Food and Agriculture Organization of the United Nations

Food loss analysis for TOMATO 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

This report analyzes the value chain and presents a food loss assessment of tomato crop in Nubaria District and Sharqia Governorate, 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 Egyptian Ministry of Agriculture and Land Reclamation (MALR) with funding from the Italian Agency for Development Cooperation.

Egypt is the fifth largest producer of tomatoes in the world and tomatoes are a very important crop in Egypt in terms of consumption and income for smallholder farmers. In 2015, the area cultivated with tomato was estimated at 469 000 feddans[1], representing 32 percent of the total area cultivated with vegetables in Egypt. The selection of Nubaria and Sharqia for this study is based on being the largest production volume and cultivated area, since Nubaria produces 20 percent of the tomatoes in Egypt, and Sharqia produces over 11 percent.

The analysis of food loss in the tomato value chain was based on available literature and secondary data, as well as a primary data collection through sampling, survey, field observations and focus group interviews. The collected information allowed for a value chain mapping and analysis, estimates of food loss levels at critical points, as well as a SWOT analysis for the sector and recommendations for reducing food loss and increasing tomato competitiveness in Egypt.

Several weaknesses and bottlenecks all over the value chain were found, in addition to high levels of quantitative and qualitative losses. The tomato value chain in Egypt is dominated by small-scale growers using traditional growing methods on highly fragmented land plots. Up to 80 percent of the land cultivated with tomato is on plots of 5 feddans or less, with the remaining 20 percent of land categorized as medium to large-scale farms. Only a fraction of tomatoes goes to processing or exports, leaving the bulk of fresh tomatoes in the domestic distribution system that is largely informal, dominated by traders and intermediaries, and traditional in terms of technology, handling practices and marketing methods. The weaknesses in the tomato value chain are directly related to high levels of quantitative and qualitative food loss. However, without applied quality standards or customer awareness about quality, the damaged tomatoes that standard definitions would consider as losses tend to be sold anyway.

Tomato losses appear along the value chain as a quantitative loss (or decrease in mass) and as a qualitative loss (which affects economic and nutritional value and food safety). The loss assessment was conducted in 2016 and 2017 through sampling and survey questionnaires. Survey respondents – farmers, wholesalers, and retailers – reported perceiving a much lower level of losses as compared to the findings of the technical sampling based on identified quantity and quality symptoms. This reflects a lack of awareness about loss, which does not recognize the value in investing in food quality through postharvest operations like sorting, grading and culling. Instead, damaged products accumulate along the value chain from farm to traders and wholesalers until they reach retail markets.

1 feddan = approximately 1 acre

At the farm level, sampling conducted in 2017 estimated quantitative losses at 35 percent in Nubaria and Sharqia, while qualitative losses were estimated at 12 percent. According to farmers surveyed, losses at farm level were 18 percent in Nubaria and almost 19 percent in Sharqia caused by bad weather followed by losses during harvest. At this level of the value chain, quantitative losses were mainly attributed to insect injuries, mechanical injuries and physical damage as a result of direct sun exposure or the use of palm crates for packaging. The qualitative losses of tomatoes were mainly attributed to the absence of proper information related to production and postharvest operations which is mainly due to the lack of extension services, widespread presence of low-quality high-priced uncertified inputs and the application of agricultural practices that don't comply with international best practices.

At the wholesale level, sampling revealed that quantitative loss was 40 percent and the qualitative loss 19 percent. According to wholesalers surveyed, loss was perceived to be about 5.7 percent and increased to 16 percent if the tomatoes stayed in the wholesale market for 3 days without selling. The causes of the losses found at the wholesale markets were mainly due to the accumulated damage caused by inappropriate packaging, such as palm crates whose edges are rough and cause abrasions to the fresh tomatoes. These crates are also overpacked which causes compression injuries to the fresh produce. During transportation, unpaved roads and poorly equipped transportation vehicles cause major injuries due to vibration. Furthermore, overloading the trucks to decrease the cost of transportation adds to the compression injuries. The produce reaches the market without any sorting or grading. Wholesales also have no storage facilities adding one more cause to the reduction of the already short shelf life of the tomatoes.

At the retail market level, lower quantitative and qualitative losses were found in hypermarkets (34 percent) and supermarkets (41 percent) as compared to informal markets (61 percent). The retailers' perceived the loss to average at 7.4 percent in retail markets which they attributed mainly to the rough handling by consumers and conditions of the open-air market. At this level, the different types, sizes and practices of the market channels seem to affect the quantitative losses. Both hyper and supermarkets tend to apply sorting and cooling processes, while informal, medium to small sized markets experience higher losses due to lack of sorting and cooling facilities, and poor conditions at open-air markets.

The analysis has shown that the tomato subsector has not reached its full potential. Value addition processes are still rudimentary and tomato trade is considered immature with unexploited potential for exports. The upgrading of current production and postharvest practices as well as the introduction of new processes and products will contribute significantly to the development of the sector. Therefore, the study concludes by proposing solutions related to better production, distribution, and postharvest practices that can help to reduce losses and develop the tomato subsector. In particular, promoting good pre- and post-harvest practices through training and awareness-raising, improving business support services by establishing direct marketing centers, promoting tomato value addition especially drying (dehydration), providing market information on a daily basis, training to increase the role of women, and educating consumers about nutrition and healthy consumption habits.

1. Introduction and framework

Food loss and waste (FLW) along food value chains constitutes a major problem, especially in Egypt. Under the umbrella of the cooperation between the Egyptian Ministry of Agriculture and Land Reclamation (MALR) and the Food and Agriculture Organization (FAO), the project "Food Loss and Waste Reduction and Value Chain Development for Food Security in Egypt and Tunisia" was signed in October 2015 with a special focus on two selected horticultural crops for Egypt: tomato in Nubaria District and Sharqia Governorate, and grapes in Nubaria District. The major aim of the project is to develop evidence-based FLW reduction programmes at the national level and support relevant stakeholders in promoting more inclusive, efficient and sustainable agri-food value chains.

The current report presents a value chain analysis and case study of food losses along tomato value chains in Lower Egypt, carried out between 2016 and 2017 by the Agriculture Economic Research Insti-tute (AERI) and the Horticulture Research Institute (HRI) and consolidated into a final report by sectoral experts.

With the ultimate objective being the reduction of FLW in the tomato value chain, the value chain analysis aims at analyzing the tomato value chain in order to allow for the promotion of sustainable, market-based FLW solutions that correspond to the needs and capabilities of small-scale growers and value chain actors, whereas the food loss case study aims to identify and quantify the levels and causes of food loss in the tomato supply chains studied. The combined results seek to identify measures to reduce losses focusing on their technical and economic feasibility, social acceptability and environment-friendliness in the context of the value chain, leading to concrete proposals to implement a food loss reduction program.

2. The tomato subsector

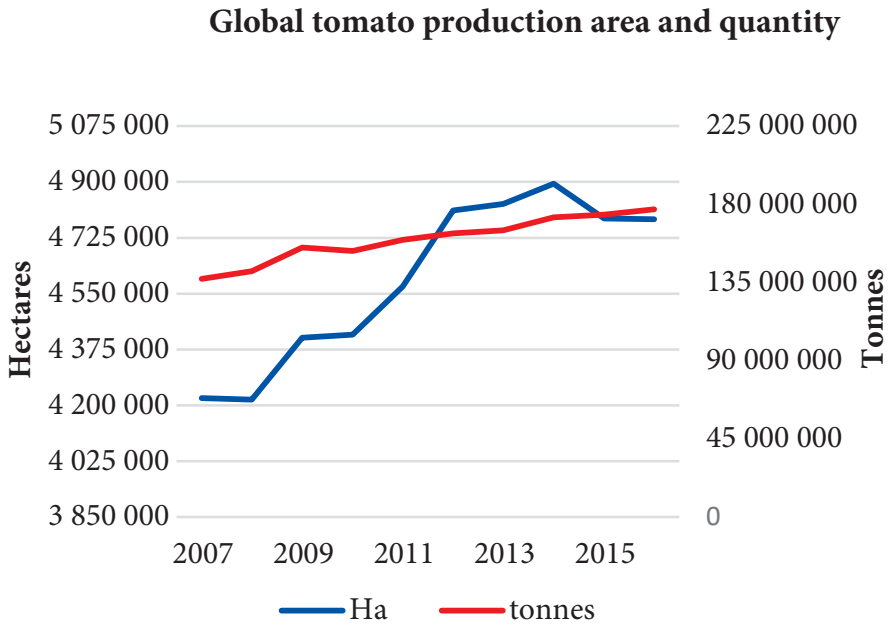
2.1. Background

Globally, tomato (Solanum lycopersicum L.) is one of the largest consumed vegetables worldwide. Tomatoes are a major dietary source of the antioxidant lycopene which has been linked to many health benefits, including reduced risk of heart diseases and cancer. They are also a great source of vitamin C, potassium, folate and vitamin K1 (phylloquinone). In Egypt, tomatoes are very important for daily consumption, used as fresh in salad or processed in cooking.

2.2. Global trends

The total global production of tomatoes was estimated at 177 million tonnes in 2016 (FAO, 2018a), an increase of 29 percent in the total production volume over the past 10 years from 2007 to 2016 (see figure 1). Global tomato cultivation increased by 13 percent in terms of total harvested area during this same period.

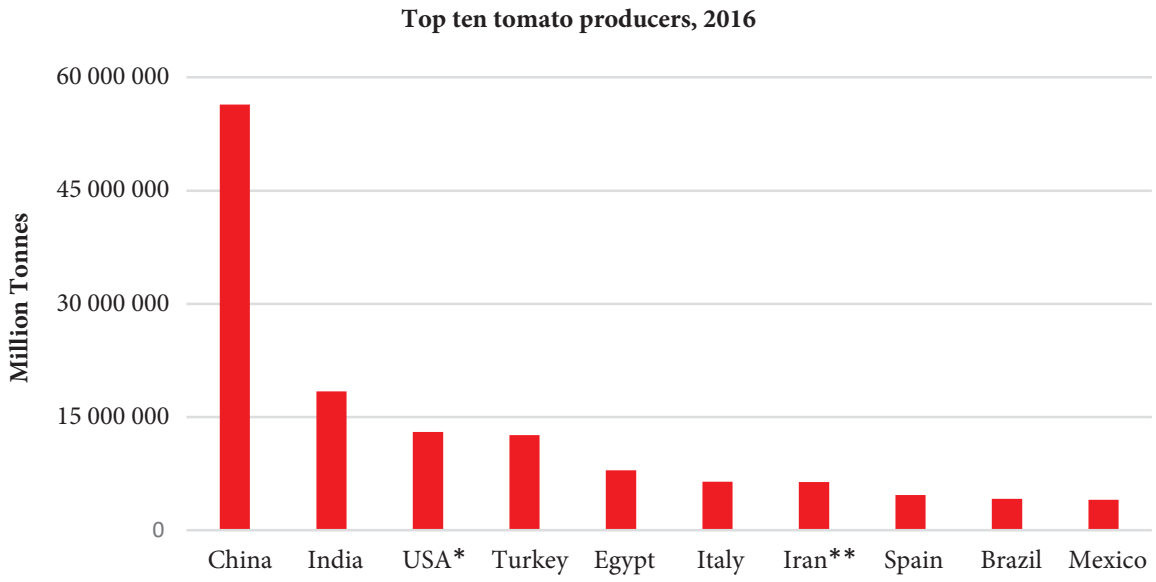
Figure 1: Global tomato production area and quantity, 2007 to 2016.



Source: FAO, (2018a).

The top five global tomato producers in 2016 were China (32 percent), India (10 percent), USA (7 percent), and Turkey (7 percent), followed by Egypt ranking fifth worldwide with 7.9 million tonnes or 4 percent of the global production volume (FAO, 2018a). Figure 2 shows the top ten producing countries, including also Italy, Iran, Spain, Brazil and Mexico, who together account for 76 percent of global tomato production.

Figure 2: Top ten producers of tomatoes in 2016.



* United States of America

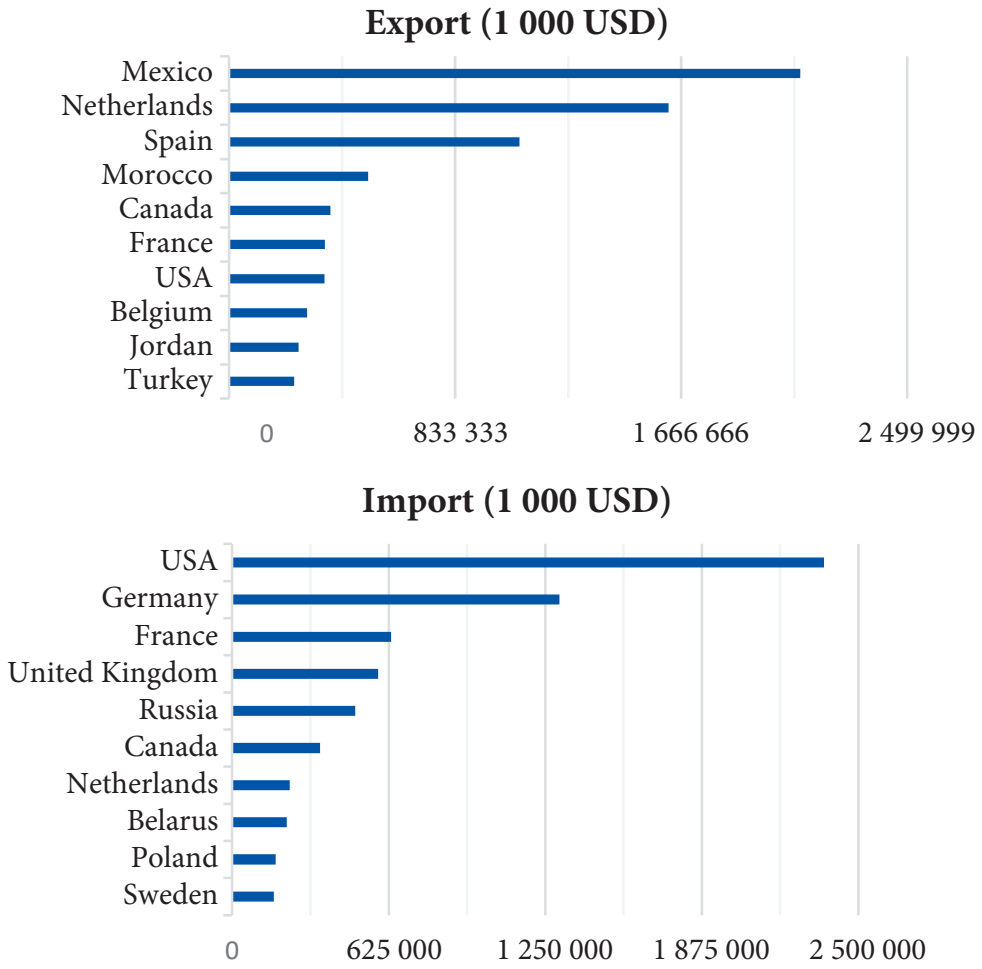
** Islamic Republic of Iran

Source: FAO, (2018a).

