazione e Sviluppo, an Italian NGO operating in the country) and Politecnico di Milano, and took advantage from fruitful interactions with the FAO Office for West Bank and Gaza.

¹The present document is a summary of the dissertation submitted by Simona Bencivenni (bencivennisimona@gmail.com) as a final work for her M.Sc. degree in Management Engineering at Politecnico di Milano. Supervisor: Paola Garrone, Politecnico di Milano (paola.garrone@polimi.it); Co-supervisors: Marco Caniato (jerusalem@cesviovseas.org), Cesvi; Emanuela Colombo (emanuela.colombo@polimi.it), Politecnico di Milano.

²FAO – Save Food. 2016. Food Loss Analysis: Causes and Solutions. Case studies in the Small-scale Agriculture and Fisheries Subsectors. Methodology. Rome, Italy: UN FAO.

³FAO. 2011. Global Food Losses and Food Waste. Authored by Gustavsson, J., Cederberg, C., Sonesson U., Food and Agriculture O

Objectives and methodology

The study objectives, or Research Questions, are as follow.

1. *Assessing the FLW rates in the post-harvest phases of the supply chains*
2. (a) *Identifying the critical loss points in the supply chains (major FLW causes);*
(b) *Suggesting some potential solutions given the highlighted causes*
3. (a) *Evaluating difficulties in applying the FAO methodology to the West Bank;*
(b) *Discussing full-scale application options.*

As already introduced, the activities performed are based on the FAO (2016) methodology, but some modifications have been made to bring it to a smaller and more manageable scale. A summary of the differences is provided in Table I. Notably, the project mainly focused just on two of the FAO methodology “tools” or methods, i.e. Screening and Survey, and the Survey phase addressed two major stages of the supply chain only.

	FAO METHODOLOGY	PRESENT STUDY
METHODS	Screening, Survey, Sampling, Synthesis	Screening, Survey, Sampling (partial)
SUPPLY CHAINS	Selection based on production and economic importance	As from the FAO methodology; Cucumbers and Tomatoes
STAGES OF THE SUPPLY CHAIN (SURVEY METHOD)	Postharvest handling and storage, Processing and Packaging, Distribution	Postharvest handling and storage, Distribution
TEAM	Recommended multiple experts such as: agronomist, biologist, value chain experts, managers	Management Engineering student, English-Arabic translator with experience in waste management, agronomist’s support from Italy
OUTPUTS	List of matrixes and tables as from FAO (2016)	Detailed description of the investigated supply chains, tables on FLW rates and quantities, list of main FLW current causes, recommendations for FLW management and future research

More in detail, an important part of the pilot study took place in Tulkarem, a small city in the North-West of Palestine, thanks to the cooperation with the Thinnabeh Agricultural Cooperative. The analysis focused on the Post-harvest handling and storage and Distribution stages of the tomatoes and cucumbers supply chains, i.e. two products that are central to the Palestinian economy and society. The partnership with Cesvi has been crucial for the success of the mission given their expertise on local society, economy and institutions. More particularly, Cesvi had already worked with Thinnabeh Cooperative in the past, a fact that was the starting point for this new project.

For the Screening phase, performed during the first two weeks between Jerusalem and Ramallah, a variety of sector's experts have been interviewed from FAO, Ministry of Agriculture, World Food Programme, Food Security Cluster, Applied Research Institute of Jerusalem and the Economic and Social Development Centre, following the FAO methodology protocol. A detailed list is provided in Table II. The Screening activity was critical in obtaining a greater understanding of the Palestinian agricultural sector and horticultural supply chains.

The following Survey activities were performed in the Tulkarem governorate. This phase included direct interactions with and collection of primary data from different actors of the supply chains such as farmers, middlemen, retailers, wholesalers and also the directors of both Thinnabeh cooperative and a compost facility located in Tulkarem. The list of actors interviewed is provided in Table III.

Assessment of FLW rates and quantities

Concerning Research Question 1 (assessment of the FLW rates in the post-harvest phases of the supply chains), Table IV summarizes the data obtained from the Survey interviews in Tulkarem about FLW rates for the stages of Post-harvest handling and storage and Distribution, in the components of Wholesalers, Middlemen and Retailers. The key figure is the average FLW rate as it offers a clear representation of the magnitude of the issue. Wherever possible, however, the range of typical values is reported to highlight seasonal peaks or particular situations. In the following parts, the per-capita FLW estimates will be discussed as a further representation of the issue.

