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Food loss analysis for GRAPES value chains in Egypt

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Abbreviations and acronyms

AERI	Agriculture Economic Research Institute
CAPMAS	Central Agency for Public Mobilization and Statistics
CLP	Critical Loss Point
EU	European Union
FAO	Food and Agricultural Organization
GAP	Good agricultural practices
HORECA	Syllabic abbreviation for Hotel/Restaurant/Café
HRI	Horticulture Research Institute
IFAD	The International Fund for Agricultural Development
ICARDA	International Center for Agricultural Research in the Dry Areas
LLP	Low Loss Point
MALR	Ministry of Agriculture and Land Reclamation
MENA	East and North Africa
OIV	International Organisation of Vine
TSS	Total soluble solids
UN-Comtrade	United Nations Comtrade Database
USDA	United States Department of Agriculture

Executive summary

The current work analyzes the value chain and presents a food loss assessment for grapes in Nubaria District, as part of the project "Food Loss and Waste Reduction and Value Chain Development for Food Security in Egypt and Tunisia" implemented by the Food and Agriculture Organization (FAO) in collaboration with the Ministry of Agriculture and Land Reclamation (MALR) with funding from the Italian Agency for Development Cooperation. The objective is to deepen understanding of the grapes value chain and the particular problem of food loss, in order to promote sustainable, market-based solutions that respond to the needs of small-scale holders.

Egypt ranks 4th worldwide in the global production volume of table grapes, and has shown impressive growth in the past 5 to 10 years. Along with growth in grapes production, Egypt has seen a rapid expansion of grapes exports with an 18-fold increase between 2001 and 2015. In 2016, production of grapes in Egypt amounted to 1,691,194 tons on 184,254 feddans[1] of cultivated land. The Nubaria district is very important for national fruit production, representing 51.7 percent of the total productive area of fruits and specifically 50.1 percent of the total grapes area. The production in this district accounts for 55 percent of total volume of grapes production, hence its selection for this study.

The report presents the main actors in the grapes value chain in Egypt by focusing on the Nubaria case study. It was clear that actors and their interlinkages across the supply chain of grapes depend on the destination market, whether domestic or export. Increasingly, all grapes producers and value chain actors in Egypt are susceptible to shifts in Egypt's position in the global grapes markets. For example, delays in harvesting due to climate or entry of other grapes producing countries into Egypt's export window can have a significant impact on the volumes of production not exported and diverted to local markets instead. For small-scale producers and local value chain actors without access to export markets, new ways to upgrade the table grapes value chain need to be explored.

As for grapes losses, they occur across the whole grapes subsector (SS) and are a multidimensional problem affecting the income of value chain actors, the environment and food security. In the Egyptian grapes value chain, critical loss points (the points in the food supply chain where food losses have the highest magnitude) were identified to be at harvesting, wholesale markets and retail markets.

The study applied sampling and survey methods to assess losses over two years, 2016 and 2017. In 2016, survey-based estimates of loss were 18.6, 5.3, and 6.7 percent at the three critical loss points of harvest, whole sale market, and retail market levels, respectively. In 2017, sampling technique was used to find losses of 10.3, 16.41, and 19.05 percent at same critical points of harvest, wholesale and retail.

A clear divergence between stakeholder perceptions and product sampling (weighted calculation of losses) is shown in these results; one evident insight is that losses calculated during the marketing stages are much higher than what is perceived from value chain stakeholders. Challenges in understanding the concept and relevance of food loss has an influence on the responses given by stakeholders, and a lack of awareness (technical and economic) hampers incentives to implement solutions to reduce loss. The differences in the sampling results between 2016 and 2017 also showcase that results are subject to market and study conditions.

[1] One feddan is approximately 0.42 hectare or 4200 m2

Based on the study findings and an integrated analysis of the value chain and grapes losses, a set of recommended actions are presented which support grape loss reductions and value chain development. Providing training on best practices in production, harvest and postharvest techniques, and raising awareness about loss among all value chain actors is highlighted as a main action. The study also suggests to establish quality standards and regulations for the domestic market to upgrade fruit quality and use grading as a marketing technique; improve post-harvest infrastructures and storage facilities; improve marketing infrastructures and marketing information; activate the role of small associations and cooperatives in gathering small holders for collective marketing and providing services to farmers; encourage the role of women in the value chain; establish a direct marketing center to support vertical integration among value chains stakeholders and provide business support services; and promote processing of grapes into raisins. Raisin production was highlighted as a particular opportunity for value addition given the effective local demand and potential for import substitution.

1. Background

Food loss and waste (FL&W) along food value chains is a major problem in food systems of Egypt. Under the umbrella of the cooperation between the Ministry of Agriculture and Land Reclamation (MALR), and the Food and Agriculture Organization (FAO), the project GCP/RNE/004/ITA was signed in October 2015 under the title of "Food Loss and Waste Reduction and Value Chain Development for Food Security in Egypt and Tunisia" and with special focus on two horticultural crops (tomatoes and grapes). The major aim of the project is to develop evidence-based food loss and waste reduction programmes at the national level and to support relevant stakeholders in promoting more inclusive, efficient and sustainable agri-food value chains. To this effect, the tomato value chains are studied in depth for the Nubaria district and the Sharqia governorate while the grape value chains are investigated for the Nubaria district only.

The goal of the current report is to document a case study of losses along the value chain of grapes sourced from the Nubaria district from the farm up to the retail sector. The study was carried out from July to December of 2016 by the Agriculture Economic Research Institute (AERI) and the Horticulture Research Institute (HRI). Sampling was repeated by HRI experts from July to September 2017. By identifying the main causes of food losses, and quantifying food loss in the food value chain, measures can be evaluated based on their technical feasibility, economic effectiveness, social acceptability and environmental consciousness leading to concrete proposals for a food loss reduction strategy and a set of actions.

The study performed an assessment of grapes food loss by identifying, surveying and sampling critical loss points. The backdrop of the study is a value chain analysis for grapes in Egypt, with more detailed evidence collected in the Nubaria region.

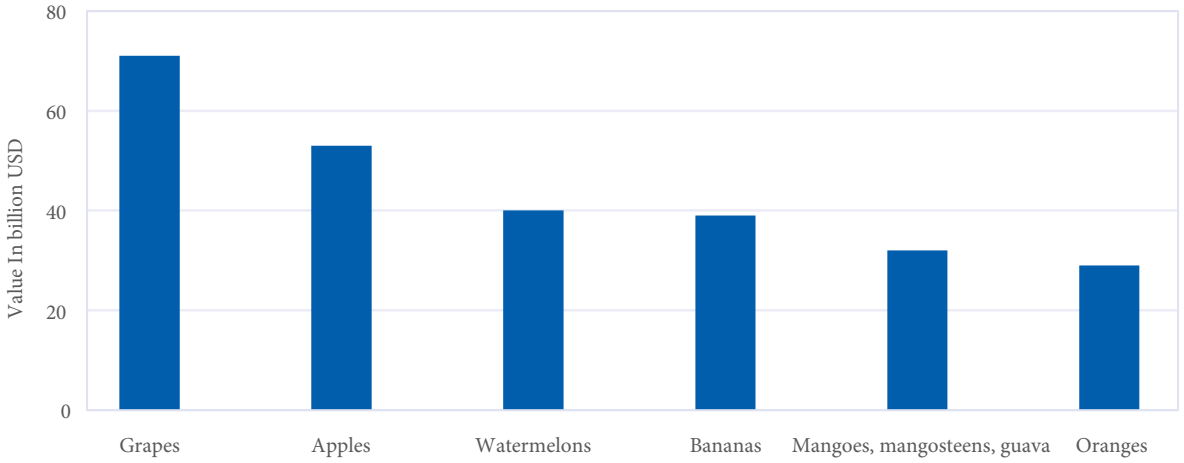
2. Value chain of grapes

2.1.Overview

Grapes, the fruits of a deciduous and perennial woody climbing vine (Vitis vinifera L.), are generally occurring in clusters and can be crimson, black, dark blue, yellow, green, orange, and pink. The vine can be supported in various ways, and the selection of the training system depends on the harvesting method, the product harvested, the regional tradition and the climate. For example grapes can be exposed to the sun with the vine supported on trellis or may be more protected from sunburn under the canopy of an overhead arbour (pergola).

Grapes were first domesticated in the near east; today they are one of the most diffuse fruits in the world, cultivated from the Mediterranean to Iran, as far as China and New Zealand, South Africa, the United States and Argentina. They are consumed both as fresh fruit (table grape) and as processed products in the form of grape juice, jam and raisins. More than 50 percent of the world grape production is pressed, consumed as juices and the rest is consumed as table grapes berries and raisins. Grapes represent the fruit crop with the highest total value of production in the world according to FAO-OIV (2016), (Figure 1).

Figure 1: Value of agricultural production of grapes compared to other top fruit crops.



Source: FAO-OIV, 2016.

Grapes are a good source of vitamins C and K, and contain relatively large amounts of phytonutrients such as flavonoids (including the flavonol quercetin that humans cannot make), which are considered to offer numerous health benefits. Table 1 presents the nutritional value of the fresh grapes.

Table 1: Nutrient content of grapes.

Nutrient	Unit	Value per 100 g
Water	g	80.54
Energy	kcal	69
Protein	g	0.72
Total lipid (fat)	g	0.16
Carbohydrate, by difference	g	18.1
Fiber, total dietary	g	0.9
Sugars, total	g	15.48
Calcium, Ca	mg	10
Magnesium, Mg	mg	7
Phosphorus, P	mg	20
Potassium, K	mg	191
Vitamin C, total ascorbic acid	mg	3.2
Thiamin	mg	0.069
Vitamin B-6	mg	0.086
Vitamin E (alpha-tocopherol)	mg	0.19
Quercetin	mg	2.17

Source: USDA (2018) and Martin and Thiel (2017).

In Egypt grapes are one of the most widely-grown fruit crops, second only to citrus. There are many varieties of table grapes produced in Egypt, most of them seedless. Prominent varieties include Early Sweet, Superior, Thompson, Flame seedless, Crimson, and Red Globe (not seedless). Table 2 presents details about selected varieties. Larger growers are trialing new varieties mainly aimed at improving shelf life and quality, as well as meeting export demand specifications mostly per EU retailer recom-mendations. In the last 7 years new (mainly export) varieties, like ARA varieties, were introduced and are under evaluation by growers relative to their potential suitability to Egyptian conditions and meeting importer standards. Pictures of grape varieties mentioned in this study are found in Appendix I.

Table 2: Selected grape varieties in Egypt.

Variety	Description	Growing Region	Harvest Season	Exportability
Flame seedless	Red, early cultivar	Nubaria, Wadi Natrun el Minya (old land with updated practices)	Mid-May–Early June	60%-75%
Crimson	Red, early cultivar	Dispersed	Mid-August	50%
Red globe	Red, late maturity	New reclaimed area, and parts of Upper Egypt	Mid-July	80%
Early sweet	White, early season variety	Desert road (new reclaimed area), el khatatba, Nubaria, Badr city	Mid-May	70%
Thompson seedless	White, medium season variety	Nubaria - Khattatbah - El Beheira - El Alamein	Mid-July	Limited 40%
Superior	White, early season variety	Desert road (new reclaimed area) abou ghalib, el khatatba, Markaz Badr	Mid-May–Early June	60%
Sugraone	Green, wide season, also called Superior Seedless	Dispersed	May–July	60%
Autumn Royal	Black, late cultivar	Khattatbah Abou Ghalab, New reclaimed land	Mid July–Early August	60%
Prime Seedless	Green, early season	New reclaimed area	Mid May–June	Mostly Local
Timco	Red, seedless, intro-duced 2016, late season variety	Old Land	Late August	Mostly Local

Source: Author's compilation based on expert consultations.

Egypt's grape cultivation is spread geographically from Alexandria to Aswan (see Map in figure 2), which, combined with the production of early and late ripening grapes, enables the prolonged availability of fresh table grapes from May to November. The production window is further elongated when using modern growing techniques such as growing under plastic covers. In addition to early ripening of different varieties, such techniques improve the total soluble solids (TSS) of early fruits and their overall quality.

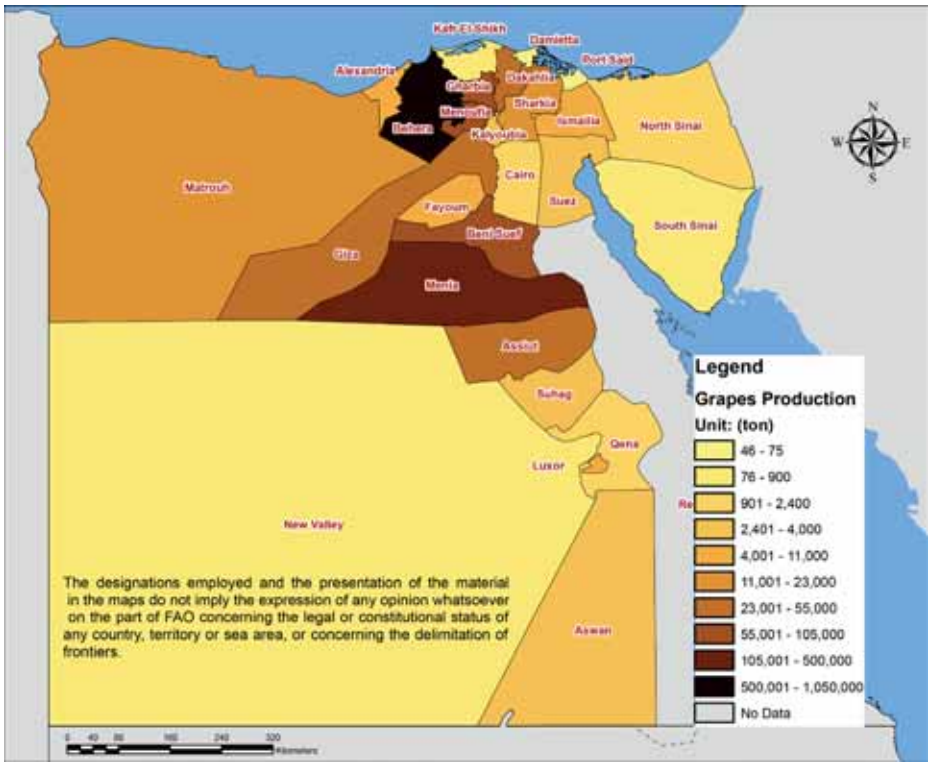
There are two major types of grape farming that can be derived from Egypt's geophysical and socioeconomic factors:

- Nile valley farming (old land farming).
- Reclaimed desert land farming (new land farming).

In the Nile valley, average farm sizes are small where the majority of grape farms are below 5 feddans. While larger farms exist, intergenerational transfer has led to high ownership fragmentation of the land (Willer et al., 2010). The smallholder farmers in the Nile Valley are older and less educated.

Grape farms in the reclaimed desert areas are generally larger and modern due to incentives promoting foreign investments as well as lower prices for land. Their minimum size is 5 feddans, as per regulations of the reclaimed lands, and many of those farmers have postsecondary, usually technical education. Figure 2 also presents the shares of grape production in the Nile Valley and in the reclaimed land in each governorate.

Figure 2: Distribution of grape production volumes by governorate.



Source: MALR (2016).
based on United Nations map. The Red Sea governorate is not represented as it hosts no grape production.

In the Nile Valley, grape farmers mainly grow grape varieties for local consumption following the arc training method—with grapes hanging under the canopy of an overhead arbour (pergola)—and apply surface irrigation (also called flood irrigation). Menia is an exception hosting some exportable varieties as well as newer production and irrigation techniques.

The reclaimed desert land also hosts exportable varieties. In this area, many different types of training are used and drip irrigation is applied (ICARDA, 2011). The soil is also enriched with nutrients from ma-nure and compost brought in from the Nile Valley, however better practices to eliminate weeds, diseases and pests are needed.

The total area of grape cultivation in Egypt was estimated at about 199 214 feddans in 2016 representing about 13.6 percent of the total area dedicated to fruits. The fruited area, which

excludes vines that did not reach the productive stage (vines usually take 4 years to reach productive maturity), was 184 254 feddans. For the period of 2001 to 2016, the total grapes area averaged 171 580 feddans, with 150 950 feddans area fruited with grapes. From 2001 to 2015 the cultivated area increased by 34.5 percent.