Despite global production of over 177 million tonnes of tomatoes in 2016, the international trade of fresh tomatoes is relatively small, as it just reached 8 million tonnes. Only about 25 percent of global production is used for processing purposes (FAO, 2018a).

Global exports of fresh tomatoes reached a total of USD 8.6 billion in 2016. This represented an increase of 3.4 percent compared to the previous year, and of 58.5 percent for the period 2006 to 2016 (FAO,, 2018a). In terms of volume, international trade increased by 3.9 percent since 2015 and by 39.4 percent since 2006. Figure 3 illustrates the value of tomato trade in 2016 for top-ten importers and exporters.

Figure 3: Top ten countries with highest value of tomato imports and exports, 2016.



Source: FAO, (2018a).

Mexico, the Netherlands and Spain account for about half of the world's fresh tomatoes exports, account-ing for 45.4 percent of the total volume and 55.5 percent of the total value worldwide in 2016. Egypt ranked 18th among the exporting countries with total exports of USD 66 million, representing 0.8 percent of global exports.

Global imports were valued at USD 8.5 billion in 2016, with USA and Germany importing the largest quanti-ties and together counting for 42 percent of import value. Egypt's tomato imports are negligible.

Table 1 shows quantity and value of tomato imports across the NENA region. This region is interesting for Egypt to explore as new export market, especially that its proximity can reduce transport expenses.

Table 1: Main importers of fresh tomatoes from NENA countries, 2016.

Country	Import Value (USD)	Import Quantity (tonnes)
United Arab Emirates	127 201 000	179500
Saudi Arabia	113 553 000	160 337
Iraq	39 695 000	100 655
Kuwait	37 264 000	77 510
Qatar	32 788 000	57 792
Oman	16 588 000	28 601
Bahrain	13 054 000	31 825
Libya	5 377 000	13 368
Lebanon	4 484 000	5 131
Syrian Arab Republic	4 431 000	18 725
Total	**394 435 000**	**673 444**

Source: FAO, (2018a).

Tomatoes can be processed in a wide variety of products for end use or as intermediary products for fur-ther processing, such as: paste, peeled, whole or chopped and canned, ketchup, dried, sauces, juice, con-centrate etc. However, tomato grown to be industrially processed only account for about a quarter of to-mato production.

Generally, there are remarkable differences between the supply chain of fresh tomatoes and that of pro-cessed tomatoes due to the difference in the purpose of usage and the different stakeholders of each chain. Varieties suitable for processing are produced in contract farming arrangements between proces-sors and growers, farmers' organizations or traders in order to maintain consistency of quality, quantity and prices. As such, the price of processed tomatoes is more stable than fresh tomato prices.

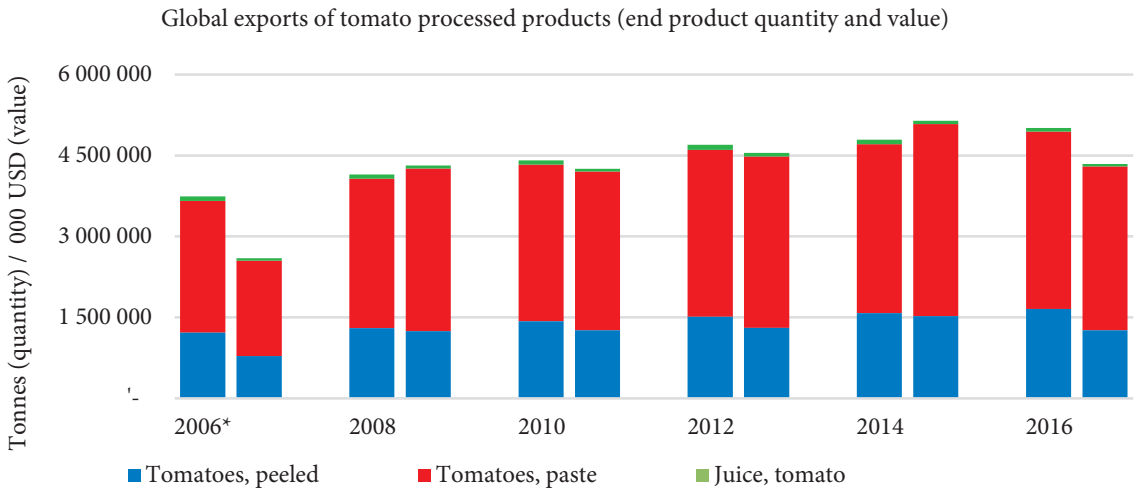
While comparable national-level data for production are not available, trade data allow to compare inter-national demand and trade flows for processed tomato products. Figure 4 shows a slow but steady in-crease in volume of international trade by 34 percent between 2006 and 2016, reaching 5 million tonnes in 2016 (in terms of end product weight). In the same decade, the value of global exports of tomato products also saw a remarkable 67 percent increase.

Hundreds of varieties of tomatoes are currently available in the world market; breeders tend to introduce new varieties of tomatoes every day for different purposes of production,

taking into consideration crite-ria such as productivity, fruit size, total soluble solids (TSS) content, firmness, resistance to diseases, toler-ance to soil salinity and harsh weather conditions, density of cultivation, method of cultivation, application of modern mechanization, etc. Farmers select the varieties they produce based on their productivity, which in turn is determined by factors such as the type of cultivated soil, temperature, common diseases in the area, and farmers' expertise.

Tomato paste (paste, purees, concentrate) represents more than 65 percent of the total volume of tomato products traded. Volume of paste trade increased 34 percent between 2006 and 2016, whereas volume of peeled tomato trade increased by 36 percent. Trade in tomato juices, on the other hand, is minimal and has decreased.

Figure 4: Global exports of tomato products, 2006 to 2016*.



*For each year, left column = volume in tonnes and right column = value in 1000 USD

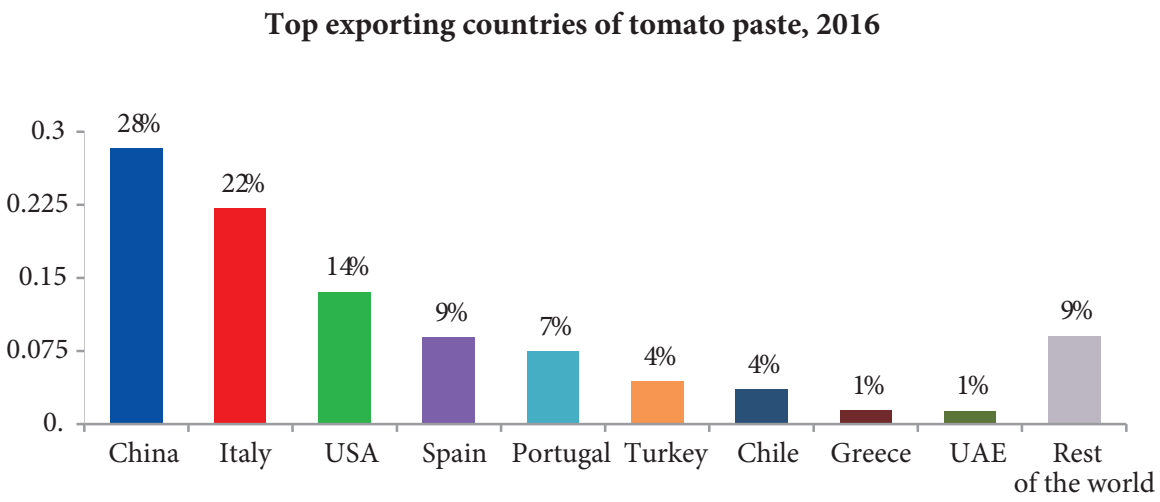
Source: FAO, (2018a).

Figures 5a and 5b break down the main global importers and exporters of tomato paste, the largest cate-gory of tomato processed product traded. According to FAO, (2018a), 3.2 million tonnes of tomato paste were exported in 2016; Figure 5a shows that China was then the biggest exporter with 28 percent of the world exports followed by Italy (22 percent), USA (13.5 percent), Spain (9 percent), and Portugal (close to 7.5 percent).

Egypt is a net exporter of tomato paste; however, the amounts are minimal. Almost 21 000 tonnes of tomato paste were exported in 2016, which is less than 1 percent of global exports, versus about 9 000 tonnes imported.

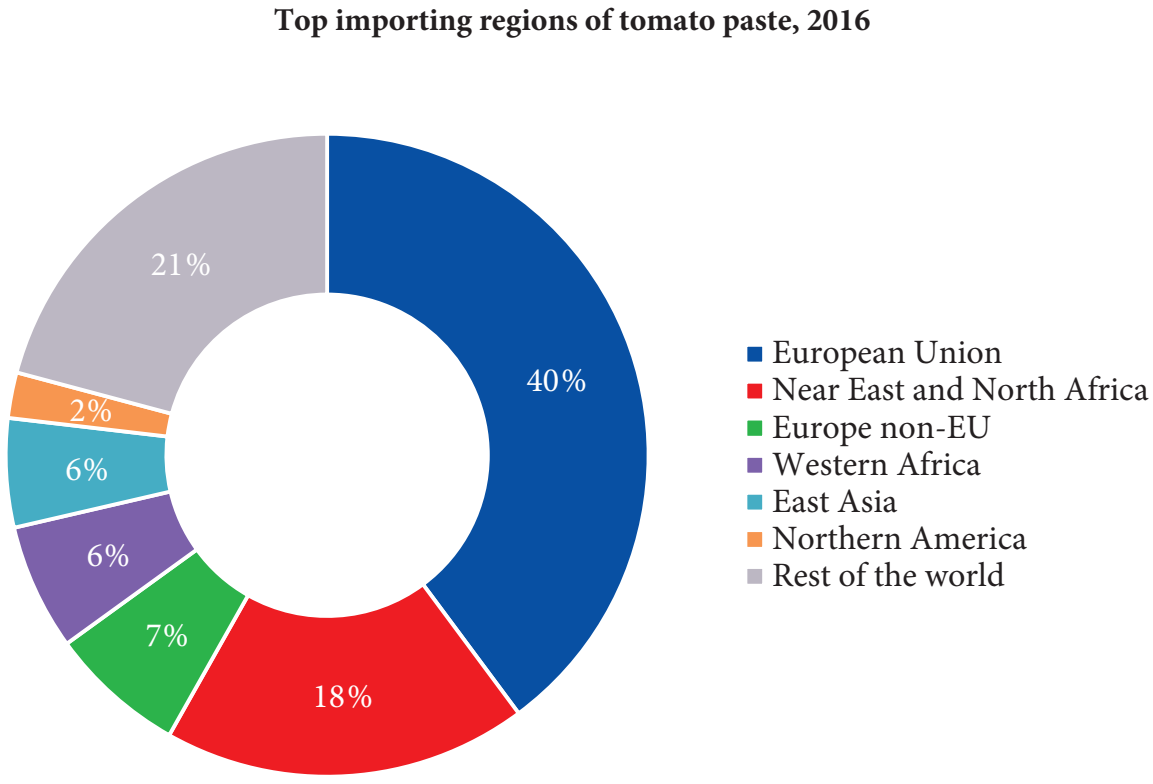
As per figure 5b, the European Union dominates the regions importing tomato paste (40 percent), followed by the Near East and North Africa with 18 percent, then by non-EU European countries with 7 percent.

Figure 5a: Main worldwide exporters of tomato paste, 2016.



Source: FAO, (2018a).

Figure 5b: Main worldwide importers of tomato paste, 2016.



Source: FAO, (2018a).