Empirical findings about FLW in different stages of the supply chain are crucial for two reasons. Causes and solutions vary along the supply chain, and results at a stage level make a preliminary validation through a comparison with studies other than FAO easier. In order to quantify the overall FLW rate it is necessary to consider the FLW outflows for different stages.

TABLE II INTERVIEWS DURING THE SCREENING PHASE	
ORGANIZATION & ROLE	NAME
FAO:	
Food Security and Econometrics Consultant	Rana Hannoun
Head of Programme, West Bank and Gaza Strip	Azzam Saleh
Policy Officer, West Bank and Gaza Strip	Pirro-Tomaso Perri
Project Manager, Value Chain Specialist	Nasser Samara
Ministry of Agriculture (MoA):	
General Director of Horticultural Extensions	Salaheddin Albaba
General Director of Planning	Hasan Ashqar
General Director of Marketing and Passages	Tareq Abulaban
Head of Vegetable Production Department	Abel Kader Kharraz
Statistical Department Consultant	Rana Karmi
World Food Programme (WFP):	
Programme officer (VAM)/Deputy Head of PSU Unit, Palestine	Salah Lahham
Birzeit University:	
Professor, Department of Biology and Biochemistry	Jamil Harb
Applied Research Institute Jerusalem (ARIJ):	
Head of Biodiversity and Food Security Department	Roubina Ghattas
Economic and Social Development Centre (ESDC):	
Fundraising and PR specialist	Reema Rashed
ESDC: Program manager	Abed S. Yasin
Food Security Cluster (FSC):	
Food Security Sector coordinator FAO/WFP	Marco Ferloni

TABLE III INTERVIEWS DURING THE SURVEY PHASE			
Role	Products	Location	Number of interviewees
Farmer	Tomatoes and cucumbers	Thinnabeh	11
Farmer	Peppers	Thinnabeh	1
Farmer	Baby cucumbers	Jenin	1
Farmer	Fruit trees	Qalqilyia	1
Farmer	Strawberries	Thinnabeh	1
Middlemen	Cucumbers and peppers	Thinnabeh	2
Wholesaler	Fruits and vegetables	Tulkarem	5
Retailer	Fruits and vegetables	Thinnabeh	1
Retailer	Fruits and vegetables	Tulkarem	4
Thinnabeh cooperative's director		Thinnabeh	1
Compost facility's director		Thinnabeh	1

The results presented by Table IV show that the FLW rate at Post-harvest handling and storage stage is on average 11% (reported minimum and maximum rates respectively equal to 7% and 15%). Concerning the Distribution phase, the FLW rate is estimated to be again equal to 11% (1% from Wholesalers plus 10% from Retailers). There are no quantifiable average results for middlemen, an alternative option with respect to Wholesalers. This is an area for further research.

TABLE IV				
TULKAREM SUPPLY CHAINS OF CUCUMBERS AND TOMATOES: FLW RATES				
ACTORS	PRODUCTS	AVERAGE FLW RATES	TYPICAL RANGE	NOTES
Post-harvest handling and storage				
Farmers	Tomatoes	11%	7% – 15%	No account of the products that are left in the fields; Peak season during summer
	Cucumbers	11%	7% – 15%	
Distribution				
Wholesalers	Tomatoes and cucumbers	1%	-	
Middlemen	Tomatoes and cucumbers	-	-	Difficult to set an annual average. Very low FLW rates of products for local markets; during summer products for Israeli market get spoiled at the borders.
Retailers	Tomatoes	10%	n.a. – 25%	No data on lower bounds; Peak season during summer
	Cucumbers	10%	n.a. – 30%	

Source: own primary data and elaboration

Note. n.a.= not available.

It is hard to estimate the FLW quantity, since some of the surveyed actors did not give precise information about production or marketed quantities. In addition, different harvesting frequencies and seasons would make information not generalizable. Nevertheless, in order to give a hint on the magnitude of the studied issue, an estimation of FLW rates will be provided for the cucumbers and tomatoes supply chain rooted in the Tulkarem Governorate, starting from the last reliable data on Agricultural Production 2013-'14 (MoA, PCBS). FLW rates are applied to the flow balance, to compute the overall flow that leaves the supply chain as FLW. Estimates of overall FLW quantities and rates are presented in Table V once again only considering the two phases of Post-harvest handling and storage and Distribution. A FLW rate of 11% at both these stages – resulting in an overall compound rate of 21% from harvest to retail – was estimated for both the products. It means that around 5,610 and 2,915 tons of cucumber and

tomatoes produced in the Tulkarem Governorate, respectively, are wasted every year.