The total area of grape cultivation in Nubaria represents 50 percent of the total grape area in Egypt (Table 3). The fact that the cultivated fruits area in Nubaria by comparison represents only 33.2 percent of the total area for fruits area in Egypt, highlights the importance of grape cultivation in this region.

The volume of production in Nubaria corresponds to an even larger percentage (55 percent) of total grapes production volume in Egypt (Figure 3). Menia follows with 13.37 percent of the land in grape cultivation and 12.2 percent of the grape production volume (Table 3).

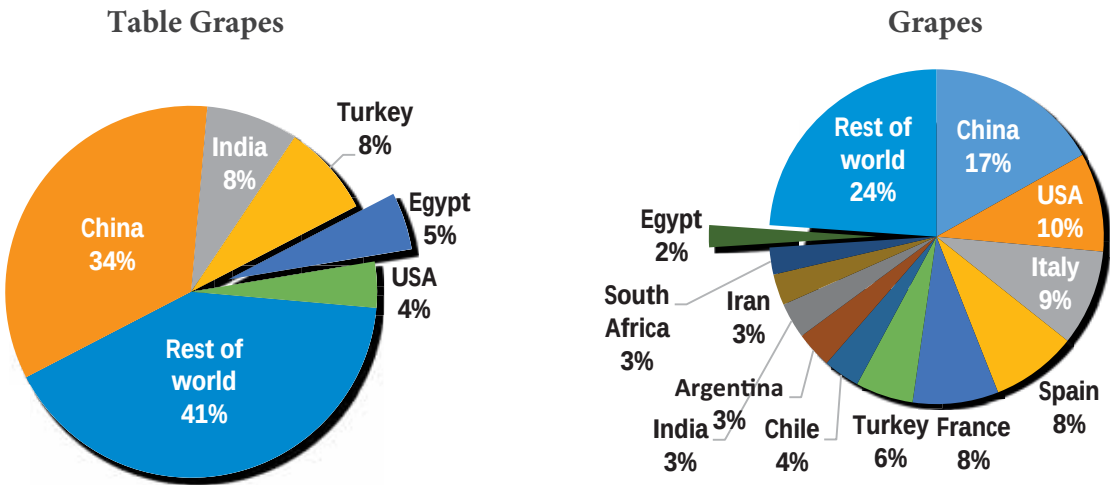
Table 3: Total area and production volume of grapes in each governorate in Egypt in 2016.

Governorate	Total area, Feddan	Fruited area, Feddan	Yield, Tons/Feddan	Production, Tons
Alexandria	741	503	8 264	4 157
Behera	10 653	10 364	11 975	124 111
Gharbia	11 277	10 435	8 982	93 722
Kafr-El Sheikh	71	48	11 229	539
Dakahlia	6 394	5 827	8 153	47 506
Damietta	8	8	7 625	61
Sharkia	3 409	2 369	8 804	20 857
Ismailia	2 259	1 403	7 106	9 970
Port Said	11	11	4 182	46
Suez	507	450	5 522	2 485
Menoufia	13 936	13 282	7 850	104 267
Qalyoubia	263	254	11 846	3 009
Cairo	125	125	7 480	935
Giza	4 481	3 006	8 152	24 506
Beni Suef	6 874	6 101	9 193	56 087
Fayoum	1 311	1 272	6 568	8 355
Menia	26 062	24 653	8 364	206 193
Assuit	2 319	2 239	12 321	27 587
Suhag	417	399	9 619	3 838
Qena	470	361	5 792	2 091
Luxor	1 102	830	4 982	4 135
Aswan	634	576	5 726	3 298
New Valley	413	164	4 872	799
Matruh	5 224	3 955	2 891	11 435
North Sinai	302	294	3 340	982
South Senai	211	70	1 086	76
Nubaria	99 740	95 255	9 765	930 147
Total	199 214	184 254	9 179	1 691 194

Source: MALR (2016).

Egypt's grape production is concentrated on table grapes accounting for almost 90 percent of total production. While in 2014, Egypt worldwide ranked twelfth in grape production overall, it ranked fourth in table grape production (Figure 3).

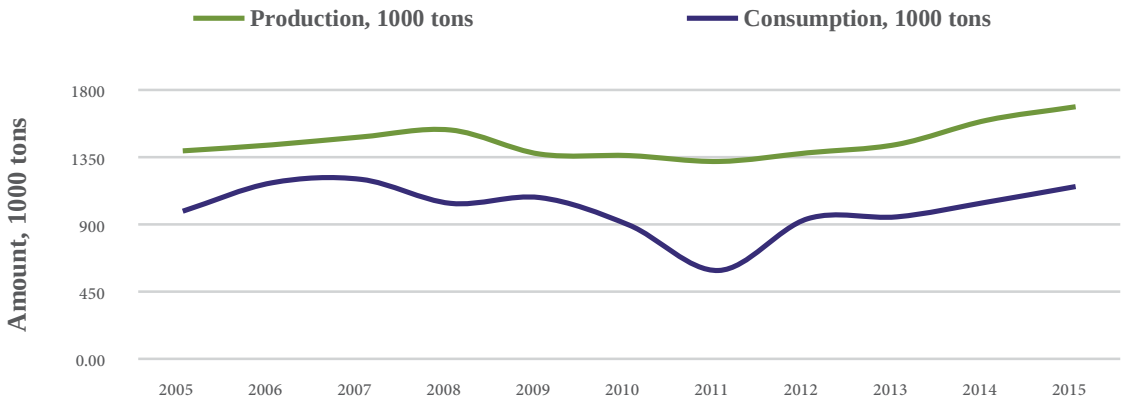
Figure 3: Grapes and table grapes global share of production, 2014.



Source: FAOSTAT and FAO-OIV (2016)

Egypt has increased the production of grapes significantly in the past 15 years, by 57 percent between 2001 and 2016. In 2016, production was 1 691 194 tons, representing 15.16 percent of fruits production. Most of the grapes produced in Egypt are destined for the domestic market. In 2015 domestic consumption was about 1 152 000 tons, representing 68.34 percent of the total production. Since 2005, domestic consumption averaged 69.05 percent of the total production (Figure 4). Egypt imports are minimal, for the last 16 years they averaged just 1 470 tons per year (FAOSTAT), and are typically consigned to the food service industry (HORECA).

Figure 4: Grapes production and consumption in Egypt during the period 2005-2015.



Source: MALR (2016).

As fresh fruits, grapes are very delicate, and losses during harvest and distribution can be high. Accord-ing to Kitinoja & Kader (2015) the total average grape loss in Egypt can be as high as 28 percent of the produc-tion. Residual calculations from 2005 to 2015 indicate that on average losses did not exceed 15.5 percent of total production, still this amount exceeded exports (MALR, 2016).
Farmers growing crops for the local market and their own family's consumption probably do not mind if their produce has a few blemishes or bruises. However, when production serves more distant and higher value markets more care needs to be applied to meet quality standards and prevent damage. Losses of grapes occur in the field (during harvest, storage and packing), in the packing house, in cold storage and during transportation. In developing countries, losses are always higher because harvest and postharvest operations to protect grapes from mechanical damage are usually poor or absent (Mencarelli, et al., 2005). This case study of the loss assessment along the value chain of grapes sourced from the Nubaria district will provide details on the points of losses and their causes for Egypt, and will serve as a guide of reference for food loss reduction recommendations in the region.

3. Case study: Nubaria

Nubaria was chosen as the case study examined to gain more insights about the value chain and food losses of grapes as it represents 55 percent of production volume. Nubaria is divided into districts, each con-taining a number of villages with each village associated with an agricultural cooperative. 93 grapes farmers were surveyed from four villages covering 584 feddans. The average farmers' age is 50 years old, with an average experience of about 14 years in grape cultivation, and three quarters of the sur-veyed farmers had secondary education (usually vocational training). Table 4 presents 5 major villages that produce grapes in the districts of Tiba, South Tahrir and El Boustan.

Table 4: Major districts that produce grapes in Nubaria.

District	Agricultural cooperative/village	Area (feddans)	No. of grapes farmers in the association	% small farmers (<5 feddans)	Average production, tons
Tiba	Adam	2 852	570	100%	22 816
	El Yashaa	1 373	332	100%	10 984
South Tahrir	El Salam	1 055	116	53%	8 440
El Boustan	Mohamed Refaat	365.12	115	91%	3 103
	Ali Ibn Abi Taleeb	31	9	9%	279
Total		5 676	1 142		45 622

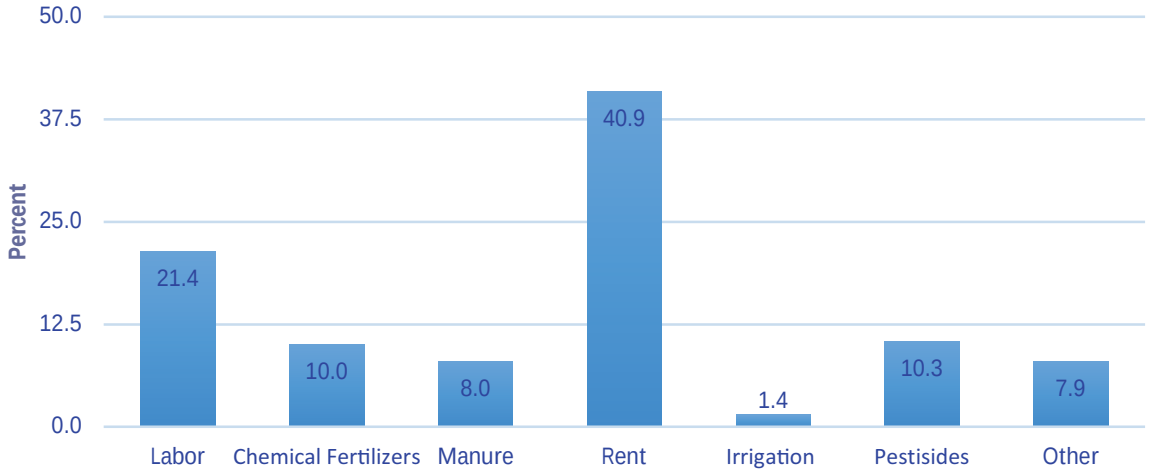
Source: Author's compilation from data provided by the Nubaria Agriculture Directorate, 2017.

The average cultivated grape area among surveyed respondents was 5.99 feddans, with an average productivity estimated at about 8 tons/feddan. Small-scale farmers with less than 5 feddans of land dominated with 76 percent of the survey sample (average of 4.5 feddans of grape cultivation); 17.2 percent of farmers had between 6 to 10 feddans and only 6 percent held over 10 feddans with an average area of 18.6 feddans of cultivated grapes. The majority of farmers in the survey (73 percent) cultivate "White banati" grapes ("Thompson

Seedless"), for which the average productivity is 7.5 tons/feddan. "Flame" variety accounts for 25 percent of surveyed farmers with productivity reaching about 11.2 tons/feddan, and "Crimson" variety for 2 percent of the total area of the sample.

In 2016, the average production cost per feddan was 16 564 6 LE (equal to 1872.2 USD in July-August 2016; closer to 1 049 USD in October 2020). Land rent costs on average 6.774 LE per feddan, represent-ing the highest input cost share for farmers that lease land (Figure 5). Labour cost followed at 21.4 percent. The selling price for grapes in the selected survey area of Nubaria depended on the quality of the product, with the average price reaching 3 900 LE/Ton for good quality produce. It should be noted that, in 2016, grapes prices were generally higher than usual. The average price for low quality grapes is approximately 1 500 LE/ton. This kind of production may be sold in local or informal markets or for further processing into raisin. According to survey respondents 3.75 percent of production was low quality. By computation, a yield of 8 Tons/feddan brings a net profit of 13 916 LE per feddan.

Figure 5: Input cost shares per feddan.



Source: survey conducted by the study team. Data is the % of respondents.

3.1.Value chain map and actors in Nubaria

This section presents the main actors in the grapes value chain in Egypt as they emerged from the Nubaria case study.

Farmers: Individuals, families or companies which grow grapes on leased or mainly owned land. They are organized in farming cooperatives' associations in each village. They are the underpinning actors in the grapes value chain.

Inputs suppliers: Parties that furnish farmers with fertilizers, pesticides and other chemicals, seeds and planting materials, and machinery and equipment. Cooperatives associations supply farmers with fertilizers at subsidized prices, but usually at insufficient quantities. There are plentiful of private retail inputs suppliers in every village that can also equip farmers. In the Nubaria case study area there are more than 10 shops of fertilizers and pesticides in each village. In the absence of an official system to guarantee the quality of fertilizers and pesticides, producers can choose between either purchasing low-price inputs of questionable quality or purchasing from reputable but more expensive distributors. In the case of fertilizers, producers use a combination of industrial product

[2] USD = 8.85LE at the time of the study (July-August 2016). Following a devaluation of the Egyptian currency in November 2016, the exchange rate in October 2020 is 1USD = 15.8 EGP

mixtures and organic fertilizers produced at the farm from agricultural and animal wastes (Box 1).

Financial institutions: While farmers with collateral can get financing from branches of the Agricultural Bank of Egypt, inputs suppliers, traders, and cooperative associations often serve as financial vehicles for small-scale farmers. For example, in Nubaria, farmers can purchase fertilizers and pesticides from inputs suppliers and pay part of the cost upfront, and the remaining after the sale of their product. Some input suppliers agree to receive full payment for inputs supplied to farmers after the produce sale, albeit at a higher profit margins.

Extension agents: They facilitate the transfer and application of scientific research and new knowledge from agricultural and a variety of other disciplines (including business and marketing) to agricultural practices through farmer education and technical assistance. The services provided by the public sector can often be inadequate due to the shortage of financial and human resources in the field. Larger farms often rely on private advisory services.

Labourers: Grapes farmers depend on seasonal agricultural labourers during the production, harvesting and marketing stages. Small farmers often depend on family members in managing their farms. Laborers are often unskilled, and landless, and earn approximately 100 to 140 LE/day. Women play an important role particularly during production and harvesting, although their labour is not always reported or perceived as different from household chores.

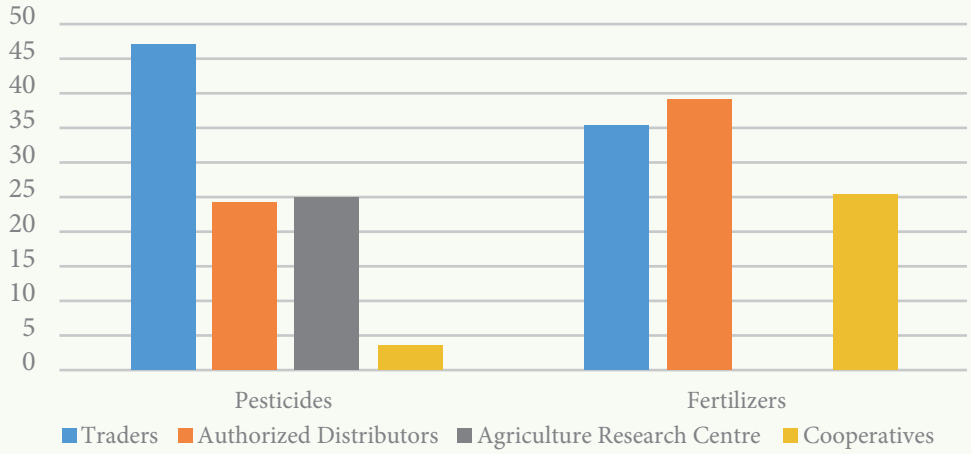
Marketing intermediaries: The link in the supply chain between producers and wholesalers. They are also known as middlemen or distribution intermediaries, and include brokers, distributors, collectors and wholesale traders. They aggregate unprocessed produce from farmers and sell them to wholesalers, packinghouses and processors. Part of the graded, packed and processed grapes are exported, while non-conforming grapes are directed, by the intermediaries, back into the local market.