2.3. Status and importance of the Tomato Subsector in Egypt

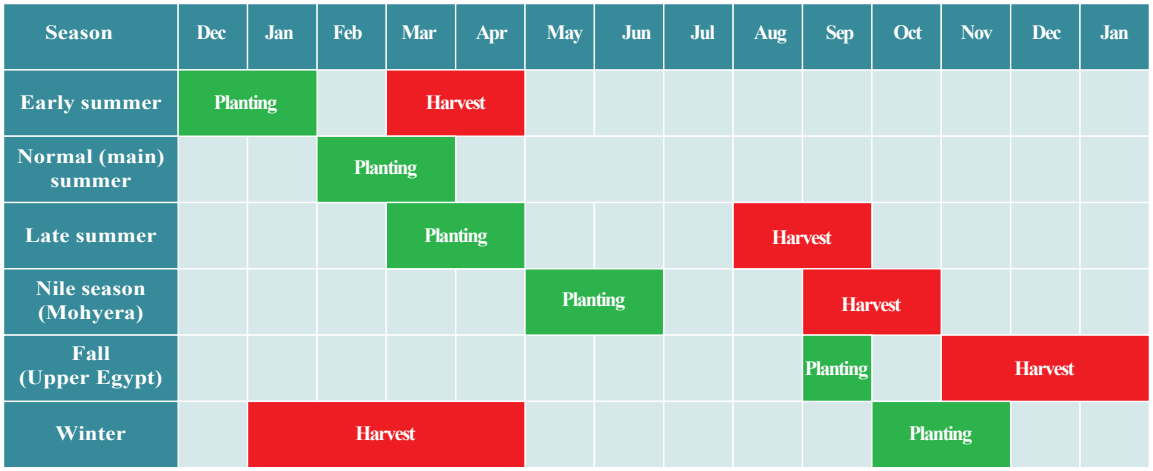
Tomato in Egypt is a unique crop that has the ability to be produced in all governorates and is available all year round. It is ranked as the first crop among vegetables in terms of total production capacity and culti-vated area. Internationally Egypt is the fifth largest producer worldwide (see paragraph 2.1) with total pro-duction volume of 7.9 million tonnes in 2016 (FAO, 2018a).

In 2015, the area cultivated with tomatoes in Egypt was estimated to be 469 000 feddans[2], representing 32.2 percent of the total area cultivated with vegetables (MALR, 2016a). The volume of tomato production was estimated to reach 7.7 million tonnes, which represents 47.5 percent of the total vegetable production in 2015.

Tomato subsector development has been relatively stable over the past 15 years, showing a slight increase in productivity (data series is provided in Annex 1). The average cultivated area over the period 2001 to 2015 was about 503 000 feddans, with an average annual growth rate of about 0.7 percent. Production volume reached about 8.2 million tonnes on average during the same period, with an average annual growth rate estimated at 1.7 percent. Productivity on average was 16.2 tonnes/feddan.

Tomatoes are mainly grown in open field on small land plots by a multitude of small-scale farmers using traditional methods. It is a moderate weather crop, most suitable to day and night temperatures of 22 to 28 °C and 18 to 21 °C, respectively. The optimum range of relative humidity for tomatoes growing is from 65 to 70 percent.

Favorable weather conditions allow for six tomato production seasons along the year, as per the below calendar that shows the planting months followed by the harvesting months throughout the year:



The majority of tomato production in Egypt comes from the Nubaria District[3] (20 percent of production volume and 20.8 percent of cultivated areas), followed by Sharqia Governorate (11.3 percent of produc-tion volume and 11.6 percent of cultivated areas). Summer season is the main season for tomato production in Nubaria District, while winter season is the main growing season in Sharqia Governorate (Table 2).

Further details on tomato varieties grown in the two areas and variety productivity can be found in Annex 2.

[2] 1feddan = approximately 1 acre = 4 200 m²

[3] Nubaria (including Bangar el Sokar) is a cultivated area of reclaimed desert land, not a fully-fledged governorate. It belongs administratively to three governorates; Beheira, Alexandria and Matrouh, however is reported as a distinct region by MALR

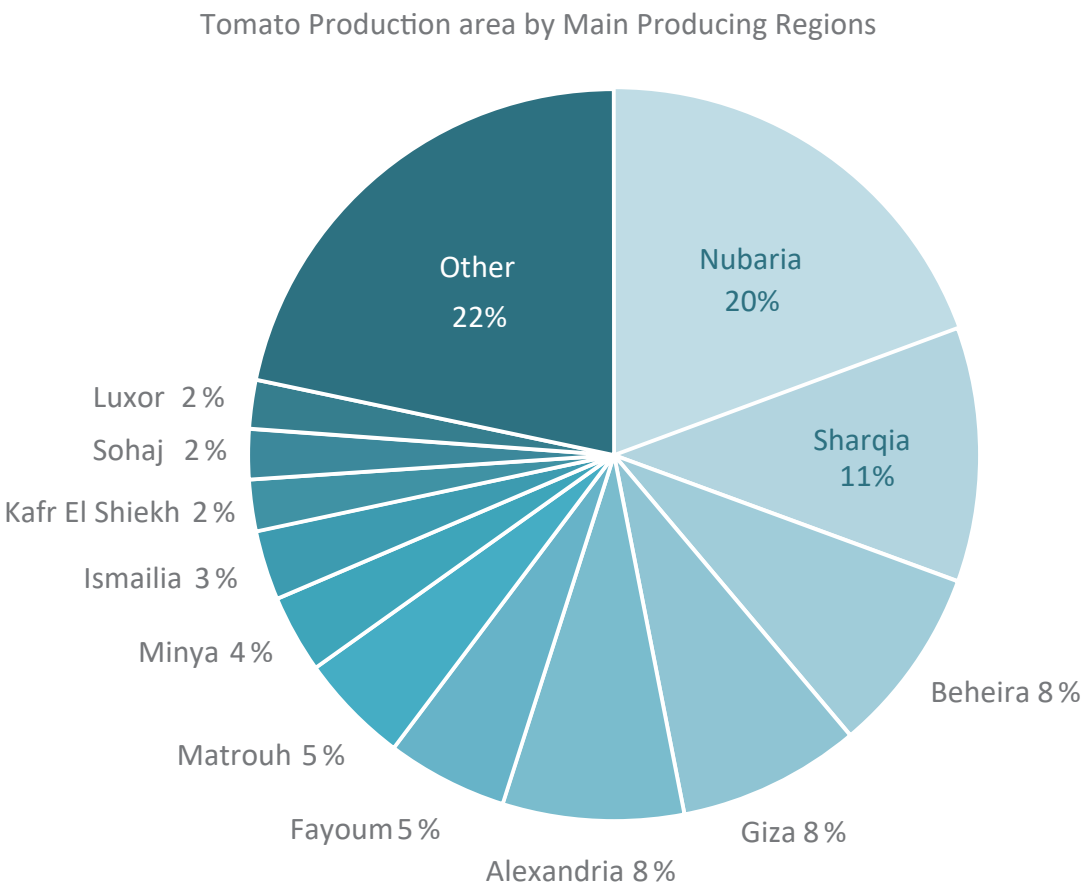
Table 2: Total area and production volume of tomato in Egypt in 2014 to 2015, by season.

Governorate or District	Winter tomato 2014-2015 (January- April)		Summer tomato 2015 (April - September)		Nile tomato 2015 (September- December)		Total	
	Area (Feddans)	Production (Tonnes)	Area (Feddans)	Production (Tonnes)	Area (Feddans)	Production (Tonnes)	Area (Feddans)	Production (Tonnes)
Nubaria	25 561	519 068	2559 245	894 946	12 803	151 641	97 609	1 556 596
Sharqia	30 341	530 196	23 466	338 828	341	3 240	54 148	872 264
Other	131 233	2 259 247	159 392	2 616 997	26 128	413 054	316 753	5 298 357
Total	**187 135**	**3 308 511**	**242 103**	**3 850 771**	**39 272**	**567 935**	**468 510**	**7 727 217**

Source: MALR (2016a).

The data in Figure 6 shows that the main five production regions in Egypt are Nubaria, Sharqia, Beheira, Giza, and Alexandria, which combine for more than 55 percent of the total tomato production volume of Egypt. The data also shows that tomato production is widely distributed across most governorates in the country, with amounts coming to the markets from every corner at different times of the year.

Figure 6: Relative importance of tomato producing regions in Egypt in 2014 to 2015



Source: MALR (2015).

Tomato is considered an important cash crop in Egypt that generated high profits, although varying since that time due to national economic reforms, which led the average production cost to increase[4] .
Nonethe-less, tomatoes remain an economically critical crop to Egypt.

The scale of production, or farm sizes, and production methods differ from one region to another with a rough breakdown as follows:

1. About 25 percent of the total production area is located in Nubaria and Matrouh regions, where the average farm size (as one plot) measures 5-6 feddans and is provided by the Egyptian govern-ment to fresh graduates through land reclamation projects ("new lands"). Normally these new farmers cultivate one crop in the plot (monoculture), are educated and business oriented. The productivity in this area averages between 25 to 35 tonnes/feddan.

   More than 50 percent of the total production area is distributed among farmers with plots measur-ing 1 to 3 feddan(s). Most of the landowners within this category are traditional farmers; they gener-ally have lower productivity of 15 to 20 tonnes/feddan.

2. About 20 to 25 percent of the total production areas are for medium to large-sized farms that apply modern production techniques (such as vertical cultivation) and Good Agricultural Practices (GAP) principles. Their productivity is the highest, at around 60 to 70 tonnes/feddan and with higher crop quality and value. These farms are scattered in the Cairo-Alexandria desert road, Minya, Fayoum, Assiut, Sohag, Luxor, Ismailia regions.

Harvest is generally manual in almost all cultivated areas, with the exception of a minor presence of agro-mechanization, modern technologies and good agricultural practices, but these are applied on a limited basis in farms or regions where there has been some exposure to improved technologies.

As such the tomato subsector is largely traditional in terms of production and distribution practices and mainly confined to the domestic market. Furthermore, it is largely a market for fresh products - about 95 percent of Egypt's production is sold in the fresh market through traders, wholesalers, and traditional and modern retail shops. Only an estimated 2 to 3 percent is directed to processing factories and a smaller amount is directed towards export channels.

Despite the dominance of tomatoes in vegetable production in Egypt, and its importance in the Egyptian cuisine and diet, there are extremely high levels of losses both qualitative and quantitative. Tomato losses are related to reasons such as improper growing practices and conditions, insect injuries, mechanical dam-ages during harvest and postharvest handling, and others. In fact, losses in the supply chain of horticultural crops constitute a major problem, especially in the post-harvest handling chain up to the retail level.

[4] In December 2016 a strong devaluation took place and the currency fluctuated considerably in the following months.

2.4. Markets for Egyptian tomatoes

2.4.1. Domestic market

Demand for fresh tomatoes is high in Egypt all year round; tomatoes are a staple in the Egyptian daily diet and the base of many local dishes. The supply of tomatoes, on the other hand, is highly dynamic: interna-tional seed companies constantly introduce new varieties, and no reliable market trends or predictions can be made. Farmers select varieties to improve productivity, but rarely to respond to marketing trends. At the same time, usually tomatoes are not differentiated by variety when displayed in retail outlets, and con-sumer awareness about different varieties is low.

The majority of farmers sell the crop directly to traders, according to the daily price per palm crate (tradi-tional package crafted from palm fronds). About 30 percent of the produced crop enters the wholesale market directly, specifically when producers are medium and large scale. Small-scale producers usually sell their products to intermediaries or to the wholesale market, and very few have direct access to exporting agencies. Regarding processing, a small percentage of producers sell the crop to tomato paste factories, which also collect damaged and spilled tomatoes.

Tomatoes are sold to traders and in wholesale markets in palm crates with an average weight of 18 to 25 kg. The part of production which is sold to tomato paste factories is packaged in plastic crates carrying an av-erage of 25 to 30 kg/crate. The average price of tomatoes is EGP 40 to 45[5] (USD 2.25 to 2.52) per crate in 2018 (for a crate weighing approximately 22 kg). However, records show wide variation in prices, ranging from EGP 20 to 25 (USD 1.13 to 1.4) in some seasons and up to EGP 250 (USD 14.1) per crate in other seasons. This crop is colloquially referred to as "Crazy tomato" because price fluctuations are common all year-round. The average price for tomato paste is at least EGP 1 200/ton (67.5 USD) for the best quality. Farmers are responsible for transportation costs only if they sell in wholesale market themselves, otherwise the inter-mediary is responsible for transportation and any other logistics or marketing costs.

The main end markets for tomato production in Egypt are the following:

- Three types of local markets for fresh vegetables (formal wholesale markets, such as El-Obour, 6th October, El-Nozha, El-Zagazig; Informal wholesale or retail markets; Hypermarkets and supermarkets).
- Export markets (not exceeding 1.5 percent of the overall production).
- Local markets for processed tomato.
- Export markets for processed tomato.

[5] In 2017 to 2018 the exchange rate was USD 1 = EGP 17.8

There are three main methods used to sell tomato in the local market for **fresh tomato,** as follows:

Kelala sale:

Kelala system is a traditional method of sales, whereby the farmer sells the entire crop in bulk before harvest ("on the plant") to a trader or wholesaler who estimates the total yield. The process includes bargaining between the two parties about the expected market prices, and part of the payment is made in advance while the balance is paid upon collection. The balance can be fixed or variable ac-cording to the crop's market price at the time of payment.

Per kilo selling at farm gate:

Farmers sell their products at the farm gate at a per kilogram price. Also in this case, the process in-volves bargaining, but is more dependent on the prevailing market price at the time of trade.

Per kilo selling in "Chalish":

This process takes place when the traders fund the farmers during the early production stage, as credit in cash or in kind. The trader then takes 8 to 10 percent commission of the production total sales or a pre-agreed portion of the harvest at prices below the market average price.

The market for **processed tomato products** mainly consists of two types of products, tomato paste and sundried tomatoes.

Tomato paste: There are 16 tomato-processing factories in Egypt, mainly located in Lower Egypt, with a total daily capacity of approximately 7 500 ton of fresh tomatoes, as shown in (Annex 3). The average fac-tory operates only 80 days/year, a problem mainly attributed to unreliable supply due to the absence of contract farming agreements.