In order to obtain estimates of FLW per capita for the two supply chains, we should determine the FLW quantities that can be linked to the number of Tulkarem inhabitants. Unfortunately, we do not have direct observations of such quantities. In fact, we could not obtain thorough primary information on the quantities outflowing toward other governorates or foreign markets, nor we could undertake thorough sampling activities. Based on a few assumptions and secondary information on the weight of Tulkarem markets relative to the whole country (see the methodological note in the Appendix), the share of Tulkarem FLW quantity for cucumber and tomato that is linkable to local consumers is assumed to be, respectively, 28.5% and 45.4%. The resulting FLW per capita is 13.39 and 8.29 kg/person-year for cucumber and tomato respectively. The overall sum is 21-22 kg/person-year for both products.

TABLE V
TULKAREM SUPPLY CHAINS OF CUCUMBERS AND TOMATOES: FLW ESTIMATES

			Cucumbers	Tomatoes
Production	Product volume	[tons-year]	26,983	14,02
	Post-harvest handling and storage FLW	[tons-year]	2,968.13	1,542.20
Distribution	Product volume	[tons-year]	24,014.87	12,477.80
	Distribution FLW	[tons-year]	2,641.64	1,372.56
Total FLW (supply chain)	FLW quantity	[tons-year]	5,609.77	2,914.76
	FLW rate		21%	21%
	FLW per capita	[kg/person-year]	13.39	8.29

Source: own elaboration of own primary data and MoA, PCBS and ARIJ data

A proper validation of FLW rates and per capita estimates is a matter for further research, given the lack of comparable studies and the pilot nature of the study. However, a preliminary comparison of our results with the figures for the region aggregating North Africa, West and Central Asia reported in the FAO study of 2011.³ Our FLW rates, i.e. 11% and 11% for Post-harvest handling and storage and Distribution respectively, are not hugely different from the benchmark estimates for the aggregated region, i.e. 10% and 15% for the same stages. Overall FLW per capita generated in all the stages, from production to consumption, is reported to be around 250 kilograms per person per year for the aggregated region. As this figure includes many products different from cucumber and tomato (e.g. dairy products, grains, meat, other vegetables, fruit, olive oil and so on) and also covers harvest, processing and consumption stages, our FLW estimate of 21-22 kilograms per person per year does not appear to be completely implausible at a first sight.

³FAO. 2011. Global Food Losses and Food Waste. Authored by Gustavsson, J., Cederberg, C., Sonesson U., Food and Agriculture Organization of United Nations, Rome.

Critical loss points

Concerning Research Question 2a (identification of the critical loss points / FLW causes in the supply chains), results will be presented referring to the two different stages studied during the pilot study.

In Post-harvest handling and storage, farmers are the main involved actors, and there is a variety of FLW sources.

- ***Pest and diseases.*** The presence of insects, other pests and diseases damages the quality of the harvested products causing the direct spoilage.
- ***Lack of knowledge on post-harvest treatments.*** Many farmers do not have sufficient knowledge on how to treat the produce after the harvesting phase. Some bad operational practices lead to spoilage of food or the decrease in quality of the offer.
- ***Lack of cold storage.*** The unavailability of cold chambers to store the products after the harvest is identified by farmers as one of the major causes of FLW. Mainly during summer time, huge quantities of food have to wait in the sun and heat, and degrade to FLW.
- ***Lack of proper and up-to-date irrigation system.*** The absence of an adequate irrigation system does not permit to provide the right amount of water to the seedlings. This often causes over-irrigation that leads to a greater risk of spoilage at the later stages.

In the so-called Distribution phase, there are actors as different as traders, wholesalers and retailers. Two main FLW causes stand out.

- ***Lack of cold transportation and storage.*** The unavailability of cold trucks and warehouses is a major FLW cause. Products have to travel long distances and/or wait for long hours at checkpoints to get into Israel. During summertime, the problem gets worse and large amounts of food go spoilt. Regarding cold storage, neither the wholesale market facilities nor retail markets' stalls are equipped with refrigeration system. This is a major cause of spoilage and quality reduction
- ***Lack of a proper marketing system and by-contract agreements.*** Production planning is poor, because the majority of sales are not based on pre-arranged contracts. Predictability on sales is lower than in context where longer run agreements are in place. Over production is more likely to occur.

Recommendations

Related to Research Question 2b (suggestions of some potential solutions for the specific emerging FLW causes), there is a set of indications and proposals to improve the current situation.

Operational and managerial improvements include the following actions.