Packinghouses: Companies which grade, refine and package grapes into a finished product destined for export or hypermarkets and supermarkets. Packinghouses are semi automated and provide this service to traders and larger farmers; alternatively they can be chartered by exporters or hypermarkets or they can directly buy the grapes from farmers and traders and sell the the finished product to their clients. They handle about 15 percent of the grape production, most of which is directed to exports. There are private packinghouses in the Nubaria region owned by private agricultural companies (about 29 packinghouses with estimated capacity of 122.013 tons, but a utilization rate that does not exceed 51.6 percent). Packinghouses usually do not source from small scale grapes farmers.

Box 1: Inputs suppliers:

Each village in Nubaria District has a number of inputs suppliers that can supplement the cooperative associations' limited supply of subsidized fertilizers and pesticides. Figure 6 shows an example of Farmers' sources of inputs.

Figure 6: Farmers sources of inputs in Nubaria.



Source: Collected data from survey.

Wholesalers: They usually own a shop in a formal wholesale market and they buy and sell in bulk either loose or packed grapes. Almost 50 percent of the grape production flows through wholesalers whether directly from the farmer or indirectly by passing by intermediaries. Further details on the wholesale market are provided in Box 2 and fig 8.

Exporters: Companies which export grapes originated from their own production or from finished products bought from a packing house. A limited amount is bought from farmers directly.

Shippers: Transport companies and individual truckers that transport raw and processed products throughout the value chain. Most truckers are not well organized and work individually. Exporters and hypermarkets rely on organized companies like El Sheikh or Villanova, who have a fleet of reefer trucks, work on schedules and can be held liable in the case of accidents or wrong handling of products.

Freight forwarders: Companies which organize and facilitate the export of sea container or air freight shipments. There are numerous local and multinational freight forwarders in Egypt and several compa-nies have specialized on the handling of perishables; examples include DHL, Panalpina, Venus, Falcon, Kuehne and Nagel.

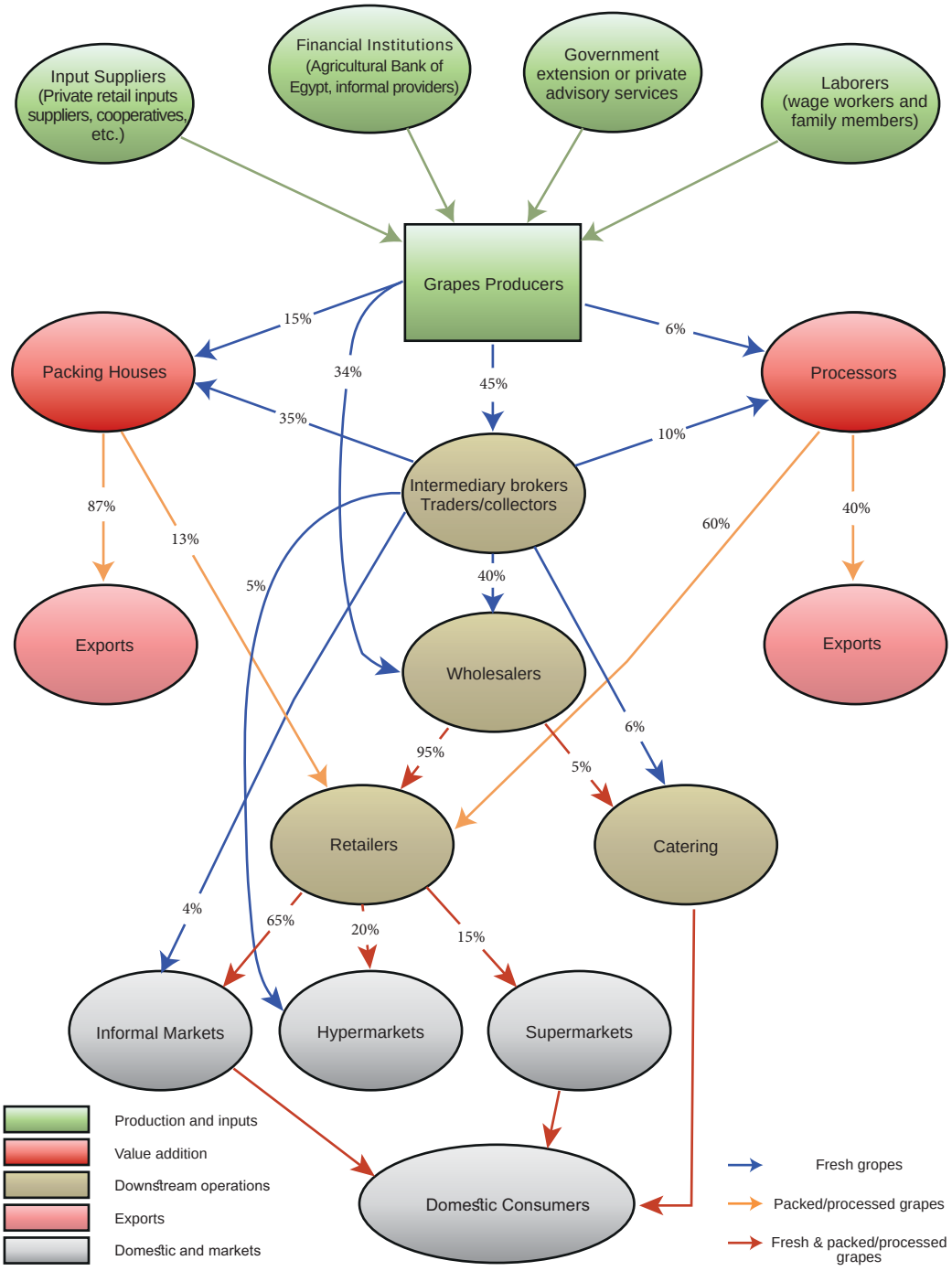
Grape processors: are manufacturers of grape products, mainly juices and raisins. There is one major commercial raisin producer; all others are prepared informally in small farms mainly for household con-sumption. They absorb a small share of the grape production, about 6 percent. Processed grape products are mainly sold to retailers in the local markets. Around 40 percent of it is exported.

Retailers: Companies which sell finished products to end consumers. Retailers include vendors at informal markets, supermarkets and hypermarkets. Informal markets dominate, with 65 percent of retailers selling to this channel.

Catering: The catering industry includes hotels, hospitals, academic establishments, restaurants, coffee shops, airlines and event catering companies. They buy smaller volumes from intermediaries and wholesalers.

Figure 7 presents the value chain map for the grapes in Nubaria. The interactions among value chain actors, the flow of products and volumes described above are represented based on field interviews and primary data collected in the survey; the diagram was validated via expert and stakeholder consultation and prior literature. Although the paths are often interlinked, the map uses different types of arrows to indicate the flows of fresh and packed/processed grapes to local or export markets.

Figure 7: Grapes value chain map in Nubaria.



Source: Author, based on screening and expert / stakeholder consultation.

Box 2: Wholesale market assessment

The study included 27 wholesalers at the main 3 wholesale markets for grapes (El Obour and 6th October in the greater Cairo area, and Nozha in Alexandria). 43 percent of grapes volume is supplied to the wholesale market by traders, followed by a 23 percent supplied by farmers that sell to the wholesale mar-ket directly. The main buyers of grapes at the wholesale market level are retailers, accounting for 90 percent of the purchases. A limited quantity is purchased by traders and catering.

Figure 8: Wholesale market: suppliers and customers at the main 3 wholesale markets for grapes.

3.2.Fresh grapes marketing

Farmers sell their grapes via three main systems, as follows:

"Kelala" sale at farm gate: Kelala is a traditional method of sales regularly used in the agricultural sector of Egypt, where the farmers sell in bulk the total estimated production capacity of their field to a wholesaler, a trader, or an exporter. The process usually includes bargaining between the two parties before the harvest is ready, and agreeing on a sales price that accounts for a profit margin and requires a certain percentage in advance as a down payment (or guarantee). The grapes are sold "on the vine" and the buyer handles the harvesting operations, field packing and transportation off the farm. It is the most common method in Nubaria, adopted by 43 percent of grape farmers (Figure 9).

Per kilo selling at farm gate: The farmers sell their product at the farm gate at a per kil-ogram price with the agreement that the proportion of grape leaves should not exceed 2 percent of the weight of the crop. While this process involves bargaining as well, it is more dependent on the prevailing market price at the time of trade. This is field packing by the farmer, who then sells by kilo to a trader. Traders who purchase the product after harvest

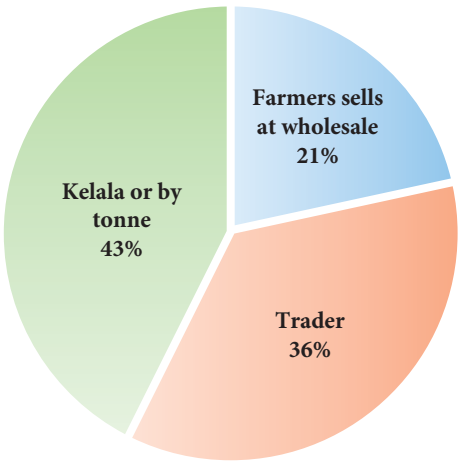
are called "Galabin". This method is adopted by 36 percent of grape farmers in Nubaria.

Per kilo selling in "Chalish": This process often takes place when the trader funds the farmer production and takes 8 to 10 percent commission of the production's total sales. 21 percent of grape production in Nubaria is sold to wholesalers through this marketing method.

Grapes reach domestic consumers through three types of markets:

- Formal wholesale markets such as EL Obour, 6 October, El Nozha, El Mansoura etc.
- Informal markets, these can include farmers markets, traditional fruit shops (known as Fa-kahani), and mobile fruit vendors (carts).
- Hypermarkets and supermarkets as well as larger formal fruit shops (Fakahani).

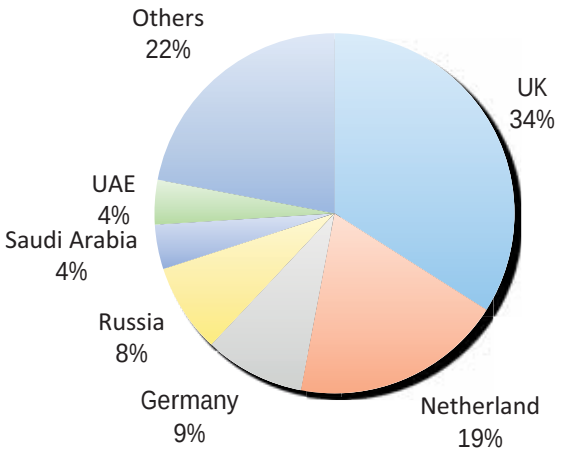
Figure 9: Methods of selling grape production based on the survey done in Nubaria.



3.3.Fresh grapes export

The exported quantity of grapes has been on average 7 percent of the production from 2005 to 2016 (MALR, 2016). The main destinations for Egyptian table grapes are the United Kingdom, the Netherlands, Ger-many, and the Russian Federation (Figure 10).

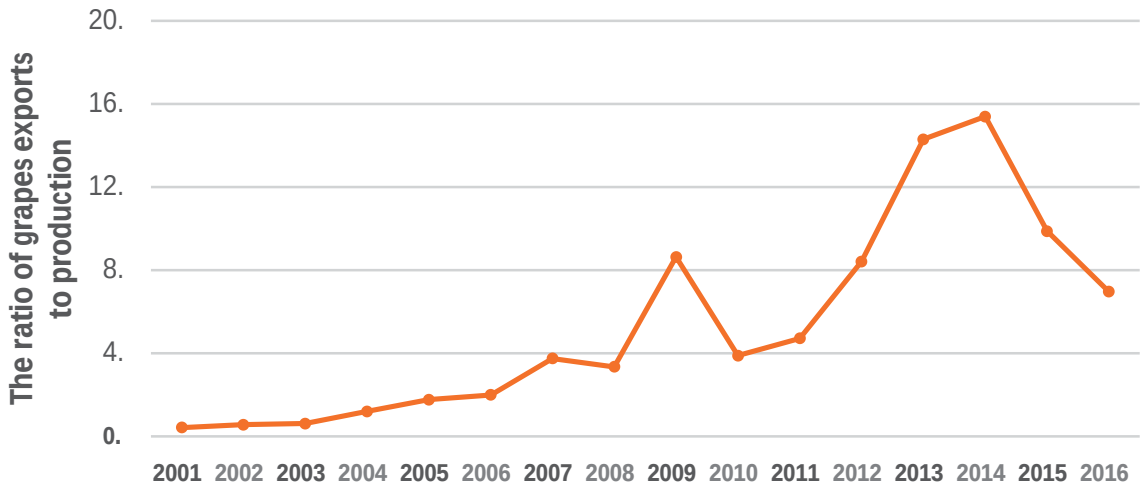
Figure 10: Main destinations for egyptian grapes in 2015.



Source: UN Comtrade (2016).

Egypt has become a competitive exporter of grapes in the last decade. While grape production in-creased by 54.5 percent from 1.100 thousand tons in 2001 to 1 700 thousand tons in 2015, exports from Egypt, increased by an even greater magnitude from 46 thousand tons in 2001 to 167 thousand tons in 2015. Figure 11 shows the momentum of this increase. The ratio of grapes exports to production was 9.88 percent in 2015, and fell to 7 percent in 2016; the maximum was reached in 2014 with 15.4 percent.

Figure 11: Export share of total grape production, 2001 to 2016.



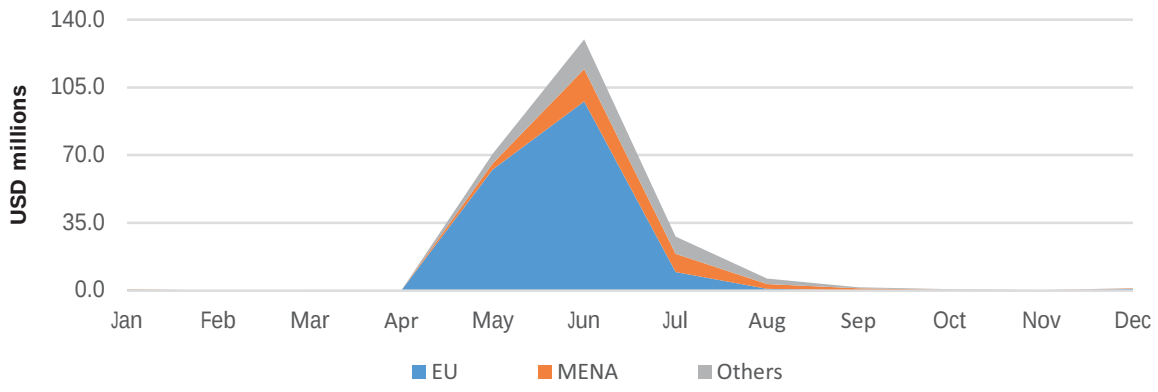
Source: MALR (2016) and UN Comtrade (2016).

The growth in exports is due to a number of reasons:

- introduction of new varieties,
- breakthrough into new markets,
- improvements in marketing, quality and packaging, as well as
- improvements in certification and importer requirements attainment.

For Egypt, grapes are a promising export crop because of the local availability of early cultivars. Egypt's export window, May-August (Figure 12), is unique; it begins after India has ended its production and before the European and US production reaches their consumers. Local demand during and beyond this export window buffers supply and absorbs non-exportable volumes.

Figure 12: Average monthly exports, 2014 to 2016, USD millions.

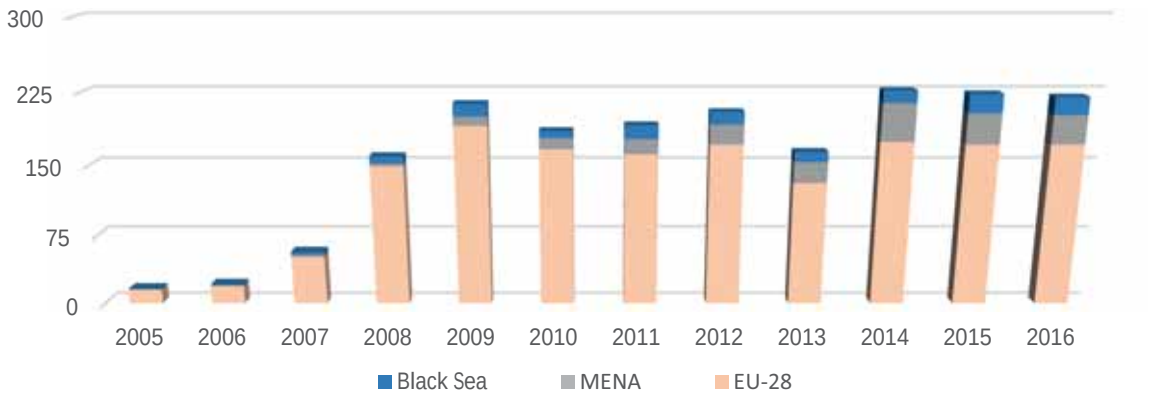


Source: UN Comtrade (2017).