Tomato paste is produced through processing whole tomatoes containing an average percentage of solids ranging from 4.5 to 6 percent, then the tomatoes are crushed into pulp which is then cooked and concen-trated. It takes approximately 6 kg of fresh tomatoes to produce 1 kg of tomato paste (26 to 28 ^{o}brix).

Some countries, such as Italy and Spain, are characterized by the presence of specific fresh tomato varie-ties with high percent of soluble solids capable of producing 1 kg of tomato paste from only 5 kg of fresh tomatoes. Adopting these varieties would improve dramatically the efficiency of production in Egypt and hence competitiveness on the international market.

Dried tomatoes: Drying tomatoes is a new value addition technique recently introduced to the Egyptian tomato subsector. Its expansion is relatively slow in the Egyptian market due to low international con-sumption rates and demand, very little domestic demand, and limited experience among Egyptian produc-ers.

Despite the low demand, Egypt has a competitive advantage in drying tomatoes using solar energy, due to relatively high temperatures and the presence of solar energy all year round. Sun drying does not generally require large investment and the processors (dryers) operate during high tomato seasons to ben-efit of lower tomato prices. Different regions are suitable for drying in different seasons, depending on factors like humidity, dust, and availability of tomato varieties suitable for processing.

Sun-dried tomato processors deal with farmers groups, traders, and medium to large scale farmers through contract farming to secure supply of fresh tomatoes. In many cases, they provide financial assis-tance to farmers to guarantee the right varieties are used and monitor costs and quality since top-grade tomatoes are needed for drying.

Tomato processing, in general, is considered a good investment opportunity for small-scale enterprises, employment generation and gender empowerment. According to informants' opinion, the production of 1 tonne of dried tomatoes provides approximately 32 working days for the production of fresh tomatoes, 35 working days for sun drying tomatoes, 10 working days for sorting, grading and packaging, and 30 working days for further processing and handling for a total of over 100 working days along the value chain.

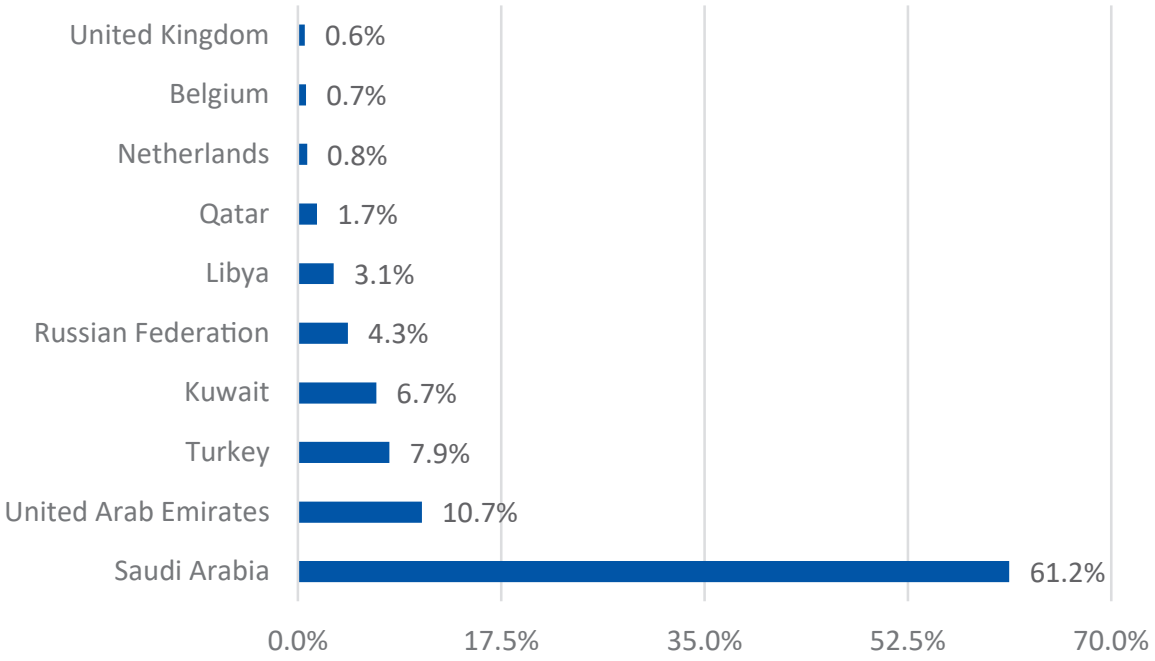
However, the fresh and processed tomato value chains are highly divergent. For fresh tomatoes, harvest-ing is usually done manually using traditional techniques and production takes place in either uncovered (open) field, protected (under greenhouses) or tunnel systems. On the other hand, tomatoes grown for processing include more mechanization in both production and harvesting stages, and usually involve large scale farms with relatively higher density to allow for more control on production costs, especially labor, which can consume about 22 percent of the total production cost.

Tomatoes grown for processing would require contract farming agreements, to allow for planning cost and volume of production at factories. Contract farming is still undeveloped in Egypt, however tomato paste factories have recently started establishing this kind of agreements.

2.4.2. Export markets

Although tomato production in Egypt reached about 8.2 million tonnes on average during the period 2001 to 2015, the average exported quantity was only 1.3 percent of the production or 107 000 tonnes. In 2016, exports were 109 707 tonnes with the top ten destination markets for Egyptian fresh tomatoes shown in Figure 7: Saudi Arabia, United Arab Emirates, Turkey and Kuwait together account for almost 87 percent of exported Egyptian tomatoes. Overall, almost 85 percent of total exports are directed to Arab countries and over 14 percent of fresh exports are directed to Europe including the Russian Federation (the main Eu-ropean importers are Turkey and Russia).

Figure 7: Top ten egyptian tomato export markets by trade volume (%), 2016.



Source: UN (2018).

Annual exports of fresh tomatoes (including Table and cherry tomatoes) just exceeded 60 000 tonnes in 2016 (less than 1 percent of production), noting that cherry tomatoes were about 3 600 tonnes. Processed tomato (paste and peeled) net exports (i.e. export minus import) neared 13 000 tonnes as shown in Table 3. There is no accurate data for sun-dried tomatoes and tomato powder, however it is not believed to ex-ceed 500 tonnes.

Table 3: Tomatoes and tomato products exports and imports 2012-2016 (000 tonnes).

	2012		2013		2014		2015		2016	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Fresh Tomatoes	23.5	0.1	74.8	0.1	61.8	0.1	58.7	0.2	62.6	0
Tomatoes, paste	10.1	10.1	4.3	3.6	26.7	3.6	20.2	6.3	20.7	8.9
Tomatoes, peeled	0.6	0.4	0.4	0.7	0.8	0.4	0.1	0.6	1	0
Juice, tomato	0	0	0.1	0.2	0	0.2	0.1	0.2	0	0
Totals	**34**	**11**	**80**	**5**	**89**	**4**	**79**	**7**	**84**	**9**

Source: FAO, (2018a).

The tomatoes trade business in Egypt is considered to be immature with underexploited potential. Egypt has considerable opportunities to expand its tomato exports; however, there are obstacles that currently hinder this sector from reaping its full potential, as indicated below:

- Production methods: The majority of locally produced fresh tomatoes rely on open unprotected cultivation, which has low productivity in terms of quantity and quality and does not meet interna-tional markets' requirements. Conversely, the production technology for fresh export (vertical, mechanized cultivation) is expensive and is not available nor it is widely known locally The contract farming concept is still underdeveloped, although recommended to ensure a reliable supply for export as well as for developing the tomato processing sector.

- Market orientation: Local producers don't distinguish between varieties demanded by local fresh markets versus those demanded by export markets. Also, although many varieties are grown in Egypt, highly profitable varieties suitable for processing are still unexplored. At the same time, Egyptian consumers' awareness about the various tomato varieties is usually low.

- Post-harvest handling: Lack of information on good practices, poor post-harvest infrastructure and logistics lead to high levels of quantitative and qualitative losses.

- Value chain governance: Land fragmentation results in a vast number of small-scale producers with no clusters' or economies of scale. Likewise, cooperatives play an insufficient role in organiz-ing producers. The key players in tomato supply chain are traders, who exert significant influence but are not motivated to invest in value chain upgrading and development.

- Lack of extension services and follow up bring about low productivity levels and food safety issues. Currently adopted agricultural practices (fertilization, pest control) do not meet safety and hygiene regulations.

- Profitability: Fluctuation and instability in tomato prices make it difficult to predict profitability, thus reducing incentives to invest in expensive value addition practices and technologies related to exporting (certification, testing, packaging, shipping, etc.).

3. The Tomato supply chain in Nubaria and Sharqia

3.1. Case study rationale

Nubaria District and Sharqia governorate were chosen as a case study given the size and importance of their tomato production. Chapter 3 provides insights based on data and information gathered through ex-pert interviews, focus group discussions with value chain actors, and questionnaires issued in 2016 and 2017.

The reasons for studying the tomato value chain in Nubaria District and Sharqia Governorate are the following:

- These regions ranked as first and second in terms of total cultivated area of approximately 153 000 feddans (97 609 feddans in Nubaria – 54 148 feddans in Sharqia) representing more than 30 percent of the total cultivated area in Egypt.

- They are economically important tomato production areas with 20 percent and 11.3 percent re-spectively of the total production areas of tomatoes all over Egypt in 2015. Fifty seven percent of the tomato production in Nubaria is harvested in summer, while 60 percent of the tomato produc-tion in Sharqia is harvested in winter.

- Both areas are characterized by family farms and high land fragmentation, which means that the tomato value chain in the two regions supports the economy of more than 45 000 families. Toma-to crop is labor intensive where 1 feddan of tomatoes needs at least 110 labour days (70 labour day for harvesting and 40 labour days in production), so the subsector in the two regions can be calculated to provide 16.8 million labour days, amounting to 67 000 permanent job opportunities.

- Nubaria District has potential for value addition through tomato drying and generating employ-ment opportunities, especially for women.

- In Sharqia governorate there is a big international wholesale market in New Salahia, which could represent a good opportunity to enhance market linkages, reduce losses and increase tomato exports.

3.2. Survey methodology

Field visits/observation, questionnaire, interviews and focus group discussions were used to analyze the value chain of fresh tomatoes, the linkages along the value chain, and how these factors relate to losses.

1. In 2016, a series of questionnaires were issued to value chain actors at critical loss points (CLP) along the chain. A total of 98 tomato farmers were surveyed in Nubaria and Sharqia Governorate; 45 from Nubaria among three villages in Bangar El Sokar District (El Ola Village, El Zohoor Village and Village #5), and 53 farmers from two different areas of Sharqia Governorate (El Kassasin and New Salheya).

2. The case study also used semi-structured interviews with 27 wholesalers and 15 retailers in Cairo, Giza and Zagazig (Sharqia). As for the retail level, the study team visited Carrefour in Cairo and Hy-per One in Giza as a sample of hyper markets. Ten traditional retailers were surveyed at Dokki and Faisal markets ("souq") in Cairo, and five traditional retailers in Zagazig, Sharqia.

3. In 2017, 15 farmers attended a group discussion in Nubaria and another 15 farmers in Sharqia to determine the causes of losses and costs related to tomato production.

4. Regarding gender and the role of women in the tomato value chain, information was gathered from women in Nubaria and Sharqia in 2016 and 2017 through focus groups and in-depth inter-views. Four focus groups were held in Nubaria, involving 74 women in total; in Sharqia, six focus groups were conducted, with a total of 47 women. Secondary tools included observations and in-formal discussion in the field, as well as project records (such as training and workshop participa-tion) and literature. Findings were compiled and validated by project stakeholders.

The sample of farmers surveyed cultivate, on average, 6.6 feddans of tomato in Nubaria and 9.1 feddans of tomato in Sharqia. Table 4 shows the land distribution of sampled farmers in both areas. In Nubaria, which is part of the "new" reclaimed desert lands, the average productivity of tomatoes among the sample was found to be 20.7 tonnes/feddan. In Sharqia, the average productivity sampled from the "old" Nile del-ta lands and newly reclaimed lands in Sharqia's eastern edge was estimated to be 23.3 tonnes/ feddan.

Table 4: Land tenure among farmers surveyed in Nubaria and Sharqia

Land Tenure	Nubaria		Sharqia	
	% of farmers	Average area cultivated with tomato (feddans)	% of farmers	Average area cultivated with tomato (feddans)
< 5 feddans	49	3.2	40	3.9
6-10 feddans	38	6.6	34	8.4
> 10 feddans	13	19.2	26	18
Total (weighted average = average land area x % of farmers)	**100**	**6.6**	**100**	**9.1**

Source: Data collected from survey.

The majority of farmers surveyed completed their intermediate education (40 percent in Nubaria and 28.3 percent in Sharqia), while 16 percent in Nubaria and 13.2 percent in Sharqia reported to have completed higher education. Illiterate farmers counted 7 percent in Nubaria and a much higher share in Sharqia (22.6 percent).

3.3. Tomato value chain map and stakeholders

This section summarizes the main actors involved in the selected tomato value chain in Nubaria District and Sharqia governorate.

Input suppliers

The inputs for tomato cultivation include mainly: seeds or seedlings, fertilizers, irrigation systems, pesti-cides and machinery. Input suppliers are usually small-scale, formal or informal business owners that sup-ply producers in their local districts. Medium to large-sized producers usually have access to formal large distributors of inputs.