- ***Irrigation plants and devices.*** Installation of tensiometers and modern pipes would allow to regulate the amount of water for irrigation, and to prevent vegetables from developing a suboptimal consistency and consequent smaller market opportunities.
- ***Cooling facilities.*** Refrigerated warehouses, portable storage chambers and trucks would be needed in order to grant a full and effective cold chain. The investment is not feasible for individual farmers, but the creation of cooperatives would facilitate, among other things, the collective use of assets. Intervention of external donors would probably be necessary as well to face the investment.
- ***Farmers' technical capabilities.*** In order to deal with the insufficient capabilities of farmers, direct training should be offered to farmers. Thus would allow farmers to have a higher level of understanding of new practices and techniques and to discuss their problems directly with experts.

In order to solve the issue of poor marketing systems there is a set of suggestions that may gradually help the most disadvantaged actors of the supply chain (e.g. farmers) to improve their conditions.

- ***By-contract agreements.*** It would be important to diffuse by-contract agreements. They are critical for planning production and avoiding overproduction.
- ***Price management.*** Nowadays during the hot season products get rapidly spoiled and farmers are forced to accept the proposed prices. Conditional on the availability of cold storage solutions, farmers would be no more compelled to choose between FLW prevention and profitable selling periods.

Aside from very practical suggestions, ideas that could bring structural changes and challenge the current situation are important for inspiring the design of new solutions. A second set of recommendations address policies that are longer term and should be adapted to the local context.

- ***Development of compost facilities.*** This could be a winning solution to recover and recycle FLW, saving it from landfill disposal. Thinnabeh Cooperative, which already owns a compost facility, could create a more effective and profitable business model. A significant reduction in FLW could be obtained if Palestinian farmers are supported in the purchase of local compost, which is more expensive but has a better quality than the Israeli input, and the collection system of organic waste is improved.
- ***Establishment of local Food Banks.*** This arrangement could redirect safe and good losses to people in need. This solution is much more powerful if we consider the percentage of people that are food insecure in Palestine

(27%) and the fact that refugees' food baskets do not include fresh products. Of course, also in developed countries with more structured logistic networks it is hard to manage food banks and even more fresh products. This proposal would require full collaboration of many different stakeholders, a challenging task.

Bridging a full-scale application

The Screening and Survey phases of the pilot study highlighted a few critical issues in the application of FAO methodology (Research Question 3a). Reviewing them is necessary to put forward some recommendations for enlarging the study and applying the FAO methodology at full scale (Research Question 3b). The Screening phase suffers from context and methodology difficulties.

- **Screening: Data.** Information provided on official documents is scattered and not always coherent internally. It is hard to find reliable sources of data. This may have drawbacks on the quality of the assessment.
- **Method / protocol.** There are some unclear requests, i.e. either too specific or too generic questions to be answered. In a context in which roles, responsibilities, reporting are often not properly defined, some requirements appear to be “unrealistic” and out of context.
- **Survey: Data.** Different actors within the same organization happened to give different answers on the same topic. Output and performances accounts are difficult to access when interviewing farmers, wholesalers, traders, retailers. In addition, due to the variability of production, harvest and distribution process, scheduling an effective agenda resulted to be a difficult task.

In order to limit the consequences of the mentioned criticalities, a few recommendations will have to be taken into consideration.

- **Planning of meetings.** First, it is necessary to plan the Screening meetings and not to overestimate the number of expected outputs. This would allow experts to get prepared and gather necessary documents. At the same time, interviews have opened new doors and provided valuable contacts. This demands flexibility from the researchers.
- **Contacts and data collection.** It is of crucial importance to maintain relations and to “politely insist” if Screening data are not provided as agreed. Furthermore, collected information that appears not to be important or in line with the study could prove to be valuable in subsequent elaboration. Every piece of information may provide ideas or links for future developments. This is valid for both the Screening and Survey phases.
- **Cross-check of data.** It is important to cross-check all the collected information. This can be done either by comparing answers from different people or different written sources, or by asking the same questions in different ways.

- **Time window.** Focusing on the Survey phase, there are two cautions that help to exploit the available time. Researchers should avoid the holy month of Ramadan and periods outside the production phase.

In order to move to a full-scale application of the FAO methodology, greater efforts in designing the study will have to be made and a greater pool of resources should be granted to the study.