Egypt's favorable export position however can be compromised. Weather changes can reduce Egypt's export window, and new and old competitors can undermine the Egyptian position. For example as new competitors like Saudi Arabia are entering international markets they can offer high quality of the same grape varieties within the same or similar production window. The difficult season for Egyptian grapes in 2017 showcases most clearly these risks (Mulderij, 2017). The Indian season lasted longer and flooded the European and United Kingdom market with grapes during the Egyptian export season. Furthermore, cool weather in Egypt affected the start of the grapes harvesting, and exports started with 7 days delay. Weather also advanced the Spanish season, reducing the export opportunities for Egypt in July and August. Egyptian traders had to divert supplies to other markets and sell at lower prices than the EU Market. Egypt has also faced phytosanitary issues for produce exported to countries such as the U.S., Saudi Arabia and Russia and EU (FAO, 2017).

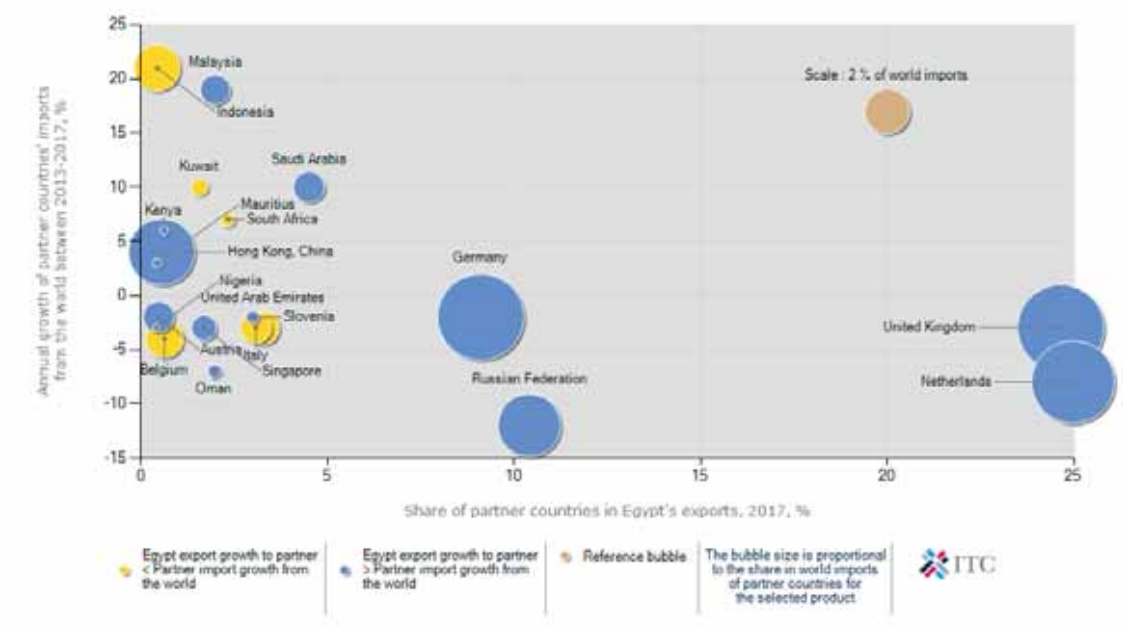
As India is trying to improve the quality of export grapes and extend its production window with comparably lower production costs, Egypt has to continue developing new markets while also focusing on quality and cost improvements as well as season expansion. The EU is a higher value market that has served as the main market for Egyptian grapes representing 72 percent of total Egyptian grape exports. In recent years, markets have also been developed in the MENA region, the Black Sea region, (Figure 13) and Asian markets. In 2016, USD 30 million worth of Egyptian grapes were absorbed in Russia, USD 630 million in China and USD 460 million in Hong Kong (FAO, 2017). Other markets becoming of growing importance for Egyptian exporters are the Far East, South Africa, West Africa and East Africa (Figure 14).

Figure 13: Egyptian fresh grape exports, USD millions, 2005 to 2016.



Source: UN Comtrade (2016).

Figure 14: Prospects for grape exports in 2017.



Source: ITC (2018).

3.4.Processing and value addition

There are no official data on the production of processed grape goods, however residual calculation from the 2015 Food Balance Sheet (MALR, 2016) (with food loss share specifically identified and ac-counted for) suggests that in 2015 processed products did not exceed 8 percent of grapes in terms of fresh equivalent volume. Additionally, since in 2014, about 90 percent of grape production was destined for fresh consumption, the remaining 10 percent was processed into juices, musts, and raisins (OIV, 2014).

Grape juice is the simplest processed product made from grapes, obtained from crushing and blending grapes into a liquid. Cold press is a simpler method used in most commercial operations. Hot pressing is older and requires that the juice be removed by pressing the fruit while hot; appropriate for more deeply pigmented grapes. Grape jelly, jam, preserves, butter, or marmalade are made from whole or crushed fruits mainly by cooking the grapes and/or their juice in combination with sweeteners and pectin to the proper solids level. Local demand for locally produced grape juice and jams is low; most grape juices are exported to the nearby Arabic countries. The exported quantity of grapes processed into juice is also small, at only 11 tons in 2015 (FAOSTAT), while imported quantities of grape juice (figure 15) are mostly directed to the HORECA sector.

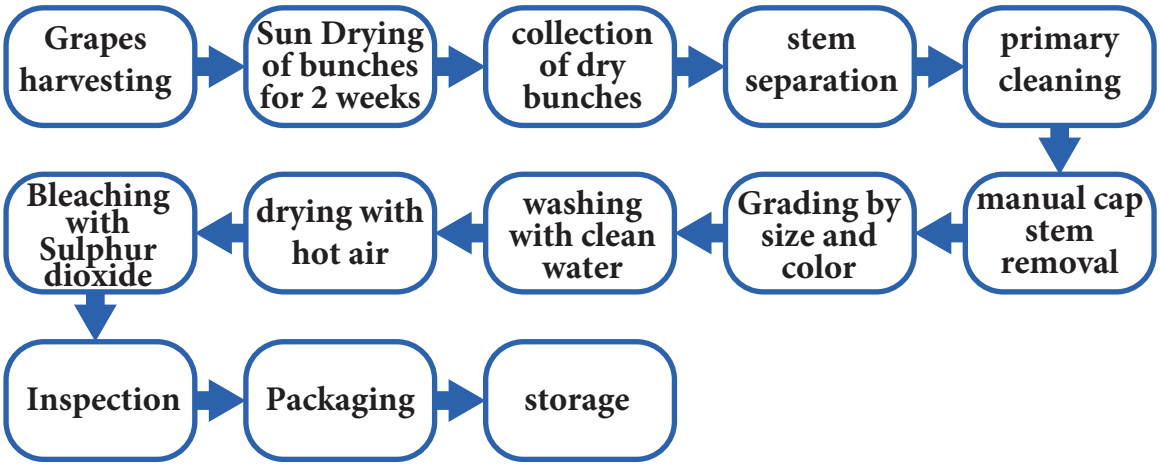
Figure 15: Imported and exported amount of grapes juice.

Source: FAOSTAT.

Pomace is a byproduct of grape pressing that can comprise about half of the fruit and is approximately 40 percent skin, 50 percent pulp and 10 percent seed. Pomace puree has been used in a variety of products (Sharma, 2012), such as grape seed oil extraction (Garavaglia et al., 2016), and extraction of pigments from grape skins to color products and increase the nutraceutical content of foods. Due to the limited industry in grape pressing the byproduct opportunities are also small.

Egypt is a net importer of raisins, which are un-pressed, dried grapes; the country imports large quanti-ties of raisins throughout the year and especially before and during the season of Ramadan. Imports were 2 330 tons, with a total value of 4.8$ million in 2016 (UN Comtrade, 2017). The exported quantity of dried grapes is very small at only 159 ,212, and 52 tons in 2013 ,2014, and 2015 respectively (CAP-MAS, 2015).
The most popular grapes varieties for producing raisins in Egypt are Thompson Seedless, Flame Seedless and Crimson. Other white varieties like Early Sweet, Superior Seedless (SugraOne), and Prime are also processed to raisins. The raisin production process is summarized in Figure 16.

Figure 16: Raisin production steps.

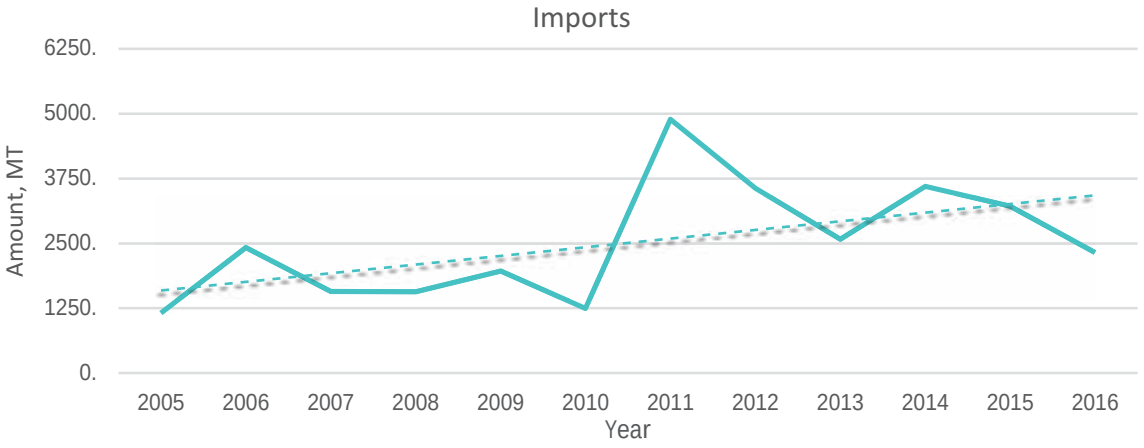


Once dried, collected raisins are separated from their stems during separation and primary cleaning. Locally available machines can remove big stems and can also grade the raisins based on their size. After primary cleaning, cap stem removal is done by hand and grading can be finalized. Generally raisins are graded on the basis of size and color. To remove dust particles from surface and unwanted oil residue, raisins are washed again with clean water. Raisins are then dried with hot air to remove moisture from their surface. During drying, berries can be bleached with Sulphur dioxide (SO2) to keep the color and reduce the development of mold, a common process for the "golden yellow" types preferred in the local market. However other markets like the EU market do not permit the use of SO2. While not yet commercially valorized raisin wastes can be used as compost, and animal feed.

Raisin manufacturing firms are classified in three categories, small, medium and large. Small firms pro-duce 0 to 15 tons of raisins, medium firms are those which produce 16 to 30 tons of raisins and finally the large firms are those which produce more than 30 tons of raisins. In Egypt sun drying raisins is the tradi-tional and most common method to dry grapes, and typically takes 2 weeks. The general lack of hygienic and food safety practices in traditional drying leads to low quality local raisins that cannot compete with imported raisins.

By developing the raisin processing in the grape sector, there is a business opportunity to reduce the large imported quantities of raisins and reduce losses and waste along the value chain. The devaluation of the Egyptian pound in 2016 makes import substitution with locally produced raisins even more opportune. Furthermore, demand for raisins is growing; during the period of 2001 to 2016 the growth rate of imported raisins to Egypt was 100 percent (compared to 10 percent in the world) (UN Comtrade, 2017). Figure 17 shows the variation in imported amounts from 2005 to 2016. Box 3 explains the profit margins for raisin processing.

Figure 17: Raisin imports, 2005-2016.



Box 3: Profit margins for raisin processing:

Costs of sundried raisin production is presented from the Nubaria case study. The transformation rate of grapes to raisin is 5 to 1, meaning that five kilograms of fresh grapes are required to make one kilogram of raisins, but for low quality grapes the transformation rate is higher, reaching 7 to 1). Average profit margin for 1 KG raisin is presented in table 5.

Table 5: Profit margin for 1 kg of raisin.

Cost for KG of Fresh Grapes	**Price 3 LE/KG of grapes**	**15 LE**
Processing Cost		**4 LE**
Revenue	**Price 30 LE/KG of raisins**	**30 LE**
Profit margin		**11 LE**

Source: Author's calculation from data collected during visit to processing facility in Nubaria August 2016.

Note: Exchange rate 1 USD =8.87 EGP (July-August 2016)
Note: LE = Egyptian pound

Source: UN Comtrade (2017).

3.5.The role of women in the grapes value chain

Women have more difficulties compared to men in accessing productive resources and in participating in and benefitting equally from agri-food value chains. In this context, a brief study was conducted to gain an understanding about gender roles in the grapes value chain in Nubaria, and the relation to causes of food loss and waste to come up with solutions for reducing them. Information was gathered from women in Nubaria in 2016 and 2017 through focus groups and in-depth interviews. Four focus groups were held involving 37 women in total. Secondary tools include observations and informal discussion in the field, as well as project records (such as participation in trainings and workshops) in addition to literature review. Results were compiled and validated among project stakeholders.

The women who took part in this study agreed that women have a big role in the grapes value chain. Grapes are a delicate fruit, and there is a general perception that women are gentler when harvesting and handling. However, women and girls prefer not to work in agriculture as they see it as a downgrade to their social status. Older women stressed that they do not wish their girls to work in the agriculture sector, preferring they work in factories, nurseries or staying at home to help when possible. This is the general perception adopted by families through different generations.

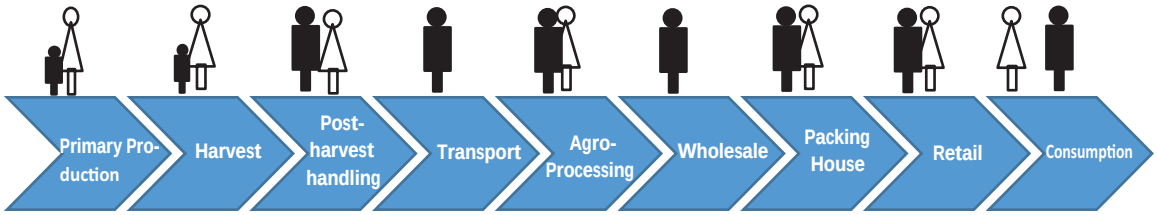
Moreover, farming is considered a daily chore to family members rather than a paid job, much like laundry, cooking, or schooling their children. In Nubaria, in line with the smaller sizes of land ownership, most of the land is run as family farms. On one of the family-run farms visited, the wife and three children had a big role in the primary production and harvest. When speaking to them, they expressed the need to help their father/husband in any way possible in order to decrease the cost of hired laborers and increase the farm profits.

Generally speaking, women have an important role in the first three stages of the value chain: primary production, harvest, and post-harvest handling. They also have an

important role in the agro-processing. On the contrary, women have little to no role in transportation or wholesale. Some women work in wholesale markets, but usually only if they inherit this role from their husband or father. Moreover, Nubaria does not have an official wholesale market, so any market is informal.

Figure 18 presents the findings about the role of women and men in the grapes value chain, showing their presence at each stage and relative size of the role they play.

Figure 18: Description of the Grapes Value Chain – Social Structures.



Source: Authors compilation based on study findings and adapted from FAO (2018).

The symbols indicate the presence (or not) of women and men in the different stages of the value chain. When both are involved, a larger symbol indicates which gender is the main actor or more active at that particular stage. Equal sized symbols mean women and men play an equal role.