Payment: Producers mainly use one of the following payment methods during their transactions with in-puts' suppliers:

- Payment in cash upon purchase.
- Payment of a deposit upon purchase and of the balance after the crop is harvested. The latter in-cludes a late payment percentage).
- Payment after the product is harvested and sold, at a very high additional markup due to full late payment.

Fertilizers and pesticides: Most fertilizers and pesticides are sold to small and medium scale producers via many small informal businesses located in nearby districts or villages - each village was found to have more than ten shops of fertilizers and pesticides. These businesses often deploy a sales agent to the field, direct-ly advertising their products to several local producers each season. In the case of fertilizers, producers use a combination of industrial product mixtures and organic fertilizers produced at the farm from agricultural and animal wastes.

Overall, there is no official system to guarantee the quality of fertilizer or pesticides, and producers can either purchase low-cost low-quality inputs or rely on reputable but more expensive distributors/sources. Large producers depend on distribution centers mainly located in Cairo, Ismailia, Alexandria and Delta, where they purchase higher quality and non-adulterated inputs. Lately, stricter regulations have been im-posed on the quality of inputs all over Egypt, which helps to improve input quality but can increase production costs and decrease yields if farmers cannot afford the price and thus use less inputs.

Lastly, cooperative associations are a key supplier of certified fertilizers to farmers at a subsidized price, but usually insufficient in terms of the quantities needed. Cooperatives nowadays are investigating the possibility of supplying other chemical inputs and machinery at subsided prices and some initiatives have been taken in this regard.

Tomato seedlings: There are no registered public nurseries responsible for supplying seedlings near the major areas of production, even though farmers are totally aware of the importance of high-quality seed-lings for productivity and quality. The farmers consulted reported a constant rise in the prices of seedlings due to the high inflation prevalent in the

period since late 2016[6]. They reported Heinz variety seedlings as being the cheapest available in market at EGP 65/tray (USD 3.65/tray) of 200 plants, and mentioned that other varieties might cost up to EGP 180/tray (USD 10.11/tray). Some seedling nurseries provide an after-sales service where they monitor the seedling cultivation process for an additional cost ranging from EGP 30 to 35/tray (USD 1.7-1.96/tray).

Farmers

Farmers select the varieties they will cultivate based on their experience or recommendations from suppli-ers or private extension agents. They purchase various materials from input suppliers, prepare the land, cultivate the crop, implement pest control, harvest the fruit and pack it for the market.

Small-scale producers usually sell their products to intermediaries or to the wholesale market, and very few have direct access to exporting agencies. These producers rely on family labor for crop production and harvesting and they try to limit production costs by purchasing cheaper inputs. Conversely, medium and large-scale producers are often able to sell directly to wholesale markets, tomato paste factories and exporting agencies. Large-scale producers can manage to hire permanent as well as seasonal labor and they can afford to purchase higher quality inputs and benefit from economies of scale during production.

Farmers are usually organized in farming cooperatives associations in each village. Inputs suppliers, finan-cial institutions and traders interact with farmers through the cooperative associations.

Laborers

Large producers hire both permanent and seasonal labor, while small producers (less than 5 feddans) main-ly depend of family labor and occasionally hire seasonal labor from their own village. Permanent laborers often come from distant villages by means of an agent. The average number of labor-days required to grow and harvest tomatoes is 90-110 per feddan. 1 kilogram of tomatoes has a labor cost of EGP 0.25 to 0.35 (USD 0.01 to 0.2), and the proportion of labor costs over total costs of production amounts to approxi-mately 20 to 22 percent (down from 25 percent a few years ago because costs of other inputs have become proportionately higher). The average fee for day laborers in harvesting is EGP 70 (USD 3.9). In Sharqia, fe-male workers represent about 50 percent of the labor force although generally classified as family labour. In Bangar El Sokar, Nubaria, female workers comprise only around 10 percent of the labor force since most women choose to work in the neighboring industrial zone in Borg El Arab.

Intermediaries / traders

The main actors in the tomato value chain in Egypt are traders, especially those who own distribution shops and wholesale market stalls. Local traders collaborate with small-scale producers in their own villag-es, or supply to the main traders in the wholesale markets. They exert significant influence over the whole value chain, especially but not only through the functions or operations they cover, such as:

[6] In 2017, the exchange rate was USD 1 = EGP 17.8

- Provide inputs/credit to small farmers. In most cases, traders supply farmers with transplants and fertilizers, or provide monetary credit (an average of EGP 5 000 to 10 000 per feddan; USD 281 to 562 per feddan) to purchase these inputs.

- Own and rent the palm crates used for harvesting and packing material along the chain.

- Provide transportation. Traders control much of the harvesting and post-harvest operations, by di-rectly supervising the harvest, packing and loading of fruits on trucks and selling the crop to the wholesale markets or processing factories based on the market daily or weekly price.

- Sell the final product. Traders take around 10 percent of the sales value from farmers in return for selling their products in the markets.

Tomato trading can be divided into several systems:

- Traders (wholesalers) own shops in the wholesale market and either directly or through intermedi-aries make informal contacts with farmers to supply their shops with tomatoes all year round. Traders provide farmers with a down payment (EGP 5 000 to 10 000 per feddan) to ensure the whole crop produced will be delivered to them, and the deposit is deducted from the price of the final product. Farmers mentioned that the wholesale market deducts 10 percent from the total in-voice as selling commission, and that traders exert control over tomato prices by charging higher selling commissions for trading services.

- Intermediaries: They collect products from small farmers to sell to the wholesale market, upon a commission. In many cases the intermediary buy from the farmers through "Kelala" system (see paragraph 2.3.1 Domestic Market).

- Traders open their own sales outlet inside production areas and collect the crop from farmers. They pay farmers according to the daily price which is determined based on the main wholesale market in Cairo.

- Contract farming between processors and individual farmers, farmer groups or traders where pric-es are fixed.

The tomato trade systems described above, with the exception of contract farming, are almost entirely informal. No written or formal agreements are used to govern transactions, nor invoices or receipts usual-ly issued. This puts farmers at a disadvantage, as they often bear the risk of damages or losses which take place even following the production phase - traders will sell the farmers' product for a commission but may not pay in full in the event of losses, and no record exists of what volume was delivered by the pro-ducer in the first place. Written contracts occur only between tomato paste factories and traders or big farmers, where the factories provide farmers with seeds or transplants with guaranteed quality.

Medium scale farmers, on the other hand, usually directly sell their production to the wholesale market or through key traders, whereas large-scale farmers normally produce fresh tomato for export market and in some cases for processing or drying purposes.

Transporters

Transportation procedures depend on the different trading systems. When trading involves an informal contract between farmers and traders, the traders rent out palm crates with a capacity of 20 to 22 kg to farmers for the price of EGP 2 per trip (USD 0.11 per trip) (the crates themselves cost EGP 25 (USD 1.4) and can last 1 to 2 years or 5 to 6 uses). Traders use their own trucks (in most cases) to transport from the farm to the wholesale market. When farmers do not sell through intermediaries, they either use their own trucks or rent trucks to transport the crop to the wholesale market. The typical truck used by farms close to re-gional wholesale markets is an open-air pickup carrying about 2 tonnes of product, but for long distances bigger trucks are used carrying 5 to 7 tonnes. Trucks with a capacity of 25 tonnes are used to transport tomato to paste factories.

Trucks are normally non-refrigerated, and cover distances up to 100 to 300 km from Sharqia and Nubaria to reach the two main wholesale markets in Cairo and 6th of October, in addition to other smaller whole-sale markets in the neighboring governorates.
There is no data available for the number of transporters in the selected region. They are not well orga-nized and mainly work individually and informally. Transportation from wholesale to local retail markets is usually by motorbike or smaller pickup trucks.

Processors

The processor's main role is to transform fresh tomatoes into another product that has longer shelf life, easier handling requirements, and higher value, such as tomato paste, ketchup, canned tomatoes, and sundried tomatoes. Processors rely on traders and large-scale farmers to supply them with raw materials. In order to tackle issues related to price fluctuations and lack of consistency in supply, processors started to promote contract farming.

Exporters

The role of exporters in the tomato value chain is marginal, since most of the crop is directed to the do-mestic market. Exporters to Arab countries are mainly trading agencies or medium or large-scale farmers. For the EU market channels, the role of exporters is performed by big farmers. In the case of processed and dried tomatoes, exporters tend to directly deal with the big local producers (in most cases the produc-er is registered as exporter).

Financial institutions

Some farmers in the studied areas of Nubaria and Sharqia finance their production activities through the Agricultural Bank of Egypt, however the main and most effective financing source for small scale farmers remains the intermediaries and input suppliers. In the latter case, farmers fulfill their input needs from local input suppliers purchasing on credit. In some cases, farmers obtain the inputs without paying any deposit and pay in full after the crop is cultivated and sold, however at a higher premium.

Extension services

Extension services are the main sources of production information and guidance for farmers, however there is a general lack of these services in the selected value chain in Nubaria and Sharqia due to the short-age of financial and human resources in those areas.

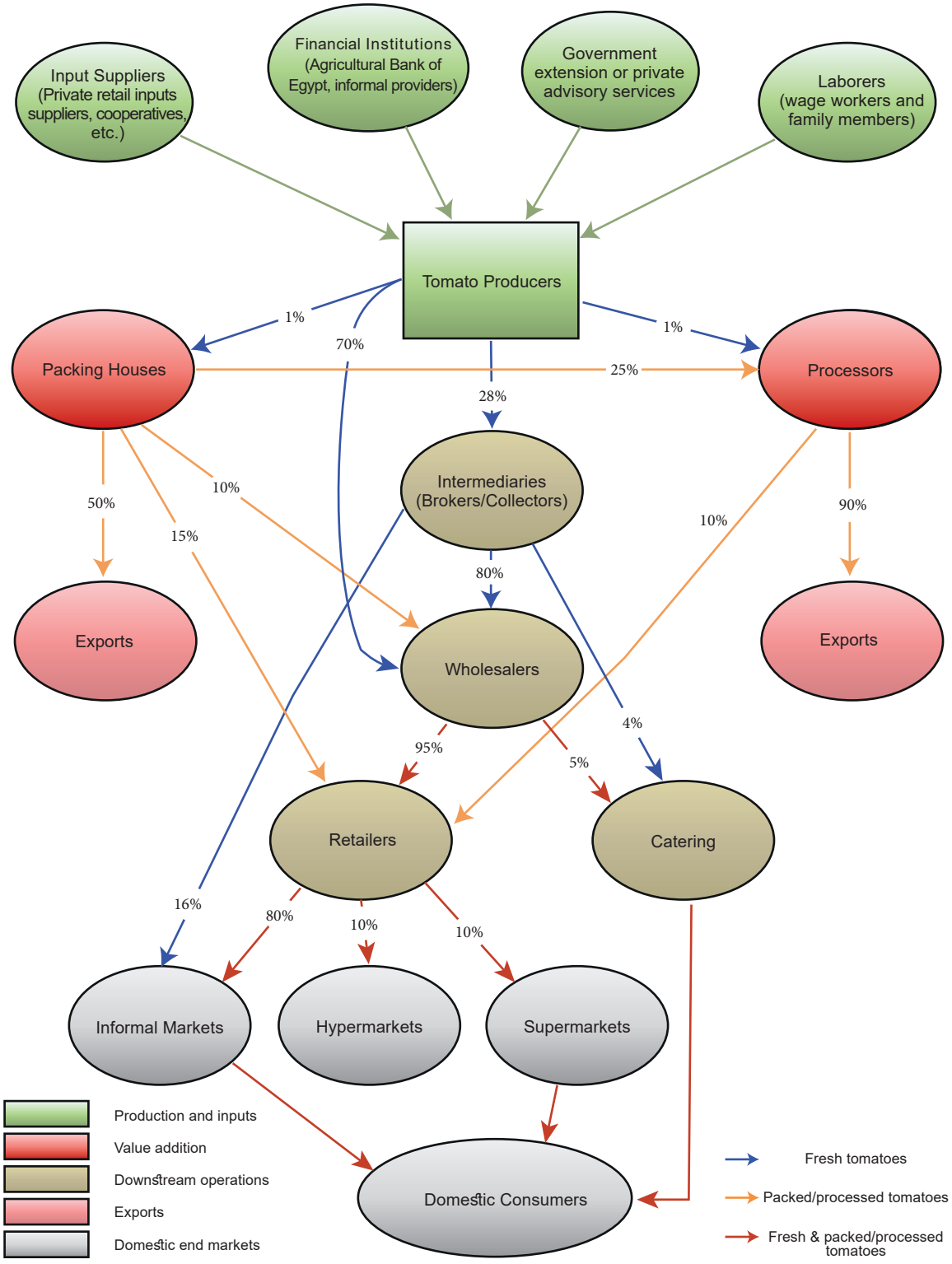
Packing facilities

The tomato production area in Banger El Sokar, Nubaria District has several packinghouse facilities with proper shipping equipment and cooled storage areas. However, no more than 3 to 5 percent of total pro-duction from Nubaria area is exported.

Figure 8 shows the main stakeholders and flows involved in the tomato value chain as captured in the case study covering Nubaria and Sharqia. The percentage of volumes flowing through each branch is also shown, using estimates gathered through literature review, interview, and primary data collected in the survey during the economic and technical assessments in 2016 and validated with stakeholders from both regions.

By far, the most important channel is the local informal market, which according to figure 8 absorbs over 95 percent of the tomato volume.