- **Selection of supply chains.** It would be important to select products with different shelf lives and perishability, an attribute that may have major impacts on FLW generation.
- **Leveraging existing networks.** Since the agricultural sector is mostly managed on an informal basis, written accounts are limited and full support from the real-life actors is necessary. Given the difficulty to reach out for interviewees, Cesvi's existing relations and contacts were a key asset. The pilot study would not have been possible without the support and willingness to collaborate of the Thinnabeh Cooperative. To this purpose, it will be of crucial importance to collaborate with cooperatives, farmers and unions that have already participated in close projects. Practically speaking, this means easier organization of meetings and interviews, full availability, disclosure of information, and, most important, trust. In addition, the dissemination efforts will be easily offset, if communication fails to reach the target, because solutions will not be perceived as appropriate and valuable by the beneficiaries.
- **Research team.** For the Synthesis method, the implications of individual solutions will have to be fully understood. To this aim, a greater mix of competences is necessary. E.g. analysis of the agronomic characteristics of products or sociological and political components of Palestinian farming could accompany the mere study of supply chains.
- **Joint commitment.** A choral commitment of the different NGOs, ministries, UN agencies and other organizations that already work in the field of food security, agricultural capacity building and food waste reduction, is necessary. Only if the FLW issue is considered as a common goal, it can be managed in a proper way.

Finally, when developing the comprehensive national study, it is necessary to adapt the FAO methodology to the unique situation in which Palestinian agriculture unfolds.

- **Available statistics.** First of all, coherent data on agricultural production are necessary to prioritize the right crops and areas. The Agricultural Census 2017 by the Palestinian Central Bureau of Statistics could be a step forward.
- **Political FLW causes.** Appropriate consideration in data collection and analysis should be given to special institutional and political features of the country. For instance, in the West Bank, a big amount of losses is caused by long waiting times at check points and this issue can be eliminated only through broader political changes. More in general, FLW analysis and assessment should pay attention to all those issues that can be just partially bounded with some operational improvements but would require much more efforts to be solved.

Further steps

The dissertation results should be regarded as preliminary, since they come from a small-scale pilot study and concern two specific crops (albeit important for the local economy). Nevertheless, they are quite close to the benchmark values provided by a pioneering study for the broader region of North Africa, West and Central Asia (FAO, 2011), a fact that confirms the necessity of reducing FLW in Palestine. Concerns originally raised by that study on FLW quantities and impacts cannot be dismissed for Palestine.

So far no sizeable and long-run projects have been undertaken to address the challenge of FLW reduction in Palestine. A larger-scale effort to measure and analyse FLW is necessary to corroborate the empirical evidences offered by the present work on the magnitude of the issue and its causes. In order to achieve a more comprehensive understanding of FLW impacts, causes and remedies in Palestine, the project scope should be enlarged relatively to the pilot study. All the stages of the selected supply chains must be included in the study. Cucumbers (or tomatoes) should be supplemented by another product with different perishability characteristics, keeping in mind the crucial role of shelf-life in the FLW generation. It would be also interesting to consider some crops that are strongly processed to evaluate how much the Processing phase accounts in FLW. Finally, the scope of the study should be enlarged to other Palestinian areas in order to include different environments and needs.

At the same time, the design and demonstration of solutions appropriate for different supply chain stages and products would be another important component of a FLW reduction programme for Palestine. A few ambitious programmes are unfolding in the broader Near East and North Africa region (<http://www.fao.org/neareast/perspectives/food-waste/en/>).

The present report offers motivations for including Palestine in this endeavour.

Appendix Methodological note

In order to estimate FLW per capita, we have to determine the FLW quantity relevant to Tulkarem inhabitants. To this aim, we use an “educated guess” on the share of Tulkarem production that is consumed locally.

The ARIJ’s study of 2015 on “Palestinian Agricultural Production and Marketing between reality and challenges” reports that the average weight of local markets over Palestine agriculture production is 60%. However, in our case, this figure could overestimate the share of production that is consumed locally, because the Tulkarem Governorate is an export source, as a national leader in the production of cucumber and tomato. Alternatively, the local consumption of cucumber and tomato might be assumed to be equal to, respectively, 28.5% and 45.4% of local production, i.e. the weight of Tulkarem inhabitants in Palestine population (3.85%; source: PCSB) over the weight of Tulkarem production in Palestine production (13.52% and 8.47% for cucumber and tomato respectively; source: PCBS). However, these rates may be regarded as an underestimate, because they assume that (intra)export from Tulkarem to other governorates is friction-less and the local demand for cucumber and tomato is the same as in governorates with different agricultural specialization.

The upper and lower estimates set a range of possible measures of the weight of local consumption over local production for the two products. The mean value, i.e. 44.2% and 52.7% for cucumber and tomato respectively, is our preferred proxy.



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