At farm level, women are tasked with tying, trimming and cleaning the vine leaves, spraying the vines with Dormex (Box 4), harvesting and post-harvest handling. Tying, trimming and cleaning of the vine leaves is usually done in January and February to prepare for cutting the leaves in March and April. Once they are done, they gather the leaves and stack and tie them together to sell to traders or factories that repack them for commercial use. At this level of the value chain, women are said to be the backbones of their husbands in the field, supporting in whatever way possible.

Box 4 - Dormex toxicity:

Dormex is a plant growth regulator used in vineyards and orchards to break bud dormancy and stimulate more uniform and earlier bud break. Dormex active ingredient is Hydrogen cyanamide. It is imperative to note that studies show preliminary evidence of toxicity of Hydrogen cyanamide, which may cause adverse health effects to farmers and workers exposed to this substance. Therefore, adequate information, training, personal protective equipment (PPE), and regulation are needed to ensure occupational health and safety of grape women and men producers (Davanzo, et al. 2001; Gamaluddin et al., 2012; Hafez, 2010).

When the grape bunches mature, women participate in harvesting especially if the farm is family-run. Women also have a role in sorting grapes and packing into plastic crates or carton boxes, to prepare them for traders or wholesale markets in Alexandria, Amreya or Obour. However, women are not generally active in selling the grapes or dealing with traders.

After harvest, women perform treatment of nematodes, as well as weeding. Children may participate in this process, especially girls, while boys tend to help men in spraying, irrigation and pruning. In a focus group, women described the practice of growing garlic under the grapes, which has pest repellant qualities and reduces nematodes in the soil. Garlic is then consumed, or sold to generate extra income for the household.

Regarding shattered or lost grapes, some women explained that they collect them to produce raisins for their personal consumption. Other women take the grapes to someone

who processes them into raisins for around 2 EGP/kilo which are then consumed by the household. These raisins are reported to be of better quality than those produced at home as they retain their golden color. Others produce jams and juices.

In the traditional packinghouses, men (boys and adults) dominate this stage, where they re-sort, grade and pack in boxes to be used for export or factories. On the contrary, women are known to be employed in modern packinghouses as well as processing factories.

Women have a clear role in informal retail markets; their presence dominates the very small street stands in Nubaria. Most women farm laborers purchase grapes at farmgate price or receive some of their wage in kind, then keep a part and sell the rest at local street markets as seen all over Egypt. However, the formal retail markets are dominated by men, and the hypermarkets by both genders.

The last stage of the food value chain is the consumption stage where food waste can occur. Specifically, food waste refers to the removal of food from the food supply chain that is fit for consumption, or has spoiled or expired, mainly caused by economic behavior, poor stock management, or neglect (FAO, 2018). This study gave a few insights on the matter of consumption behavior and habits, and food waste. In the focus groups and interviews, most women stated they never waste food, explaining that instead of re-using rice, bread and pasta (staple foods eaten) they tend to use it to feed their poultry. However, feeding leftovers to poultry is still considered waste according to FAO, as this food could have been fit for human consumption.

Women's labor participation is either through family farms or as wage laborers, performing harvesting and sorting with a daily wage of around 75 EGP. Among the women interviewed there are some that perform activities in the grape value chain as part of their daily chores, in addition to working full-time jobs in neighboring factories, stores or nurseries. Income generated by women from non-farm activities is aimed at providing their children with private tutors and books to supplement public education. Where employment in industry or agri-business is available, as in Nubaria, women prefer these jobs due to the provision of transportation and social and health insurances, even if the wages are lower.

During the focus groups, women were asked about gender-related obstacles faced in their village. An-swers were often similar; they claimed that the selection of the trainees should be improved in order to actually reflect the needs of value chain stakeholders. Women who have a chance to receive training find the training environment has not been designed taking women's context and constraints into consideration (in terms of timing, duration and location, for example). This could be due to the prevalence of men, preferential selection of women close to the premises of the training organizers, or the provision of information that is irrelevant to their roles. This means that women may be unable to participate fully or reap the full benefit of existing training programmes (FAO, 2016a).

Lastly, based on the focus group responses, there is a growing awareness for women (and men) on the importance of creating income-generating projects to raise the standard of living for their families, and adding value to crops instead of selling it fresh is a key way to do so. This can include raisin processing, vine leaves packing, and producing grapes-based food products such juice, jam and jelly. These activities require investments in equipment as well as the awareness and implementation of food safety standards.

4. Conclusions of value chain analysis

The grape sector has experienced a period of growth over the past 15 years with success in the export sector for Egyptian grapes. However, there is a wide disparity between the large-scale export-oriented producers and the small-scale grapes farmers who are largely resource-poor and produce mainly for the local market. Of course, the developments in external trade, both in term of opportunities and threats remain important to the local grape market. For example, any compromises to Egypt's favorable export window result in export-oriented grapes ending up in the local market, thus increasing local supply of all available varieties and putting downward pressure on prices. This especially poses a risk for small-scale farmers if prices drop too low during peak harvest season; they do not have access to proper cold storage or processing facilities as alternatives to add value or prevent loss. The case study team observed lower prices in 2017 and instances of farmers not harvesting their fields at all because the farm gate price was too low to recoup the cost of harvesting. In other cases, to preserve profit margins farmers may choose to use less or poor quality inputs leading to pest, disease, or lower quality grapes. Likewise, with lower profit margins, less care might be paid in postharvest handling given the costs of labor, transportation, and materials.

The following table (table 6) is a SWOT analysis where the strengths, weakness, opportunities, and threats faced by the Egyptian value chain for grapes are summarized.

Strengths	Weaknesses
• High production volume (1.6 million tons). • Increasing demand. • Established export channels to EU and Asian markets. • Availability of human resources (labors). • Early production (early May). • Competitive advantage. • Know-how available for large scale grow-ers and exporters. • Favorable weather conditions.	• Susceptibility to fluctuations in internation-al grapes markets. • Inadequate research and development. • Lack of extension services. • Inadequate cold chain facilities. • Lack of marketing infrastructures and in-formation. • Poor phytosanitary practices and controls create risk for exports. • Land fragmentation. • Poor link between small-scale farmers and other stakeholders in the value chain (packinghouses, exporters, processing factories...).
Opportunities	**Threats**
• Value added (processing) • Export opportunities to new markets • Renewable energy for cold chain • Contract farming to link small scale farm-ers and large=scale buyers • Empowering women participation • Create new job opportunities • Widen production season (May –Nov) • Establish organized cooperatives	• Water scarcity • Competition from other producers (Spain, India) • Rising costs of production • Retail price fluctuations that do not match the rising cost of inputs • Weather changes may reduce export win-dow • New entrants to the grapes export market within Egypt's export window • Currency fluctuation

Actions that will allow this sector to improve are to:

- optimize production and resource use.
- modernize the value chain in terms of practices, infrastructure and integration, and
- focus on research and extension.

These actions will facilitate the production of a more competitive output, by:

- improving the quality of grapes,
- tailoring production to market requirements and
- extending (or adapting to) the harvest and export season.

The main opportunities for all grapes value chain actors lie not in business-as-usual, but in producing better quality fresh grapes and especially in accessing new marketing channels. New markets can be pursued by opening new export markets and developing the processing industry for value added grapes products. For small-scale farmers especially, new market channels would help to smooth the price fluctuations that pose a risk to their profits and livelihoods and discourage investing in inputs for good agricultural and postharvest practices. Promoting processing, in particular grapes drying into raisins, as a market-oriented activity to add value, can also create new marketing channels, generate more income by diversifying the source of this income, and encourage better production and postharvest practices and reduce losses. These actions would create incentives for grapes value chain actors to invest in producing more or better or differently, to upgrade the value chain and prevent food loss throughout it.

5. Food loss assessment: approach and methodology

5.1.Definitions and approach

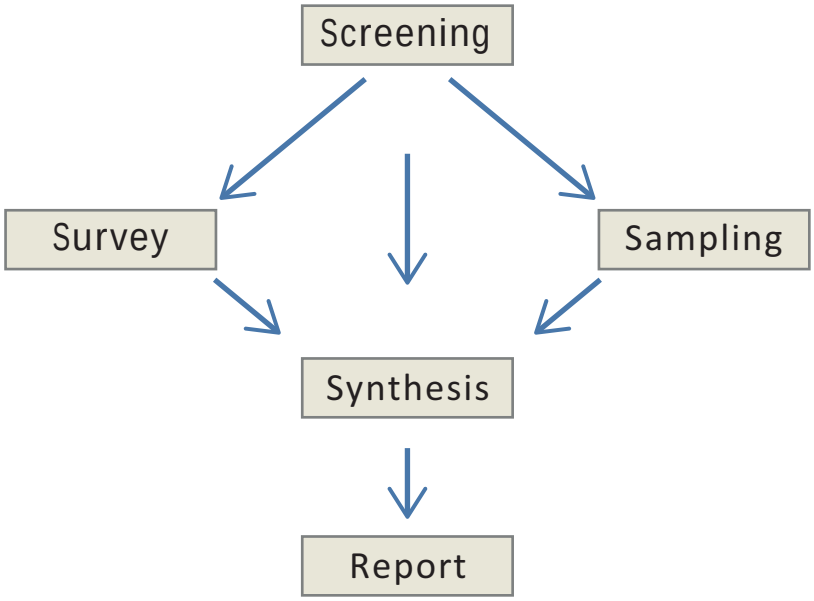
Food loss, i.e. the decrease in edible food mass destined for human consumption, takes place at all stages of the food supply chain. Food waste refers to food loss at the end of the food chain (retail and final consumption) and depends on retailers' and consumers' behaviour (Parfitt et al., 2010).

An important role of post-harvest processes is in recovering and preserving what has already been produced, reducing the gap between the biological yield obtained by the producer and the realized yield that finally reaches the retailer and consumer. Food loss reduction conserves food and it is generally conceded that considerably less energy and other inputs are required to conserve food, rather than to produce an equal quantity of food. The importance in reducing losses stems from the fact that reduction of post-harvest losses is the most effective means for increasing food availability. Decreasing food losses offers an opportunity to reduce the pressure on the land while delivering the same quantity of food to the table, thus reducing, to some extent environment damage caused by agricultural activities.

In Egypt post-harvest activities (processing and distribution activities) account for more than half of the economic value of the agricultural sector. While an important driver for socio-economic development in rural areas and of critical importance in meeting food security and nutritional requirements of the population, post-harvest activities receive less public sector attention as compared to production. Nonetheless from practical experience, a high percentage of losses can be attributed to inadequate postharvest handling, a weak cold chain, poor packing and transportation damages.

The goal of the study is to analyze the main causes of postharvest losses in the grapes supply chain, focusing the analysis on the critical points where losses occur, and offering concrete proposals to reduce the losses that are technically, economically and socially feasible, providing the basis for a food loss reduction program. The methodology adopted in this study was provided by FAO (2016b). This methodology uses the '4S' approach, standing for "screening", "survey", "sampling" and "solutions" (Figure 19) and has been designed as a tool for food loss analysis and solution-finding in developing countries. In this case study, the primary data generated helps to identify the different causes of food losses, and find feasible solutions.

Figure 19: FAO methodology concept.



Source: FAO (2016b).

Economic and technical literature review (see also Appendix II), field visits, and key informant interviews were used to determine the critical loss points in the selected grape value chains. Critical Loss Points (CLP) refer to the points in the food supply chain where food losses have the highest magnitude. The screening results are presented in table 7. Primary data were collected at the three identified critical loss points: farm, wholesale and retail levels. A survey conducted in 2016 provided for an evaluation of grape losses at these critical loss points based on the experience of value chain participants. This assessment was enriched with the results provided through sampling of losses at the same critical loss points. While a preliminary sampling study took place in 2016 on Thompson Seedless variety but was conducted late in the season, the 2017 sampling study provides the baseline for the sampling assessment. The baseline food loss study of 2017 on Thompson Seedless variety was more refined and was also extended to the Flame seedless variety, an exportable variety of grapes. The 2016 sampling results are provided in Appendix III (Table A1) along with the Flame seedless variety sampled in 2017 (Table A2), and commented in the report only when applicable.

Nubaria was selected for the case study because of its dominance in grape production. It represents 50.1 percent of the total area cultivated with grapes, and 55 percent of total grapes production (MALR, 2016). Other criteria considered were the presence of smallholder farmers and certifications in some farms. Grapes are specifically examined because they are a promising export crop, given the availability of early and late cultivars, and because of the opportunity raisin production offers for value addition and raisin im-port reduction, while also reducing food losses. Additionally the raisin industry can increase employ-ment opportunities especially for women.

Table 7: Screening results of fresh grapes losses points from Nubaria.[5]

Step in the value chain	Expected Loss Points		Reason
	Quantitative CLP or LLP	Qualitative CLP or LLP	
Production	LLP	LLP	
Harvest	CLP	CLP	Lack of good harvest and field-level postharvest practices.
Transportation	LLP	LLP	
Wholesale market	LLP	CLP	Inadequate infrastructure and lack of cold chain facilities.
Retail Market	CLP	CLP	Lack of refrigeration, inadequate packag-ing and exposure to the ambient envi-ronment.
Processing	LLP	LLP	
Packinghouses, Export	LLP	LLP	

Source: Authors' compilation based on CLP and LLP as defined in FAO (2016b).

Legend : CLP: Critical Loss Point; LLP: Low Loss Point.

5.2.Survey methodology

To evaluate social, economic, and environmental aspects related to food loss a combination of field visits, interviews and focus group discussions were used. In the survey of 2016, ninety-three farmers were interviewed by means of questionnaires. The majority of farmers in the survey (73 percent) cultivated "Thompson Seedless"; the flame variety accounted for 25 percent and "Crimson" variety for 2 percent. At the wholesale level, 27 wholesalers were interviewed, and at the retail level ten retailers were interviewed.

5.3.Sampling methodology

Sampling provided for weighted calculations of losses. Samples were examined and defects were separated and sorted by defects type, then weighed to calculate percentages. Definitions of the defect types are presented in table 8 and pictures of defects are found in Appendix IV. Losses for each category were calculated and expressed based on weight of the samples as a percentage of the total production weight. For simplicity and to avoid double counting, calculations were carried out based on one defect per berry.

Table 8: Grape defects on individual berries and associated loss

Defect	Definition	Loss per berry
Shattered berries	Detachment of berries from the cap stem.	Loss in quantity and quality but may be sold half price
Decayed berries	Berries with soft breakdown of the flesh or skin resulting from bacterial or fungal infection (deterioration because of pathological disorders	100 % loss
Waterberries	Watery, soft, or flabby berries.	100 % loss
Mechanically damaged berries	Mechanical injury to the berries.	100 % loss
Insect damaged berries	Injury to the berries caused by insects.	100 % loss
Shriveled berries	Berries which are dry and shriveled to the extent that practically no moisture is present.	100 % loss
Sun burnt berries	Injured berries due to exposure to the sun usually occurring as a sunken and discolored or dried area on the exposed surface.	100 % loss
Sulfur burnt berries	Sulfur treatment is applied to protect berries from fungus development and preserve their color. However, Sulphur-treated berries may show symptoms similar to the ones caused by sun burn.	100 % loss
Shot berries	Very small berries resulting from insufficient pollination, usually seedless in those varieties which normally develop seeds.	100 % loss

Harvest sampling

In each village three representative farms were sampled. Samples were chosen randomly from each farm: three replicates were analysed, each sample represented by a field package which was a box of ten kilograms weight of grapes.

Wholesale market sampling

At the wholesale market level, three big wholesale markets were selected (El-Obour, 6th October, and El-Nozha). In 2017 three dealers were chosen from each market for sampling (five in 2016). For each dealer three replicates of 10 kilograms' packages were sampled.

Retail market sampling

Sampling took place in three types of retail markets: hypermarkets, supermarkets and informal markets.

a. **Hypermarkets:** Three main stores were included in the study in both 2016 and 2017, notably Carrefour, Spinneys, and HyperOne (Lulu was not included in 2017). Three samples of 1 kilogram were collected at each store; these were either already packaged by the seller (usually 0.5 to 1 kilograms per package) or loose in display containers (plastic or cartoon boxes). While hypermarkets are located in all governorates of the country, sampling focused at the Cairo and Giza branches.

b. Supermarkets: Three main stores located in Cairo and Giza were considered for the study in 2017; Awlad Ragab, Saudi and Alfa market for Thompson samples, Metro, Khair Zaman, Awlad Ragab for flame samples. Three samples of one kilogram were collected from each supermarket similarly to hypermarkets. (In the 2016 Thompson study, the stores selected were Metro, Khair Zaman, Awlad Ragab, and Fathallah).

c. Informal markets: Three main local informal markets were included in 2016 and 2017: , Soliman Gohar, Al Giza and Al Omrania in Giza (the 2016 study also included the Al Mataria market in Cairo). Three samples of one kilogram from each market were collected from loose grapes in display containers.