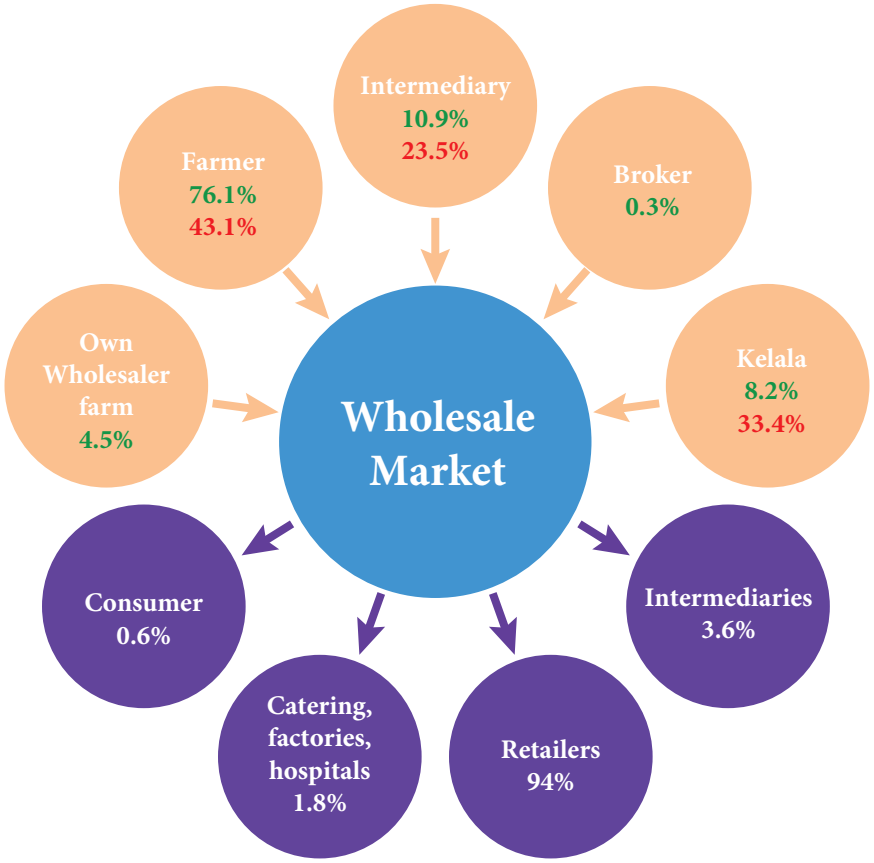
Figure 8: Tomato value chain map in Nubaria and Sharqia



Source: Literature review, interview, and primary data collected in the survey during the economic and technical assessments in 2016 and validated with stakeholders from both regions.

Figure 9 further unpacks the inflows and outflows at wholesale markets, the main node where traders in-teract (as either intermediaries, brokers or wholesale shop owners) and where control over the tomato value chain is concentrated.

Figure 9: Wholesale markets suppliers and traders.



Source: Data collected from survey.

Legend: Responses from Sharqia farmers in green, and Nubaria farmers in red. Orange arrow = sells; Purple arrow = buys

The survey showed that in Sharqia the main suppliers to the wholesale markets are farmers themselves (76 percent), who also take charge of the products' transportation and logistics. Intermediaries and brokers provide wholesalers with about 11 percent of their tomatoes demand, more than 8 percent is supplied through Kelala while 4.5 percent of the wholesalers supply products from their own farms.

Also in the case of Nubaria most farmers (about 43 percent) sell their production directly in the wholesale markets. In this area, the Kelala system is used by more than 33 percent of farmers and around 24 percent is sold through intermediaries to wholesale markets.

The main traders of tomato from the wholesale market are retailers (94 percent of the sold quantity), while about 4 percent of tomato is sold to intermediaries between wholesalers and retailers, and a frac-tion to other traders.

3.4. Production costs

In general, the cost of tomato production has increased substantially from 2015 to 2017 and it is still ex-pected to rise due to extreme increases in the costs of inputs, in turn related to the economic reform pro-gram that began in 2016 and included a devaluation of the currency exchange rate (relative to the USD) and a spike in inflation. According to some farmers, the costs of production have risen between 70 to 100 percent.

Based on focus group discussions with farmers and expert consultation, tables 5 and 6 present a cost anal-ysis for tomato production in Sharqia and Nubaria in 2017. The cost of production is slightly different in the areas under study. The average production cost of tomatoes in Nubaria district was estimated to range between EGP 26 000 (USD 1.46) and EGP 34 000 (USD 1.9); whereas the cost of production in Sharqia is slightly lower and reaches EGP 26 000 to 32 000 (USD 1.46 to 1.8), depending on the season.

Table 5: Cost analysis for tomato production in Nubaria in 2017 (EGP/per feddan*).

Items	Cost per feddan	Finance method	Comments
Land rent fees	4 000	Cash in advance	Seasonal cost
Seedlings	3 500 - 6 000	Credit 40 -60 %	According to the variety
Fertilizers	7 500	40% Cash – 60% credit	
Pesticides	5 000 - 10 000	40% Cash – 60% credit	5 000 in winter season – 10 000 in Summer season
Labor	5 000	Cash	75 labour days * EGP 70 on average (In the case of kelala sales, labour to be paid by traders)
Irrigation / machinery	1 000 – 1 500	Cash	
Total average cost	26 000 - 34 000		

*Calculation based on expert consultation and stakeholder discussion.

Table 6: Cost analysis for tomato production in Sharqia in 2017 (EGP/per feddan*).

Items	Cost per feddan	Finance method	Comments
Land rent fees	4 000	Cash in advance	Seasonal cost
Seedlings	6 000	Credit 40 -60 %	
Fertilizers	5000	40% Cash – 60% credit	
Pesticides	5 000 - 10 000	40% Cash – 60% credit	5 000 in winter season – 10 000 in Summer season
Labor	5 000	Cash	90 labour days * EGP 60, on average
Irrigation / machinery	1 000 – 2 000	Cash	
Total average cost	26 000 - 32 000		In Winter 26 000, in Summer 32 000

*Calculation based on expert consultation and stakeholder discussion.

3.5. Gender and social structures in the tomato supply chain

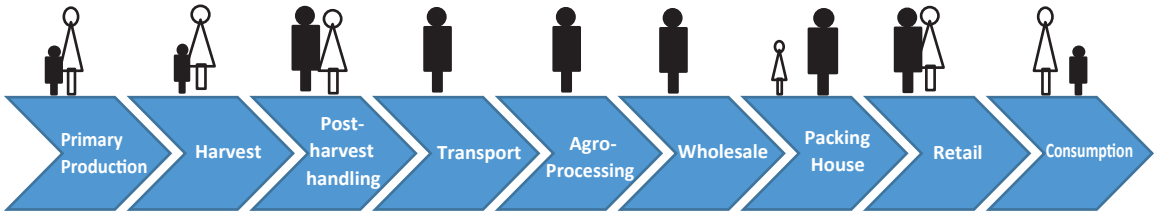
Women have more difficulties compared to men in accessing productive resources, and in participating in and benefitting equally from agri-food value chains. This gender gap represents a missed opportunity for sustainable development in the agriculture sector as well as improved food security and nutrition for all. Rural women are particularly at a disadvantage; they most often lack the power and agency necessary to benefit from or control economic activities, as well as participate in rural institutions, organizations, and public life (FAO, 2016b).

In this context, a brief study was conducted with the objective of gaining an understanding about gender roles in the tomato value chain, and the relation to causes and solutions for reducing losses throughout the value chain and waste at household level.

While conducting this study, the initial assumption made by stakeholders was that women do not have a role in the tomato value chain because of cultural restraints. However, after deeper investigation, results showed that this is in fact a misconception. Women do have a relevant role along the value chain that could be further enhanced and boosted. The case study revealed that women have a dominant role in pri-mary production, harvest, and post-harvest handling.

Figure 10 presents the findings about the role of women and men in the tomato value chain, showing their presence at each stage and relative size of the role they play.

Figure 10: Description of the tomato value chain – social structures.



Note: The symbols indicate the quantitative presence of women and men in the different stages of the val-ue chain. When both are involved, the bigger symbol indicates the sex of the group that is the main actor or more active at that stage.

Source: Authors compilation based on survey findings and adapted from FAO, 2018b.

Women in Sharqia have a more prominent role in farming given that these farms are usually smaller in size and mostly owned by families. In this case, although women often have a greater role than men on the farm, farming is considered a daily household chore for women rather than a job; men and boys work in different jobs to provide for the family, and the woman is responsible for the farming and all the household chores. Despite this division of labor, women are consistently less likely to own land or have access to rented land (FAO, 2016b).

At farm level, women's role is prevalent in the following tasks: seeding and transplanting, weed control, harvesting, sorting, packing, and processing for household use. Their role in spraying and using fertilizers is debatable; some say women are not involved due to the fear of a woman coming in contact with pesti-cides, and others say that they have a role or help their husbands with tasks like extending the hose and filling water. Most women interviewed agreed that the pesticide spraying machine was too heavy (around 10 kg) to carry on their backs into the fields. Very few women interviewed said they sometimes performed the spraying themselves, especially in the early mornings. Loading the crates onto the trucks (post-harvest handling) is a job done by men as the crates are usually heavy in weight.

It was observed that practices in Nubaria (Bangar El Sokar) differ from Sharqia and other governorates, since Bangar El Sokar is around 25km away from a major industrial zone in Borg El Arab. Women and girls prefer to work in the factories in Borg El Arab not because of higher wage - on the contrary, the wage is less than the daily wage of agricultural laborers – but because factories provide transportation, social and health insurance, which is very attractive to the women and girls surveyed. Women and girls also prefer not to work in agriculture as they see it as a downgrade to their social status. When speaking to women, they stressed on the fact that they do not wish their girls to work in the agriculture sector, preferring they work in factories, nurseries or staying at home if needed.

On the contrary, women have little to no role in the next three value chain stages: transportation, agro-processing and wholesale, in both Sharqia and Nubaria. One might see women in wholesale markets, but this is usually only the case if they inherit this role from their husbands or fathers. In the traditional packing houses, men (boys and adults) dominate this stage, where they re-sort, grade and pack tomatoes in boxes to be used for export or factories. On the contrary, women are known to be the main employees in mod-ern packing houses as well as processing factories; however, data collection for this study mainly focused on fresh tomato and traditional value chains.

Women do have a clear role in the informal markets, dominating most street markets in Sharqia and the very small street stands in Nubaria. Women farm laborers tend to purchase the tomatoes at farm gate price or receive some of their wage in kind, then either keep the produce for household consumption, or sell it at local street markets or on street corners as seen all over Egypt. However, the formal retail mar-kets are dominated by men, and the hypermarkets by both genders.

At the consumption stage, losses occur in the home or business of the consumer including restaurants and caterers. This type of loss is referred to as food waste, and it consists in the removal of food from the food supply chain that is still fit for consumption, or has spoiled or expired, mainly caused by economic behav-ior, poor stock management, or neglect (FAO, 2018b).

When assessing consumer behavior and habits and the role of women in market demand, most women engaged in the focus groups and interviews stated they never waste or throw away food. Instead of re-using rice, bread and pasta, rural women usually give it to their poultry as feed. However, throwing lefto-vers to poultry is still considered waste according to FAO, as this food could have been used for human consumption.

Women's labor participation is either through family farms (prevalent in small farms in Sharqia), where farm-related tasks are considered in the same way as other unpaid household chores, or as wage labor, performing harvesting and sorting with a daily wage of around EGP 75 (USD 4.2). As for the women inter-viewed in both Sharqia and Nubaria who work full-time jobs in nearby factories, stores or nurseries, they do so in order to provide their children with private tutors and books to supplement public education.

During the focus group discussions, women were asked about obstacles faced when engaging in agricul-tural activities. Answers were similar across both governorates.

Regarding access to capacity building, they claimed that the selection of the trainees should be improved to reflect the needs of both men and women 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 engaged in farming and training activities, preferential selection of women who live close to the premises of the training venue, or the pro-vision of information that is not relevant to their roles. This leads to women being unable to participate fully or reap the full benefit of existing training programmes (FAO, 2016b). A challenge found in one village in Sharqia (Qasaseen), was that girls and women were forbidden to work on the farm as it is considered culturally inappropriate and socially demeaning. Girls are only allowed to work in neighboring factories producing biscuits, soap, and baked goods, or to create small projects at home and trade with neighbors.

The results are complex, and the study only briefly delved into the topic of roles and responsibilities of each gender in the tomato value chain. In order to understand food losses from a gender perspective, the different productive and social roles of men and women in the food value chain and their influence on the value chain efficiency must be analyzed (FAO, 2018b). Based on the findings, we can see that women in the selected sites play an important role in the tomato value chain. However, this role is not always recognized or compensated, especially in the case of Sharqia. These women are much less likely to own the land and have limited control over income generated. They also lack access to training and extension services. On the other hand, women engaged in wage labor receive income that they can use to pay for their children's education or other household priorities. Where employment in industry or agri-business is available, as in Nubaria, women prefer these jobs due to the provision of transportation, social and health insurance, even if the wages are lower. Thus, investments in post-harvest processing and agri-business are important ways to increase the quantity and quality of jobs for women.

There is a growing awareness for women (and men) on the importance of creating income-generating pro-jects to raise the standard of living for their families, and adding value to crops instead of selling it fresh is an avenue to higher profits. This can include sun-drying tomatoes or producing tomato-based food prod-ucts such as sauces, ketchup and pastes. These activities require investments in equipment as well as the awareness and implementation of food safety standards.

3.6. SWOT analysis

The following SWOT analysis aims to synthesize and analyze the actual situation of the tomato subsector, its competitive advantage and the unexploited opportunities.