Grapes varieties studied

Thompson seedless was examined in the preliminary study conducted in 2016, and in the baseline study of 2017. Thompson seedless is one of the most famous and diffused varieties of table grapes in Nubaria. Thomson seedless is a white sweet variety produced mainly for local and domestic consumption as well as for raisins production. Some farmers prefer this variety because it can be consumed as a fresh fruit and can also be dried into raisins. The harvest period for Thompson grapes starts end of July and lasts for about one month.

Flame seedless was also added in the baseline food loss study of 2017. Flame seedless is one of the most important cultivars grown in Egypt for both exportation and the local market. This variety is a red and vigorous heavy bearing table grape. It ripens in the early season; in the case of covered production it can be harvested as early as in late May. Field harvest starts in the first week of June. In Nubaria, Flame seedless represents the second highest choice for farmers.Due to the higher prices of early grape production, this exportable cultivar can achieve high return for the grower. However the experience of 2017 showcases that because its price is more dependent on the world price standard, it has higher price volatility.

6. Food loss assessment: survey and sampling findings

6.1.Farm level harvesting survey

Based on the survey, farmers identified five food loss causes presented in Table 9. Weather conditions was the major cause identified. While packing was perceived by the farmers to cause the smallest por-tion of losses, according to case study observations packaging actually constitutes one of the main causes of loss during handling throughout the value chain (for example in transportation or during wholesale market handling). The majority of farmers use plastic cages (87 percent), then 7.5 percent follow with aluminum trays and 4.3 percent with palm cages. Only 1.1 percent use cartons, which are more protective. According to the survey results at farm level, total losses totaled 18.6 percent, which based on the 2016 grape production translates to a 441 million LE in lost value for the Nubaria

Table 9: Percent farm-level grapes losses according to farmers surveyed.

Causes of losses at farm-level	Loss %
Bad weather conditions	11.09
Insects damage	2.67
Harvest loss	2.77
Sorting	1.36
Packing	0.72
Total	**18.6**

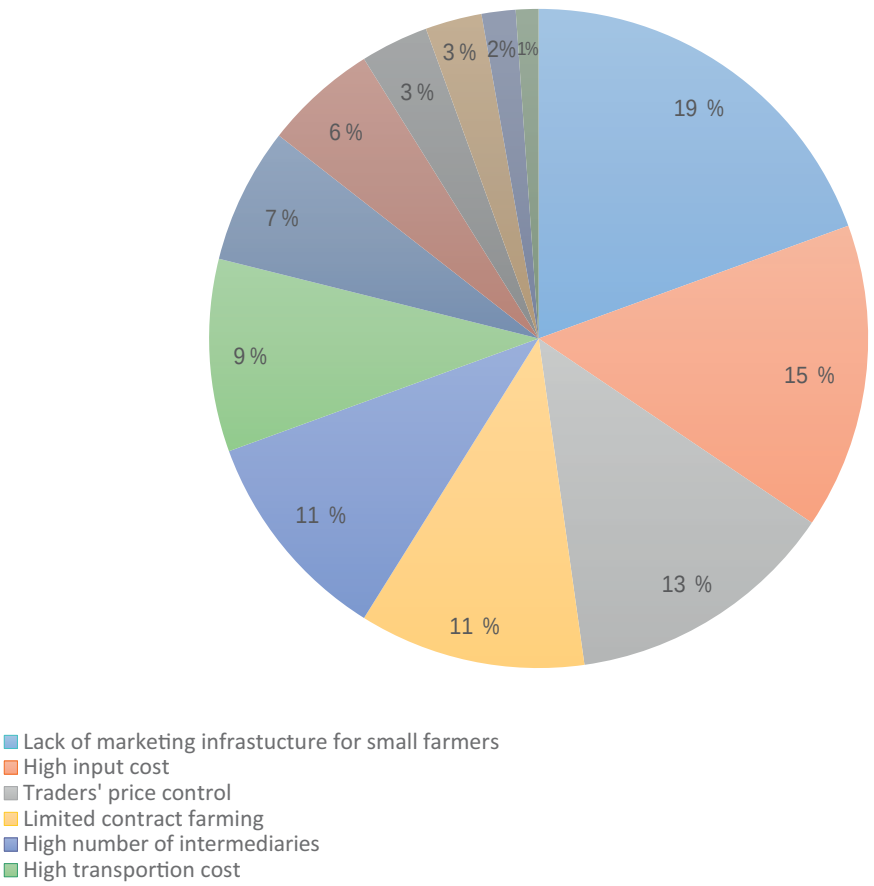
The underlying problems in grape farming as identified by surveyed farmers are presented in Figure 20, the highest share of respondents identified the absence of marketing infrastructure and associations as the main problem faced (almost 20 percent). The high cost of production inputs followed at 15 percent. Other important problems included the lack of market information and traders' control of the farm gate prices.

The solutions to marketing problems suggested by the surveyed farmers are presented in table 10 below.

Table 10: Suggested solutions for marketing problems at farm level.

Main marketing solutions at farm level	Respondent %
Strengthen the role of cooperatives (inputs and finance)	10.1%
Market oversight	7.1%
Establish a market information center	6.9%
Open marketing outlets	5.8%
Support Export Chains	5.6%
Establish packinghouse for small farmers	4.7%
Increase food processing and drying	4.5%
Promote contract farming	4.5%
Establishment of marketing cooperatives for export or Internal market	4.1%
Strengthen the role of extension and training	1.5%

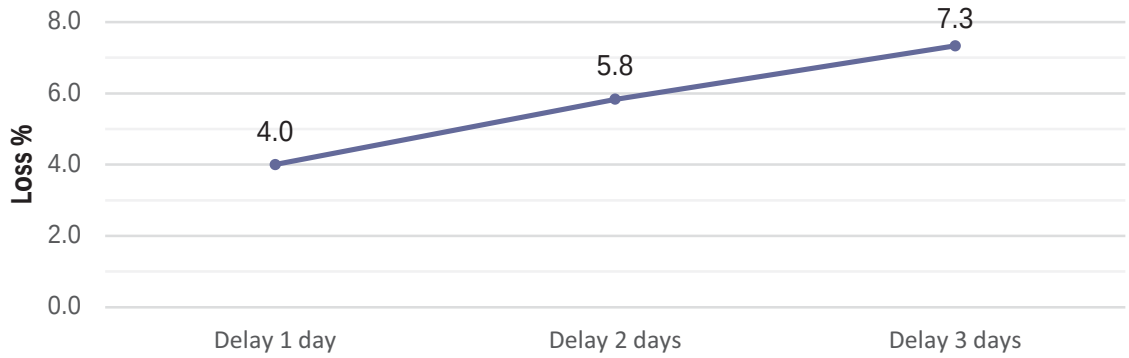
Figure 20: Main problems in grapes farming as identified by farmers in the survey.



6.2.Wholesale market survey

The study included 27 wholesaler at the three main wholesale markets for selling grapes in El Obour, 6th October in the greater Cairo area, and Nozha in Alexandria (9 wholesalers were interviewed in each market). According to respondents, on average 5.7 percent of the volume (quantity) in the wholesale market is lost mostly due to delays in selling the product. The longer the delay, the higher the losses (Figure 21). The value loss in grapes due to delays in selling was identified by wholesalers interviewed in these markets at 26.3 percent of the economic value of the supplied quantity of grapes.

Figure 21: The relation between grapes loss in the wholesale markets and the delay in selling according to wholesale respondents.



Wholesalers identified a number of underlying marketing challenges (Table 11). According to the wholesalers surveyed, 48.1 percent considered unfair competition from informal markets to constrain their sales, thus leading to losses. About 37 percent of wholesalers also claimed the high cost of transportation and the lack of refrigerated transportation to lead to substantial losses. Delays in transfer between harvest and the wholesale market was also a prominent reason.

Table 11: Marketing problems related to loss at the wholesale markets.

Main marketing problems at the wholesale markets	Respondent %
Unfair competition by informal markets nearby wholesale markets	48.1
High cost of transportation and lack of refrigerated transport availability	37.0
Lack of purchasing power for retailers and consumers	29.6
Low quality during the current season which lead to increase loss	25.9
Long time in loading and arrival to destination market	18.5
Retailers buy directly from farmers, which causes a delay for wholesalers selling their product	14.8
Shortage in suppliers in the current season (2016)	14.8
Lack of information about the cultivated area and production	11.1
Shortage of skilled labors	7.4
Shortage of grapes processing units (juice or drying)	7.4

The solutions suggested by the wholesalers are presented in Table 12, and by far most respondents (48 percent) suggested closing the informal markets located near wholesale markets. Establish equipped markets near production areas in order to facilitate exports and the need for access to market information is also highlighted. Increasing grapes processing to absorb the large quantity of production and reduce losses is necessary for 9 percent of the survey respondents.

Table 12: Proposed solutions for problems at wholesale markets.

Proposed solutions at the wholesale markets	Respondent %
Close informal markets nearby wholesale markets	48.1
Establish equipped markets near production areas to facilitate exports	29.6
Regulate the markets	14.8
Market development and establish crops Stock Exchange	11.1
Oversight and control of pesticides	11.1
Establish market information center	11.1
Increase grapes processing	9.0
Increase early production of grapes	7.3
Improve storage facilities (cold chain…)	7.4

6.3.Retail market survey

Ten retailers were surveyed at hypermarkets and local retail markets in Cairo and Giza governorates, namely: HyperOne, Carrefour New Cairo CFC and the local retail markets were in Dokki, Soliman Gohar, Faysel and el Haram.

At hypermarkets respondents identified that the (unsold) loss was at 5.8 percent a loss valued at 98 LE/day. At local retail markets respondents identified losses at 7.6 percent (with 3.5 percent unsold and 4.1 percent sold at a lower price). The main loss causes identified were; rough handling from consumers, open-air markets (in-creased loss due to high temperatures), bad handling at previous stages of the supply chain (at the farm and at wholesale markets), and packaging.

6.4.Sampling results

Table 13 reports the share of losses by type of defect, for each of the critical loss point examined in 2017, namely harvest, wholesale and retail stages.

Table 13: Loss defects and their percentages at different stages for thompson seedless

Causes of Loss	Loss Percent					
	Harvest	Wholesale	Retail			
			Hypermarket	Supermarket	Informal market	Average Retail
Shattering	3	9.64	13.63	12.34	15.48	13.82
Decay	5.1	3.68	2.31	1.53	3.58	2.47
Water berries	1.2	1.21	1.21	0.78	1.74	1.24
Mechanical damage	0.2	1.05	0.41	1.20	1.15	0.92
Insect damage	0.1	0.03	0.00	0.00	0.00	0.00
Shriveled	0.2	0.38	0.02	0.00	0.45	0.16
Sun burn	0.2	0.12	0.44	0.00	0.10	0.18
Shot berries	0.2	0.29	0.23	0.00	0.52	0.25
Total loss	**10.3**	**16.41**	**18.26**	**15.86**	**23.03**	**19.05**

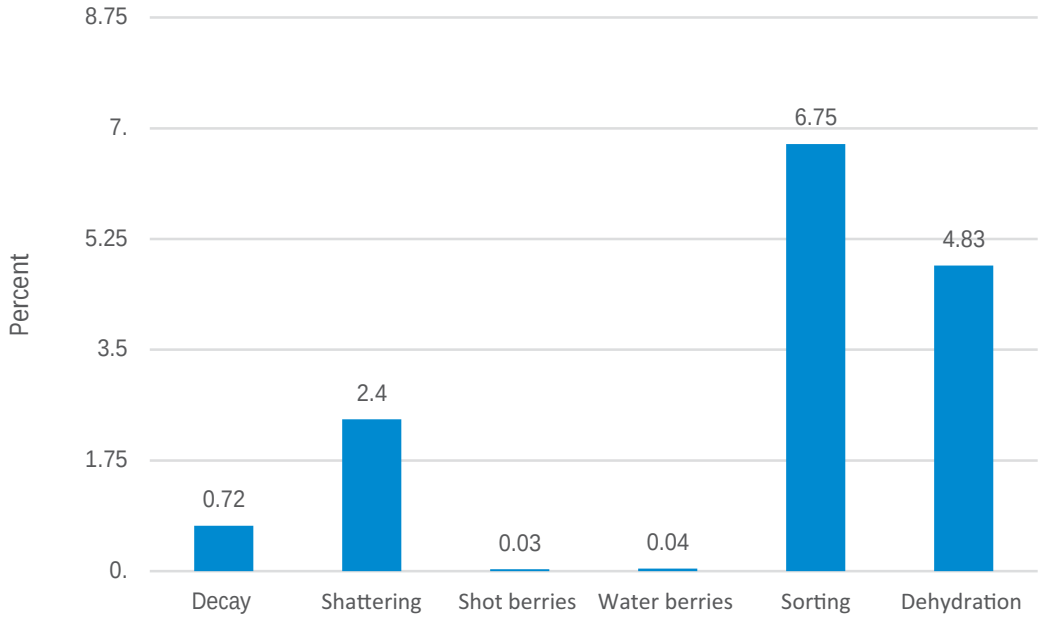
Results at harvest level indicate total losses reaching 10.3 percent in Thompson seedless. Of the defects identified, the highest percentage (5.1 percent) was from decayed fruits resulting from pathological infections during the growing season caused by the lack of effective control measures. The results in 2016 were much higher (28.4 percent), mainly due to the later sampling in the season (end of August in 2016 versus end of June in 2017). See Appendix III Table A1 for detailed results for 2016. This result can highlight the importance of harvesting time since in the late season losses are higher due to high temperatures and increased relative humidity contributing to high disease, mold and decay incidences. In addition, an intensive use of pesticides and chemicals was reported in 2017 throughout the season until shortly before harvesting, which may have also resulted in lowering losses.

However, the sampling results show only part of the picture. The price of grapes in 2017 was very low and profit margins dropped (due to higher input costs owing to the historic currency devaluation brought on by the move from a pegged to a floating currency system). The study team observed grapes left in the field unharvested, leading to foregone revenue. Additional economic loss resulted from cost of inputs and labour that had been spent on unharvested grapes. This was even more pronounced for flame seedless grapes. A ten-day maturation and subsequent harvest delay reduced exports due to weather conditions, as it was unseasonably cooler weather. The reduction in price led to higher losses of production.

Regarding wholesale-level losses, the data illustrates that the main defects observed at this level were shattering, pathological decay, water berries and mechanical damage. Total losses amounted to 16.41 percent. The high percentage of shattered berries is due to rough handling and bad stacking of crates on transport vehicles, as well as to poor road conditions during transportation from the farm. The same trend was also obtained in 2016, however the overall level of losses was lower (9.04 percent). The abrupt rise of transportation costs because of high fuel prices in 2017 probably led to overloading of grapes. Shatter incidence can be reduced by controlling pack depth and fruit packing density (cubic inches per pound), using cluster bagging, and gentle handling. Standardizing such practices and avoiding over stacking of grape containers is important to minimize losses. Pathological decay and shot berries are due to improper sorting and cleaning during field packing. With lower selling prices for grapes in 2017, such preparations might have also been more careless.

Retail market losses are also high (19.05 percent average across markets) and shattered berries prove once again to be the main cause of loss. Decay is the next most prevalent form of loss, maybe due to inade-quate sorting, storage temperatures, as well as improper display and packing of the product. Rough handling from consumers at the hypermarkets and supermarket may also contribute to shattering and decay.
To further evaluate the value chain of grapes destined for export, three packinghouses in Nubaria were visited in 2016 (Ragab, El-Maghrabi and El-Farouk), and sampling results are presented in Figure 22. Total physical losses (excluding sorting) amounted to 8 percent, with dehydration that represents the highest physical loss, followed by shattering and then decay. Sorting losses at 6.75 percent refer to grapes that do not fit export requirements and are diverted to the local market, as fresh grapes or inputs for raisin processing. The results reported in Figure 22 were mainly based on data of internal registers, plus samples taken for assessments (-5kilogram cartons destined for export).

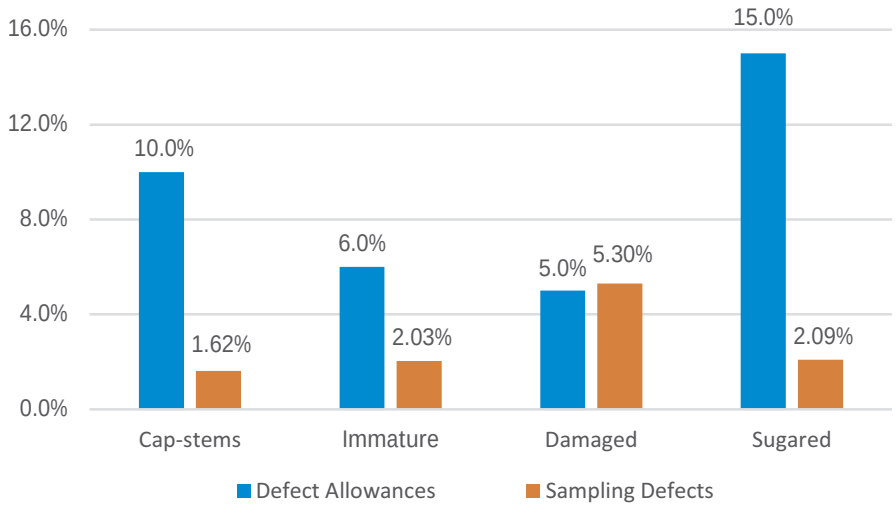
Figure 22: Grapes loss type's estimates in packing house.



To evaluate the potential for dehydration as a strategy to reduce losses and substitute raisin imports, the quality of locally produced raisin samples were evaluated. Samples of three kilograms were collected from hypermarkets and supermarkets, and identified defects were sorted, weighed and expressed as percentages of loss. Figure 23 compares sampling results to the maximum levels allowed as per CODEX standard 1981-67), and show that the defects found in the raisin samples are mostly within the permissible limits (only the damaged raisins percentage was slightly over the allowance). Moisture content was also found to be 14 percent below the maximum allowed of 18 percent.

As identified in the value chain analysis, Egypt's raisin industry is not very well developed, and thus there is room for improvement. Sun drying raisins is the traditional and most common method to dry grapes. However sun drying has some disadvantages as it can reduce the quantity and quality of the final product (Belessiotis and Delyannis, 2009). Investment in the raisin industry could provide a viable economic option as improvements in quality can allow local raisins to compete with imported raisins.

Figure 23: Defects percentage of raisin samples in comparison to maximum allowances as per CODEX standard 67 (1981).



7. Conclusions of food loss analysis

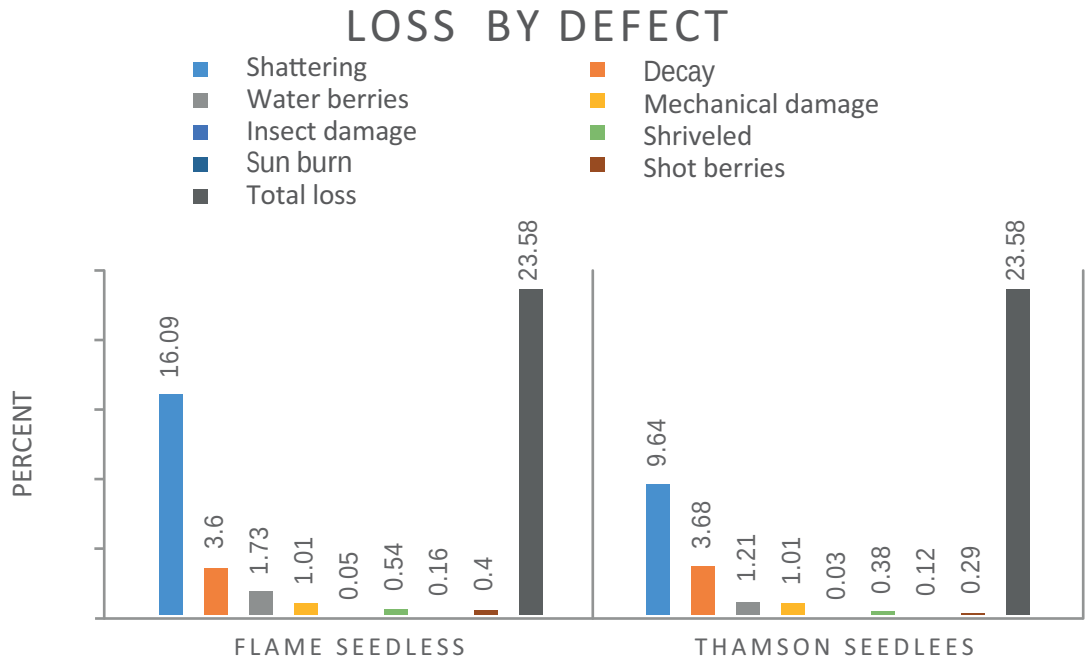
The results of the 2016 survey and the 2017 sampling study are compared in Table 14 below. It is evi-dent that stakeholder perceptions differ from sampling results. Differences in understanding the con-cept of food loss has an influence on the value estimated by stakeholders, and lack of (technical and economic) awareness hampers incentives to implement solutions to reduce food losses. One evident insight is that losses at marketing stages observed through the sampling are much higher than those perceived by value chain stakeholders. The differences in the sampling results between 2016 (in Appendix III) and 2017 also showcase that results are subject to market and study conditions, which can guide the type of practices that can lead to consistent and lasting reduction in losses.

Table 14: Percentage loss results based on survey and sampling at 3 critical points in grapes value chain in Nubaria.

Value Chain Level (CLP)	% Loss (2016 Survey)	% Loss (2017 Sampling)
Farm level	18.6	10.3
Whole sale market Level	5.3	16.41
Retail Market Level	6.7	19.05
Total	28.7	39.72

Similar food loss patterns in the Thompson and Flame sampling (figure 24) can guide the focus on the actions needed to reduce grapes loss. What is most important is not the exact percentage of loss, but the insights gained and the ensuing solutions recommended.

Figure 24: Similarities in the patterns for food losses between flame and thompson seedless varieties.



The synthesis assessment of the main causes of grape losses are summarized below at each critical point level. These specific insights provide guidance for how to reduce losses most efficiently.

At the farm level, attention needs to be given to improving agricultural practices in order to reduce pathological decay, small (shot) berries, water berries, shattering, and physiological disorders. Specifically, lack of awareness and capacity of farm laborers results in over-ripening of harvested grapes and mechanical damages. In addition, inadequate tools and packaging cause mechanical damages, bruising, inoculum diffusion and increased pathological infections.

Suggested solutions at pre-harvest include good cultural practices along with pests and diseases man-agement. Harvesting should be governed by maturity stage indices and job training is recommended for laborers. Hygienic tools and containers should be promoted; when containers or crates are loaded they should be lined with foam or air bubbles. More details on issues and solutions at the farm level are provided in Table 15.

Table 15: Food loss causes and solutions at the farm level.

Loss Type	Causes	Proposed solutions
• Decay (pathological) • Insects' damage • Sunburn • Shot berries • Shattering • Water berries • Mechanical damage • Over-ripening	• High cost of inputs (pesti-cides and fertilizers) and equipment for small-scale growers • Poor agricultural practices • Lack of awareness and capacity of farm laborers • Inadequate harvesting tools and methods • Inadequate equipment • Lack of storage facilities • Climate changes (e.g.: high temperatures)	• Provide access to affordable fertilizers, pesticides, tools and equipment to small-scale growers including hygienic tools and containers lined with foam or air bubbles. • Improve access to financial services for small-scale farmers • Improve extension services to tailor training content and delivery to the needs and context of men and women farmers • Revise and promote extension education (training of trainers & tools or equipment) • Raise awareness and build capacity through exten-sion services and technical visits • Promote a uniform concept of defects and loss • Use an extension field or pilot farms to demonstrate the package of recommendations to producers to reduce losses and improve grape quality • Promote the use of simple cooling techniques • Encourage the establishment of small associations and cooperatives gathering smallholders to provide services contributing to loss reduction • Give farmers' access to meteorological predictive information to adapt growing practices to bad weather • Raise the quality of packages for the local markets supply • Empower women participation.

The main issue at the wholesale level is the lack of storage facilities. Almost all visited wholesale markets lacked appropriate facilities to store the grapes. Typically produce is left in the open-air until sale. Under normal circumstances produce is sold immediately or within a few hours; however this mean that delays in transaction can serve as a major loss factor. Nonetheless losses at the wholesale market can originate at the farm. Non-efficient cleaning of the fruits and the transport containers can lead to decayed and damaged fruits which can spread inoculum to subsequent steps of the chain. Problems at loading and transportation can also result in losses related to the wholesale level. Unlined plastic containers are often overloaded onto uncovered trucks that travel long distances to destination markets. Attention should be placed on minimizing the time for assembly of the crates or cartons and avoiding truck overload. Solutions at the wholesale level are presented in table 16.

Table 16: Food loss causes and solutions at the wholesale level.

Loss Type	Causes	Proposed solutions
• Decay (pathological) • Shattering • Shot berries • Water berries	• Lack of appropriate storage facilities • Trucking in uncovered con-tainers and vehicles • Excessive time from loading to arrival to destination market • Product left in open-air until sale • Non-efficient cleaning at farm level	• Lobbying to improve rural roads and rural electrifi-cation • Promote loading in a structured and modular fash-ion. • Avoid overloading trucks to extend the product shelf-life • Improve post-harvest infrastructures and cooling facilities • Locate wholesale collection points closer to large production areas • Raise wholesalers' awareness and capacities on food loss reduction measures • Establish quality standards and regulations for local wholesale markets

At the retail level, attention needs to be given to sorting, cleaning, and packaging. Produce is often displayed in open air. This can lead to water loss and shrinkage, while heat, pollution and insects can further deteriorate the overall quality. Hypermarkets and supermarkets do not provide adequate cooling. Lastly, rough handling by sellers and consumers also leads to losses. Improving the quality of packaging for the local markets will increase the shelf-life of the products and reduce losses. Causes and solutions at the retail level are summarized in table 17.

Table 17: Food loss causes and solutions at the retail level.

Loss Type	Causes	Proposed solutions
• Decay pathological) • Shattering	• Open-air display • Sorting and cleaning • Packing and packages • Rough handling • Temperature (hypermarkets & supermarkets)	• Raise awareness and capacities on food loss reduction measures • Improve the quality of the package • Keep from direct sunrays and high temperatures • Establish quality standards and regulations for local retail markets • improve the quality of packages for the local market's supply

The observation of lower prices in 2017 highlighted the vulnerability of small-scale growers to prices fluctuations, and how this can translate to lower profit margins and also food loss if the cost structure in the value chain is a disincentive for farmers to invest in good production and postharvest practices. When prices drop, small-scale grapes farmers have limited alternative options for selling their grapes, therefore may decide to store the produce until prices smooth, increasing the risk of loss due to inade-quate storing and cooling systems; farmers may even decide not to harvest at all as observed in the study during 2017, or choose to use less or poor quality inputs.
Table 18 reflects on the value chain analysis performed earlier to break down the constraints to value chain development and food loss from the perspective of small-scale growers.

Table 18: Categories of grapes value chain constraints for small-scale growers.

Category	Finding Constraints
Technology/Product Development	• Inappropriate or nonexistent tools machinery/ technologies • Lack of technical skills (trained labors) • Lack of knowledge and skills in crop husbandry by small-scale growers, especially on quality and food safety aspects • Lack of information on product demand • Limited value addition and processing in the grapes SS • Import of big quantities of raisin
Inputs suppliers and use	• Lack of trusted suppliers • Rising cost of inputs and cost production (fertilizers, pesticides, electricity) • Low quality of pesticides (adulterated) • Poor phytosanitary practices and controls • Insufficient access to financial services for small-scale farmers
Market Access	• Lack of linkages to large buyers (exporters) • Lack of marketing organizations or brokers • Lack of information on product demand • Lack of marketing techniques or methods • Lack of market outlets • Unmet market opportunities • High transportation costs • Shortage of market information for small-scale farmers • Limited use of contract farming modalities
Management and Organization	• Fragmentation of land and inability of producers to organize in economies of scale • Lack of specific training for various stakeholders in the value chain (financial manage-ment, internal organization, production skills, etc.) • Poor organization of large buyers or suppliers • Lack of communication and cooperation between different stakeholders • Weak cooperatives or aggregation mechanisms for small-scale to market collectively and overcome economies of scale issues
Marketing infrastructure	• Lack of marketing infrastructures (packinghouses, precooling and cold storage, cooling transportation) accessible to small-scale farmers

8. Recommended actions

Food loss is a multidimensional problem: interventions at the above critical point levels (farm, wholesale and retail) need to be coordinated and a combination of approaches applied. Planning is needed across the value chain. Integrated actions that can support the way forward include the following:

I. Improve extension and raise food loss awareness.

a. Improve extension services through illustrated publications, simple leaflets, educa-tional movies, slide sets etc. that are tailored to users' needs and capabilities and cover dif-ferent aspects of good agricultural practices, especially diseases and pests management, harvesting and post-harvest handling of grapes. Improving the extension services can also be through the selection of the trainees and the design of the training to actually reflect the needs of value chain stakeholders. For example, to ensure women participation, training delivery should be adapted to ensure that timing, duration and location respect social norms and women's work burden.

b. Great attention should be directed to all actors involved in the chain through the de-sign of educational programs highlighting the importance of loss reduction. Raise value chain actor awareness on good pre-harvest and post-harvest practices through adopted extension services and technical visits. Conduct on-site training to improve the capability of workers to identify defects and ensure a uniform concept of defects and loss recognition. Raise awareness of value chain actors on how to deal with negative impacts of high temperatures and adverse weather conditions.

II. Establish quality standards and regulations for local market to upgrade fruit quality produced for the consumption in domestic (local) market. Improve post-harvest infrastructures and storing facilities to protect the products. Use simple, natural, and low-cost techniques (e.g., keep the product away from direct sun in shaded places, harvest during the cool early morning hours, control pack depth, fruit packing density and use cluster bagging to prevent shatter incidence, open stores for ventilation during the cool of the night, etc.). Improve sorting and cleaning during field packing to discard pathological decay and shot berries. Raise the quality of packages (by introducing new types of packages or by improving the existing one) for the local market's supply and lower the load level on trucks to increase the cargo shelf-life, when reaching the local markets.

III. Improve marketing infrastructures, access to financial services and marketing information combined with technical support on returning the loans and on ways to use the market info.

IV. Encourage the establishment of small associations and cooperatives gathering small holders to provide services that may contribute to food loss reduction (e.g. crop collection, cold storage unites, packing lines, packing and packages, transportation and marketing facilities).

V. Encourage value adding to generate more income and thus actor's standard of living.

VI. Increase the role of women in reducing grapes losses by using adding value processes and promote the active involvement and participation in all the post-harvest sector activities (education, training, management).

VII. Promote processing, in particular vine leaves packing, grapes-based food products such juice, jam and jelly, grapes drying into raisins, as a market-oriented activity to add value, create new marketing channels, generate more income, and encourage better production and postharvest practices and reduce losses.

The recommended way forward to ensure that losses are reduced consists of finding economic value and economic opportunity for investment in such interventions. The present study has **identified three business opportunities** in the grape value chain that reduce food losses.

Firstly, there is a market opportunity to **develop horticultural data services.** This will allow for better planning and reduce the occasions of food losses. By provision of price information of alternative mar-kets and marketing channels it can expand farmer options. This service could be provided by one of the national communications companies and could be offered through mobile app.