Strengths	Weaknesses
• Cash crop with high productivity and a fast return on investment. • Constant local demand throughout the year. • Favorable weather conditions for tomato cultiva-tion, resulting in three cultivation seasons. • Know-how and technology available among large scale growers and exporters. • Small-scale farmers have a substantial degree of experience in tomato cultivation. • Large volume of production among small-scale farmers (high production capacity). • High tolerance to water salinity, specifically suitable for recently reclaimed lands.	• Land fragmentation, dominance of small-scale producers leads to prevalence of traditional and less productive farming systems. • Cooperatives play an insufficient role in organizing producers. • Tomato production faces several challenges with nutrients deficiency and plants' diseases. • Production of fresh tomatoes relies on open un-protected cultivation leading to low productivity. • Production technology is expensive and unavailable. • Vulnerable to a variety of pests (tuta absoluta, white fly, red mite, powdery mildew, and nema-todes) and rising prices of pesticides, possibly linked with high demand to tackle tuta absoluta infestation. • Lack of extension and advisory services at the production and the post-harvest handling levels • Poor post-harvest infrastructure and logistics lead to high levels of quantitative and qualitative losses. • Absence of control on the quality of inputs and suppliers undermines the ability of producers to plan for crop quality. • Tomato market prices are relatively low and costs of production are increasing due to recent economic reforms. • Production sometimes exceeds the local market demand, while the export market is still unex-ploited. • Poor marketing infrastructure (e.g. unpaved roads and lacking storage system) lead to losses. • Local producers don't distinguish between varie-ties demanded by local fresh markets versus those demanded by export markets.

Opportunities	Threats
• Value addition; several possibilities in tomato paste and drying processing that meet existing domestic and potential export market demands. • Increase productivity through adoption of protective cultivation practices. • The local presence of grafted techniques. • Use of renewable energy resources (e.g. sun-drying) • Potential interest in contract farming • Empowerment of women participation • Labor force availability, and creation of new job opportunities • Strengthen the role of cooperatives. • Highly profitable varieties suitable for processing should be explored. • Contract farming concept can be developed, to ensure a reliable supply for export and tomato processing . • Traders exert significant influence and need to be motivated to invest in value chain upgrading and development.	• Water scarcity • High rates of post-harvest losses. • No written and/or formal agreements that govern local trade transactions. • Sharp fluctuation in prices, daily and weekly. • Instability in tomato prices reduces incentives to invest in expensive value addition practices. • Foreseen rises in petroleum prices will increase transportation and production costs. • High inflation rates. • Policy and political change leading to uncertainty in the policy framework for the sector.

4. Food loss assessment: approach and methodology

The goal of the loss assessment is to analyze the levels and main causes of losses in the tomatoes value chain, focusing on the critical points where losses occur and offering concrete proposals to reduce losses that are technically, economically and socially feasible.

The methodology used is adapted from FAO's "Case study methodology - Food Loss Analysis: Causes and Solutions" (FAO, 2016a) which integrates four tools (the '4S' approach): "screening", "survey", "sampling" and "solutions". In this case study, secondary data were collected through literature reviews, field visits, and key informant interviews to determine the critical loss points in the tomato value chains, then primary data generated at farm, wholesale and retail levels using sampling and survey by means of structured questionnaires with open and closed questions. The assessment was carried out during 2016 and 2017 and con-solidated into the current report.

4.1. Literature review of tomato losses estimations

Several previous studies have examined tomato losses in Egypt as well as Asian and African countries.An early study by Blond (1984) measured physical losses of tomatoes in Egypt at three different stages of the value chain, finding 10.8 percent at farm-level, 5.2 percent at wholesale and 13 percent at retail. To cor-roborate these results, and uncover losses

outside of these stages, the study followed a sample of toma-toes from farm to retail and found overall losses of 43 percent, and stage-specific losses of 8.96 percent, 17.89 percent and 16.3 percent at farm, wholesale and retail, respectively. Hafez (2004) studied the same critical loss points at farms in two northern Egyptian governorates of Ismalia (El-Kasassen district) and Fayoum (Asta district), two wholesale markets (El-Obour and 6th October) and two retail markets (El-Zyton and Giza). Tomato losses were found to be 8.29 percent at farm level, zero in wholesale markets and 18.38 percent in retail markets (Hafez, 2004).

Arah et al., (2015) reviewed the literature on tomato losses in Africa, categorizing them as on-farm losses caused by improper harvesting stages, high field temperatures, improper harvesting containers, poor farm sanitation and improper packaging materials; and off-farm losses caused by lack of accessible roads and appropriate transportation systems, lack of processing factories and lack of reliable market information.

The aim of this current study is therefore to examine the determinants of post-harvest losses of tomato in Egypt. While the factors leading to loss are generally known, the study will analyze the magnitudes of loss-es at the selected areas of Sharqia and Nubaria.

4.2. Critical loss points

Critical loss points (CLP) refer to the points in the value chain where food losses have the highest magni-tude. The screening phase and literature review identified three CLP across the tomatoes value chain; at farm, wholesale and retail markets. Table 7 below describes the results of the screening phase, identifying the quantitative and qualitative CLP and Low Loss Points (LLP)at different stages of the chain.

Table 7: Preliminary screening results of fresh tomato losses from Nubaria and Sharqia.

Step in the value chain	Expected Loss Points		Comments/ Remarks
	Quantitative CLP or LLP	Qualitative CLP or LLP	
Production pre harvest	CLP	CLP	Pest and disease, Tuta Absoluta
Harvest	CLP	CLP	Harvesting at late stages, rough handling, lack of sort-ing and grading and risk of contamination with diseased fruits
Transportation	LLP	LLP	Open-air vehicles and over-packing
Wholesale market	CLP	CLP	Rough handling, lack of sorting and grading and risk of contamination with diseased fruits
Retail Market	CLP	CLP	Rough handling by customers, accumulated injury and decay from previous stages
Processing	LLP	LLP	Only 2-3% of Egyptian tomatoes are processed

Source: Author's compilation based on literature review and expert consultation.

4.3. Sampling

Base year sampling was conducted during the summer season 2017[7] . A method based on weight was used to estimate losses, according to the following equation:

> **Quantity losses percent** = Weight of unmarketable fruits (completely rejected fruits)/Weight of total fruits *100 in each package.
>
> **Quality losses percent** = Weight of defected fruits (locally marketed)/Weight of total fruits *100 in each package.

Quantity loss are defects that lead the tomato to be thrown away; whereas quality loss are defects which reduce value (in nutritional or economic terms) but are still considered marketable. The study categorized thirteen "Quantity loss symptoms" and four "Quality loss symptoms" (See Annex 5; Boxes 1 and 2). This technical categorization was used for the purposes of analysis and calculation of the quantity losses (or completely rejected fruits) and quality losses.

However, it should be noted that the Egyptian market does not always distinguish between unmarketable tomatoes and low-quality fruits; study informants consistently say that everything is sold. This is partly due to a lack of consumer awareness about food quality. In addition, low-quality tomatoes are usually collect-ed along the value chain and sold to food shops (koshary) or factories to be transformed in handcrafted or industrial tomato sauce.

Farm level sampling

Tomato samples were collected from 24 farms in Nubaria and Sharqia Governorate. In Nubaria, 12 farms were selected from three villages: El-Ola, El-Zohour, and Village 5. With three samples taken per farm, a total of 36 samples were examined for tomato loss, each sample being a 20 to 22 kg palm crate of tomatoes for a total of 751.11 kg examined. In Sharqia, samples were collected from farms in New Salhia, Old Salhia, Kasaseen el Shark and Faqous. With three samples taken per farm, a total of 36 samples were examined for tomato loss, each sample being a 20 to 22 kg palm crate of tomatoes for a total of 764.59 kg examined.

Wholesale level sampling

Four wholesale markets were chosen to study tomato losses; Alexandria market located near Nubaria; El-Zagazig market located in Sharqia; and 6th October and El-Obour wholesale markets in the greater Cairo area. Three samples were taken from five dealers in each market, for a total of 60 samples of a 20 to 22 kg palm crate each, and 1 274 kg sampled overall. Wholesale markets were selected for their proximity to the areas of production. These markets source from nearby farms when tomatoes are in season, and from anywhere in the country in the off-season.

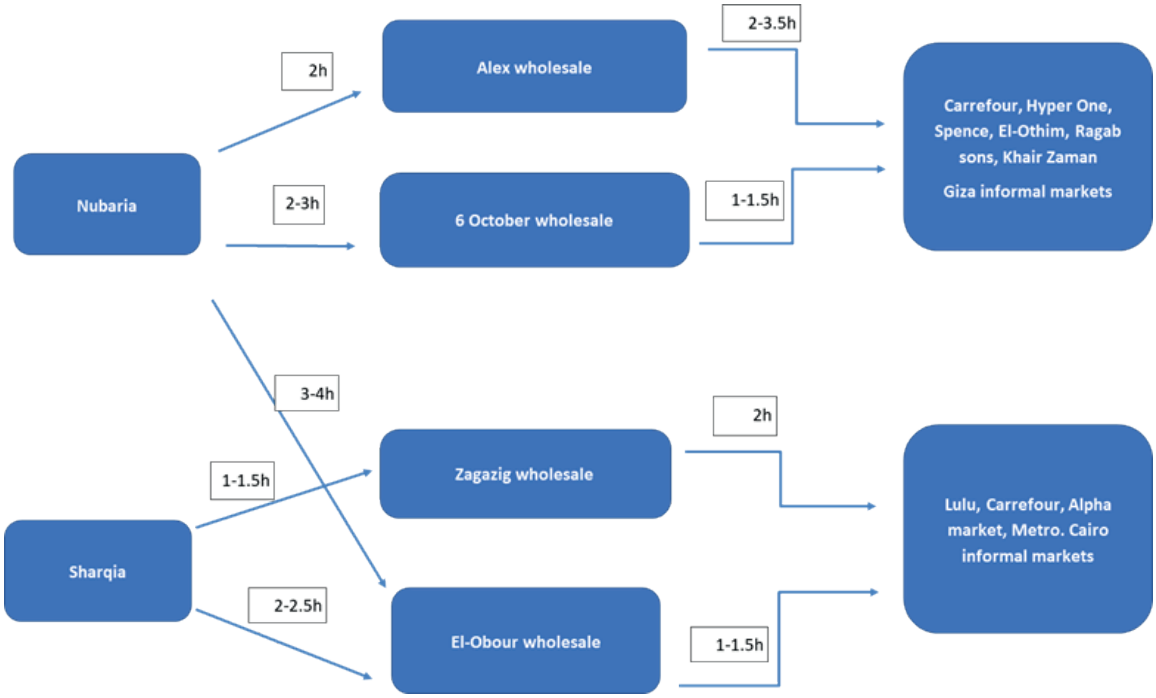
Retail Level Sampling

Six hypermarkets were chosen to examine tomato loss; Spinnies and Carrefour in Alexandria; Carrefour and Hyper One in El-Obour; Sheikh Zayed Hyper One, and LuLu in New Cairo. Three samples were examined from each hypermarket weighing 1 kg, for a

[7] Samples were also collected in summer 2016, between 1st July and 1st October, studying the occurrence and frequency of loss symptoms, but not the magnitudes of loss. These results are available in Annex 4.

total of 18 samples or 18.45 kg. Three supermarkets were chosen in Giza (Khair Zaman, Ragab Sons, and Abdullah Alothaim), and another two supermarkets in Cairo (Alpha market and Metro). Three samples were examined from each supermarket weighing 1 kg, for a total of 15 samples or 15.5 kg. Ten informal markets were chosen for sampling; Omrania, Saft Ellaban, Soliman Gohar, Monib and Giza informal markets in Giza; Maadi, Dar El-Salam, Saeda Zeinab, Old Egypt and El-Nasrya markets in Cairo. Three samples collected from one dealer at each market, each sample being a palm crate package of 20 to 22 kg, for a total of 30 samples taken or 634.57 kg. Tomatoes are usually transported in non-refrigerated trucks, and cover distances up to 100 to 300 km from Sharqia and Nubaria to reach wholesale markets, often on unpaved roads. One of the causes of losses is decay due to poor storage and damage due to poor handling and transportation. To account for these factors, the case study calculated the transfer time along the distribution route from farms to markets (Figure 11).

Figure 11: Tomato distribution from farm to wholesale and retail markets & transfer time



Source: Author's calculation.

5. Food loss assessment: study findings and results

Tomato losses appear along the value chain as a quantitative loss (rejected, unsold fruits that affect the harvested quantity) and as a loss of quality (which affects economic and nutritional value and food safety). Tomatoes are a delicate soft and perishable fruit that is climacteric, meaning that it will continue ripening after harvest through respiration and ethylene production, leading to faster deterioration. Likewise, toma-toes are susceptible to rough handling from field to consumer. Value chain actors' perceptions are critical to effective loss reduction interventions across the value chain, so the study combined a technical sam-pling with a stakeholders' questionnaire to investigate their perceptions.

The sections below present sampling assessment findings from 2017, and survey results from 2016.