Secondly, a **specialized center for marketing horticultural products** can serve farmers and/or farmer's associations for reaching local and export final markets including retail companies and outlets, export-ers, processing and industrial companies. Given the absence of vertical integration in the grape value chain, this center can be established by developing one of the marketing associations in the production area. The center would assist in reducing losses by increasing market access and could also provide extension services for farmers. The center can also offer access to needed infrastructure and technology, for example, pre-cooling, cold storage and cold transportation vehicles. In case of problems facing export such missing the window, inadequate climate for timely maturity, delay in transportation, there should be access to proper cold storage or processing facilities as alternatives to add value or prevent loss.

Finally, **investing in raisin production** can provide alternative markets for grapes and create added value. This require small investments in equipment as well as the awareness and implementation of food safety standards. For example postharvest grape loss can be minimized by utilizing a solar dryer for grapes. The expected cost of a solar dryer may be in the range of 10 000 to 200 000 LE depending on its design, capacity, efficiency, and durability. Despite consistent domestic demand for raisins, local processing activities and procedures are still very limited and rudimentary. Supporting the development of more advanced raisin production would help to smooth the wide price fluctuations in fresh markets, add value to fresh grapes and reduce imports. It is highly recommended to pursue an in-depth feasibility study and pilot activity for grapes drying in Egypt.

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Ideal Fruitful https://idealfruitful.com/ accessed Oct 3rd, 2020.
Grow Organic https://www.groworganic.com/ accessed Oct 7th , 2020.

Glossary

Critical Loss Point (CLP):
The points where food losses have the highest magnitude, the highest impact on food security, and the highest effect on the economic result of the Food Supply Chain (FSC).

Food loss and waste (FLW):
The decrease, at all stages of the food chain from harvest to consumption in mass, of food that was originally intended for human consumption, regardless of the cause.

Food losses:
refers to the decrease in the quantity or quality of food that was originally intended for human consumption, at all stages of the food chain prior to the retail and consumer level, resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers.

Food security:
Defined by the United Nations' Committee on World Food Security, is the condition in which all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life

Food Supply Chain (FSC):
The connected series of activities to produce, process and distribute food.

Food waste (FW):
food appropriate for human consumption being discarded or left to spoil at retail and consumer level, resulting from decisions and actions by retailers, food service providers and consumers.

Low Loss Points (LLP):
The points where food losses are actually unexpectedly low.

Nutritional value (NV):
Refers to contents of food and the impact of constituents on body. It relates to carbohydrates, fats, proteins, minerals, additives, enzymes, vitamins, sugar intake, cholesterol, fat and salt intake.

Quantitative (or physical) food losses:
The decrease in edible food mass available for human consumption.

Qualitative food losses (QFL):
The decrease of a quality attribute of food (nutrition, aspect, etc.), linked to the degradation of the product, at all stages of the food chain from harvest to consumption.

Subsector (SS):
One of several parts or pieces that fit with others to constitute a whole object - A branch of one agricultural sectors. E.g. fishery is a subsector of agriculture or grapes is a subsector in the fruit production.

Value Chain (VC):
The connected series of value-adding activities to produce, process and distribute food.

Appendix I Pictures of grape varieties mentioned in this study.

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Crimson seedless

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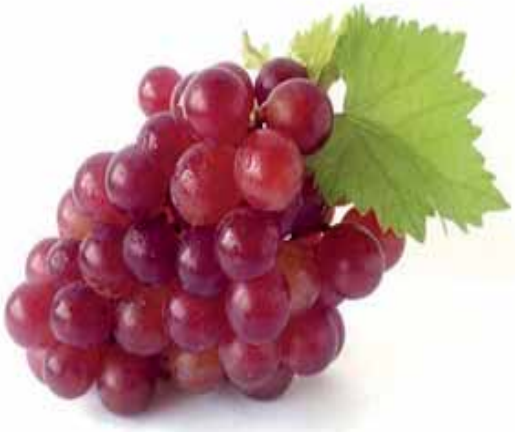
Red Globe



©idealfruitful

Flame seedless

©Peaceful Valley Holdings, Inc.

Thompson seedless

Appendix II Screening literature.

Technical literature

	Author (s)	Institution, year
Measuring postharvest losses of fresh fruits and vegetables in developing countries	Lisa Kitinoja and Adel A. Kader	The Postharvest Education Foundation PEF White Paper 02-15 September (2015)
Grape Good Practice in Egypt: A Review on Good Practice	Hassan K.M. Bekheit, Magdi Latif,	Plant Protection Research Institute, ARC, Egypt- Food and Agriculture Organization, Regional Office for the Near East and North Africa. (2015)
Losses and Waste in the Food Supply Chain	Adel Kader	University of California at Davis. May, (2011).
Reduction of the incidence of postharvest quality losses, and future prospects	Dov Prusky	Department of Postharvest Science Agricultural Research Organization, the Volcani Center Bet Dagan Israel. De-cember (2011)
Food waste within food supply chains: quantification and poten-tial for change to 2050	Parfitt, J., Barthel, M. & Macnaughton, S.	Resource Futures, Bristol, UK. julian.parfitt@resourcefutures.co.uk (2010)
Postharvest Losses of Fruits and Vegetables in Developing Countries: A Review of the Literature	Adel Kader	UCDavis November (2009)
GRAPE: Post-harvest Operations	Fabio Mencarelli, Andrea Bellincontro	Department of Food Science and Technology, University of Viterbo, Italy. mencarel@unitus.it (2005)
Increasing food availability by reducing postharvest losses of fresh produce	Kader, A.A.	UCDavis, Proc. 5th Int. Postharvest Symp. Acta (2005)
Post-harvest losses and sustainable development.	Samar Shaarawi	www.iamb.it/share/integra_files_lib/files/cd/SA_reports.pdf. (2003)
Table grapes nutrition and management	Jorge Perez-Harvey	An ATUT technical report USAID project no 0240-263, publication No. 76 April (1999)
Waste and Losses during Table Grape Export	Dr. Mohamed M. El-Ansary	Agricultural Technology Utilization and Transfer Project/RONCO (1998)
Postharvest Losses of Fruits and Vegetables in Developing Countries a Review of the Literature	edited by Blond	University of California - Egypt, Agricultural Development Systems Project Final Report (1984)
Loss in the post-harvest phase of the product until the retailer and economic applications, Paper No. (211)	Nabil Tawfique Hebash	Farming systems development project, the Ministry of Agriculture - University of California March (1984)

Economic literature

Document title	Author (s)	Institution, year	Publisher	The Results of the Study
An economic study of the productive and marketing waste of some vegetables and fruit crops	Ahmed Abdel Aziz Magdi Latif,	2006	Assiut University	Abdul Aziz 's study (2006) dealt with the loss of the fadden production which was estimated at about 1.537, 1.714, 3.929 for the crops of orange, grapes and winter tomatoes respectively. The most important factors causing this loss is the bad weather and the inadequate performance of service operations. The study estimated the marketing loss at about 5.38, 0.757, 0.926 tons for the crops of orange, grapes and winter tomatoes respectively . The reasons for this loss were the collection, packaging operations ,transportation and the wholesale markets sales. The total total productive and marketing loss average has reached 580.38, 430.09, 1170.96 pounds / acre for crops previously mentioned
Economic Evaluation of trading processes of horticultural crops between the farm and the wholesale market	Agricultural Economics Research Institute	2002	Agriculture Research Center	In a study of the Agricultural Economics Research Institute of and the Institute of Horticulture Research (2002) a comparison was held between the traditional method of farmers, and improved method of the research team concerning harvesting operations, sorting, grading, packaging and transportation. The damage ratio according to the traditional method was estimated at 1.3% , 1.03%,7%, 5.74%, 3%, 1.25%, 4.7%, 1.5,2% for crops of oranges, bananas, guava, mango, grapes, apples, apricots, peaches and figs respectively, while the damage ratio according to the improved method was estimated at about 0.7%, 0.5%, 1.4%, 1 %and 1 %for crops of orange, mango, grapes, apples and peaches respectively. As for vegetable crops the damage ratio according to the traditional method was estimated at about 5.7%, 2%, 5.4%, 4%, 4.2%, 5.1%, 0.2, % 5.8%, 2.4 %for crops of tomatoes, zucchini , cucumbers, white eggplant, pepper, potatoes, artichokes, garlic, beans, potatoes, watermelon and cantaloupe respectively, while the damage ratio according to the improved method was estimated at about 3.3%, 2%, 4.5%, 1.4%, 3.85%, 5.1%, 0.2%, 0.8%, 1.5 %for crops of tomatoes, zucchini , cucumbers, white eggplant, pepper, potatoes, artichokes, garlic, beans, potatoes and cantaloupe respectively

Document title	Author (s)	Institution, year	Publisher	The Results of the Study
Waste of fruits and vegetable production through stages, its causes and how to reduce it	Salah El-Din El-Zoghbi	2004	Cairo University	The study of (El Zoghbi and others 2004)indicated that the loss average of fruit crops was estimated at 25% of produc-tion, which is equivalent to 2281 million pounds in 2001. The study pointed out that this loss occurred through several stages of preparation, crop growth, harvesting , trading and marketing . The study indicated some loss ratios of some fruit crops namely strawberries, grapes, oranges, dates, mango, apricot, banana, which were estimated at 30% 0.28% 0.20% 0.19% 0.18% 0.14% 0.22% respectively
Agricultural Waste and its Effects on the Egyptian Agricultural Sector	Ragab.M. Zein	2000	the Egyptian Journal of Agricultural Economics	Zein's study2000 estimated the value of the loss of fruit crops at about 693.4 million pounds in 1997. The highest value of the loss was of mangos, bana-nas and orange crops whose loss values were estimated
Analytical study of the marketing policies of important Egyptian crops	Ahmed Mahmoud Imam Radwan	1991	Ain-Shams Uni-versity	(Radwan's study 1991)said that storage in refrigerators decreased the loss to about 23%- compared with losses of about 20% when stored in Alnwalat
The role of technological progress in the development of agriculture in Egypt	Alice Sami Faraj	1990	Cairo University	The most important factors causing losses in the agricultural sector were the lack of technological and technical facilities and the poor econom-ic resources.
Analytical study of the marketing policies of important Egyptian crops	Ahmed Mahmoud Imam Radwan	1991	Ain-Shams Uni-versity	(Radwan's study 1991)said that storage in refrigerators decreased the loss to about %2-3 compared with losses of about %20 when stored in Alnwalat
The post-harvest loss from the producer's stage to the retailer and its economic applictions	Nabil Tawfiq Ha-bashi	1984	The project of improving the agricultural methods the ministry of agriculture California University	In Habashy's study (1984) the loss ratio of potatoes in the farm amounted to about 11.86% due to the wrong har-vesting process and the length of time between harvesting and transport to the market. The loss ratio was estimated in both the wholesale market and the retail market at about 5%, and 4 0.8%, respectively. As for the grapes the loss ratio was estimated at the farm at about 25.3% of which 15% was as a result of crop dissolving. The loss ratio was estimated in the stage of marketing (wholesale and retail market) at about 43.5%, 29.98% of each of the palm leaves and cardboard boxes containers respectively. The loss ratio of the tomato crop was 8.96% and 17.89%, and 23.9% at the farm , the wholesale market and the retail market respectively, meaning that the total losses in the stage of marketing amounted to about 41.8%

Appendix III. 2016 Thompson and 2017 flame food loss sampling results.

Sampling results at late harvest (end of August) in 2016 mark a high loss percentage reaching 28.4 percent. Losses were sizable for every defect identified (Table A1), and unlike the harvest results in 2017 (at end of June) the highest percentage was due to decayed fruits (8.5 percent). Regarding wholesale-level losses, the data illustrates that defects observed at this level were shattering, pathological decay, water and shot berries. Total losses amounted to 8.04 percent. Retail market defects are shattering and decay (Table A2). At hypermarkets and supermarkets, decay recorded a higher percentage (4.3 percent and 4.7 percent) respectively comparing to informal markets (1.5 percent). Shattered berried showed was highest in informal markets. Flame seedless losses were 9.04 percent at harvest, 23.58 percent at wholesale and 17.83 percent at retail. Higher losses at the wholesale and retail levels (relative to Thompson seedless) may be attributed to the higher than usual diversion of un-exportable quantities of flame seedless grapes into the national market.

Table A1. Sampling results of thompson seedless at late harvest (end of august) in 2016.

Causes of Loss	Loss Percent					
	Harvest	Wholesale	Retail			
			Hypermarket	Supermarket	Informal market	Average Retail
Decay	8.50	2.08	4.33	4.75	1.53	3.53
Shattering	3.20	4.27	10.66	12.67	13.82	12.38
Water berries	2.60	0.85	NA	NA	NA	NA
Shot berries	3.40	0.84	NA	NA	NA	NA
Insect Damage	3.50	NA	NA	NA	NA	NA
Sunburn	3.50	NA	NA	NA	NA	NA
Mechanical damage	2.30	NA	NA	NA	NA	NA
Over ripening	1.40	NA	NA	NA	NA	NA
Total Loss	**28.40**	**8.04**	**14.99**	**17.42**	**15.35**	**15.92**

Table A2. Sampling results of flame in 2017.

Causes of Loss	Loss Percent					
	Harvest	Wholesale	Retail			
			Hypermarket	Supermarket	Informal market	Average Retail
Shattering	4.07	16.09	17.34	16.12	8.19	13.88
Decay	3.11	3.60	1.63	4.34	1.29	2.42
Water berries	1.35	1.73	0.60	1.21	0.30	0.70
Mechanical damage	0.07	1.01	0.17	0.25	0.55	0.32
Insect damage	0.03	0.05	0.00	0.00	0.29	0.10
Shriveled	0.12	0.54	0.00	0.16	0.22	0.13
Sun burn	0.00	0.16	0.00	0.00	0.00	0.00
Shot berries	0.28	0.40	0.15	0.49	0.20	0.28
Total loss	**9.04**	**23.58**	**19.89**	**22.57**	**11.03**	**17.83**

Table (A3): The economic value of loss at farm level based on survey data of loss.

Loss at farm level	Productivity (Tons/feddan)	Quantity loss (Tons/feddan)	Notes
18.6%	8	8*18.6%= 1.49 tons	18.6%
Total production cost (LE/feddan)	**Total production cost (LE/Ton)**	**Value of loss in production cost (LE/feddan)**	
16 564 6	2 070 5	2 070 5*1.49= 3.081	In case of all quantity of loss unsold
Average farm gate price (LE/Ton)	**Average price of loss (LE/Ton)**	**Value of loss in sell-ing price (LE/feddan)**	
4 000	1500	(1.49*4 000) - (2.27*1 500) 3 725	In case of loss quantity sold at lowest price
Grapes production in Nubaria (Tons)	**Quantity loss (Tons) (Loss = 18.6%)**	**Total grapes production in Egypt, in 2015 (Tons)**	**Quantity loss (Tons) (Loss= 18.6%)**
948 995	176 513	1 686 706	303 607
Value of loss in selling price in Nubaria		**Value of loss in selling price (estimate of national-level production)**	
(176 513*4 000) –(176 513*1 500) **441 million LE**		(303 607 *4 000) –(303 607 *1 500) **759 million LE**	

Source: collected and calculated from survey data.

Appendix IV Grape defects contributing to qualitative and quantitative food loss as per table 8.

©FAO/Yehia Salah

Shot berries.

©FAO/Yehia Salah

Decayed berries

©FAO/Yehia Salah

Shriveled berries on red and white varieties

©Purdue University

Insect damaged on berries.
Top left: thrips, Top right: fruit fly, bottom left: fruit worm. Bottom right fruit worm.

©FAO/Rashad Hegazy

Shattered berries

©FAO/Rashad Hegazy

Mechanical Injury.

©FAO/Yehia Salah

Sun burnt berries

This report analyzes the value chain and presents a food loss assessment for grapes in Nubaria District, as part of the project "Food Loss and Waste Reduction and Value Chain Development for Food Security in Egypt and Tunisia" implemented by the Food and Agriculture Organization (FAO) in collaboration with the Ministry of Agriculture and Land Reclamation (MALR) with funding from the Italian Agency for Development Cooperation. This report aims to deepen understanding of the grapes value chain and the particular problem of food loss, in order to promote sustainable, market-based solutions that respond to the needs of small-scale holders.

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