5.1.Assessment findings

This section presents the results of the sampling and survey assessment at the 3 CLP of the value chain: at the farm level, the wholesale level and the retail level

5.1.1.Farm level assessment

The findings of sampling and survey assessment at the farm level are summarised below in sections 5.1.1.1 and 5.1.1.2 respectively

5.1.1.1.Farm level sampling assessment

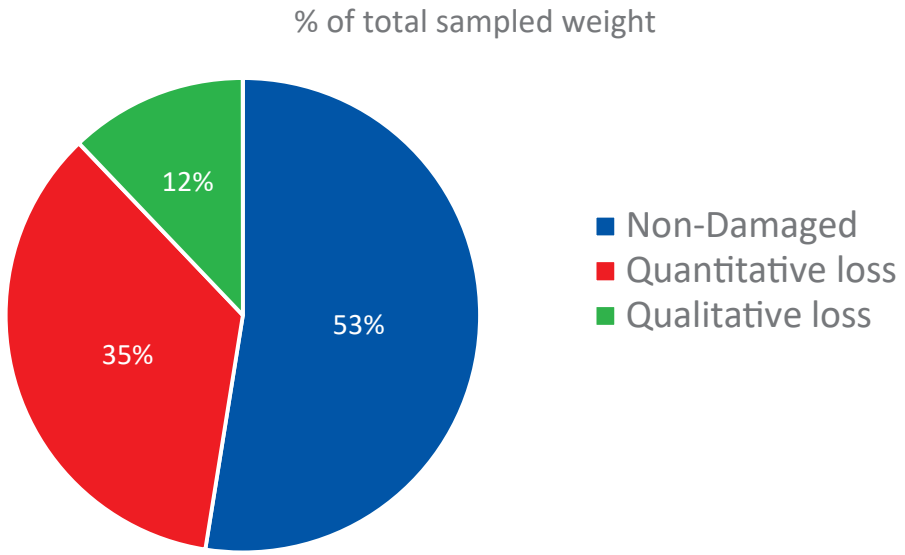
Data presented in table 8 and figure 12 show that tomato losses at farm-level amounted to 35 percent quantitative loss and 12 percent qualitative loss, and are similar in trend and magnitude between Sharqia and Nubaria.

Table 8: Farm-level quantitative and qualitative tomato losses in Sharqia and Nubaria in 2017

	Nubaria		Sharqia		Total Farm-level loss	
	kg	%	kg	%	kg	%
Total Sampled Weight	751.47		764.59		1516.06	
Non-Damaged	398.34	53	395.77	52	794.11	52
Quantitative loss	249.72	33	286.17	37	535.89	35
Qualitative loss	103.40	13	82.66	11	186.06	12

Source: Data collected from sampling.

Figure 12: Share of losses by type in tomato sampled at farm-level in 2017.

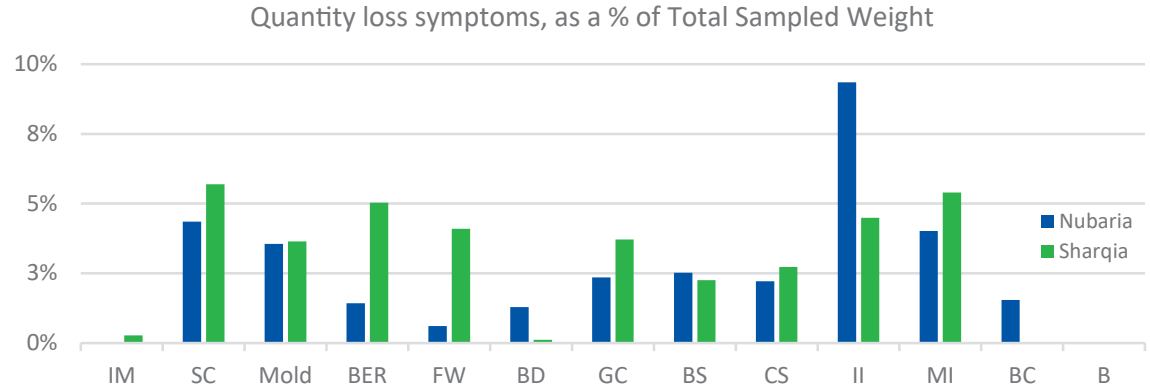


Source: Data collected from sampling.

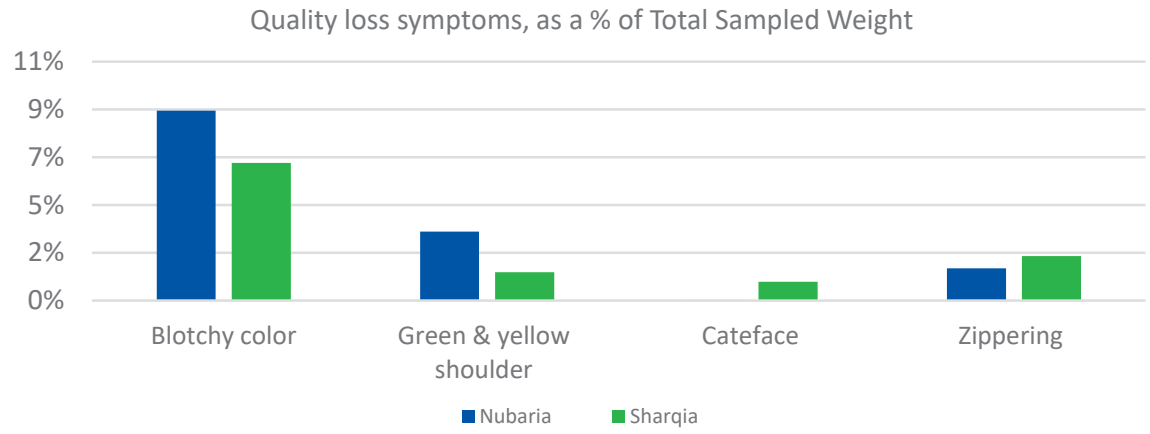
The frequency of quantity loss symptoms and quality loss symptoms within the farm-level tomato samples are shown in Figure 13 for both Nubaria and Sharqia. Of the defects observed, insect injury (mainly Tuta Absoluta) is the most frequent overall, 9 percent in Nubaria and 4 percent in Sharqia, indicating the ab-sence of good pest control programs and insufficient quality or quantity of pesticides that became unaf-fordable for poor farmers after the rise in prices. The second most frequent symptom is sun scald, which is attributed to varieties with limited vegetative growth, which do not protect the fruits from the direct sun or high air temperature during fruits development. The third symptom is mechanical injury, caused by cuts, wounds, bruises or holes in the surface of the fruit due to rough harvesting practices as well as sharpness and overloading of the palm crates. To reduce expenses, the trader may impose the use of palm crates for packaging and transportation and set the picking date when the fruits are in full red color, thus fully ripe and more sensitive to damage. Occurrence of blossom end rot and fruit worms are far more prevalent in Sharqia than in Nubaria. Blossom end rot is due to the presence of a high level of salinity in the soil and irrigation water, which inhibits the absorption of calcium.

These findings highlight the low adoption of good agricultural practices (GAPs) during production and har-vest, also due to difficult access for small farmers to inputs, equipment and finance.

Figure 13: Quantity and quality loss symptoms of tomato at farm-level in 2017.



Legend: IM = Immature green; SS = Sun scaled; Mold = Fungi injuries; BER = Blossom end rot; FW = Fruit worm; BD = Bird dam-age; GC = Growth Cracking ; BS = Bacterial spot' CS = Cloudy spot; II = Insect injuries; MI = Mechanical injuries; BC = Bacterial canker; B= Blight



Source: Data collected from sampling.

5.1.1.2.Farm level survey assessment

Farmers were questioned in 2016 about the levels of loss they experience, the problems they face in rela-tion to tomato production and marketing which could affect losses, and the solutions they feel are needed to overcome these problems.

Farmers surveyed in 2016 perceived farm-level losses to be on average higher than 18 percent in both Nubaria and Sharqia, with main causes of losses as indicated in Table 9.

Table 9: Farm-level tomato losses in Sharqia and Nubaria in 2016 based on survey.

Causes of Losses	Percent Losses	
	Nubaria District	Sharqia Governorate
Bad weather conditions	6.57	8.42
Insects damages	5.03	4.61
Harvest losses	5.86	5.15
Packing	0.58	0.50
Total	**18.04**	**18.68**

Source: Data collected from survey.

According to the survey, among Nubaria farmers, about 66 percent reported facing production problems, whereas 34 percent of them face marketing problems. Of the production problems, most cited were the high cost of inputs and adulterated pesticides (34 percent and 17 percent, respectively), as shown in Table 10. As for the farmers claiming marketing challenges, most of them cited low sale prices and weak marketing support.

Table 10: Production and marketing problems identified by farmers in Nubaria district.

Marketing Problems	Percentage	Production Problems	Percentage
Low Selling Price	20.69	High cost of production inputs	34.10
Weakness of marketing services	9.47	Low productivity due to adulterated pesticides	17.36
Large number of intermediaries and high commission rates	2.37	Unavailability of skilled labor	9.36
Unavailability of marketing information	1.30	Unavailability of pesticides and high-quality seedlings	5.37

Source: Data collected from survey.

The farmers surveyed in Nubaria proposed several solutions to overcome the aforementioned problems of production and marketing (Table 11). The two most frequently cited solutions are to strengthen the role of cooperatives ensuring supply of

high quality inputs at cost-effective prices, and to improve the refrigerated transportation facilities and paving the main roads.

Table 11: Production and marketing solutions suggested by farmers in Nubaria to reduce food loss.

Proposed Solution	%
Enhance cooperative roles to provide farmers with inputs and financing	17.3
Increase refrigerated transportation and paved roads	14.3
Establish marketing outlets close to production areas	11
Contract Farming	11.8
Provide marketing services facilities (centers for sorting, packaging, etc.)	11
Establishing food processing factory	7.1
Provide training and more agricultural extension services	8.6
Increase linkage between export market and tomato farmers	8.6
Activate a supervisory role over markets and traders	6.3
Establishing a market information center	4

Source: Data collected from survey.

In Sharqia, more farmers reported facing marketing challenges (71 percent) that lead to food loss as compared to Nubaria. As shown in Table 12, the greatest challenge for marketing is the dominating role of intermediaries who charge high commissions. As for the production challenges, 13 percent of the sample reported the high cost of inputs.

Table 12: Production and marketing problems identified by farmers in Sharqia governorate.

Marketing Problems	Percentage	Production Problems	Percentage
Large number of intermediaries and high commission rate	36	High cost of production inputs	14
Long distance from farms to markets and unavailability of outlets near production areas	15	Long periods between irrigation	4
Low selling prices	11	Unavailability of skilled labor	7
Unavailability of marketing information	5	Unavailability of high-end pesticides and seedlings	4
Weakness of marketing services	4		

Source: Data collected from survey.

The solutions proposed by the sample of farmers surveyed in Sharqia are shown in Table 13 and reflect the need to address marketing problems posed by intermediaries. Twenty-five percent suggested imposing regulations over markets and traders to control price fluctuation and monopoly, 23 percent suggested boosting the role of cooperatives, and 13 percent has suggested creating marketing cooperatives.

Table 13: Production and marketing solutions suggested by farmers in Sharqia governorate

Proposed Solution	Percentage
Regulation of markets and traders to prevent price monopoly	25
Enhance cooperatives role to provide farmers with inputs and financing	23
Create marketing cooperatives	13
Establish marketing outlets close to production areas	9
Promote contract farming	9
Establishing more food processing factories	9
Providing training for labor and agricultural extension service providers	7
Establishing a marketing information center and providing marketing services	5

Source: Data collected from survey.

5.1.2.Wholesale market level assessment

The findings of sampling and survey assessment at the Wholesale market level are summarised below in sections 5.1.2.1 and 5.1.2.2 respectively.

5.1.2.1.Wholesale market level sampling assessment

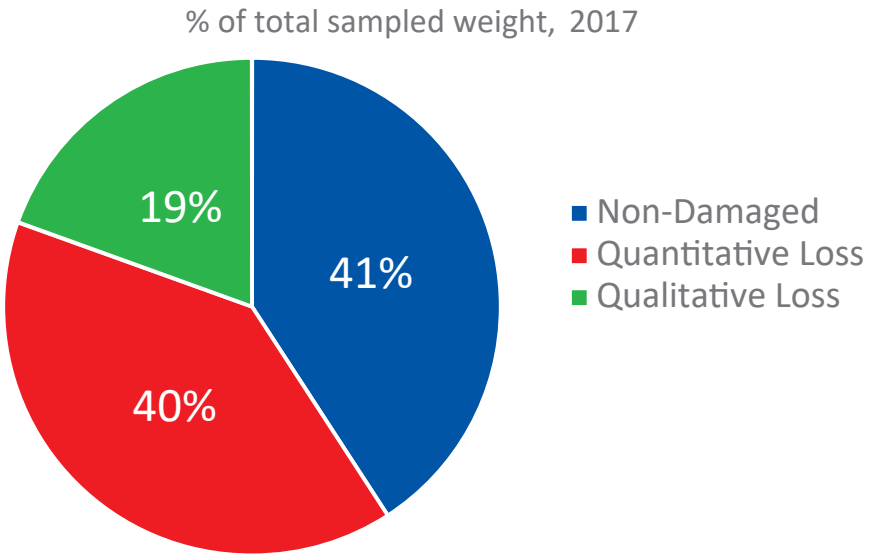
For wholesale markets, the collective results from Alexandria, 6 October, Zagazig and El-Obour markets are shown in table 14 and figure 14. Overall losses were 59 percent, with 40 percent quantitative loss and 19 percent qualitative loss.

Table 14: Wholesale market-level quantitative and qualitative tomato losses in 2017.

	Alexandria	6 October	Zagazig	El-Obour	Total Wholesale loss	
	kg	kg	kg	kg	kg	%
Total Sampled Weight	330.61	318.72	318.3	306	1273.63	
Non-Damaged	86.5	160.59	137.13	135.76	519.98	41
Quantitative loss	140.81	121.3	124.04	119.18	505.33	40
Qualitative loss	103.3	36.83	57.14	51.06	248.33	19

Source: Data collected from sampling.

Figure 14: Share of losses by type in tomato sampled at wholesale market-level in 2017.

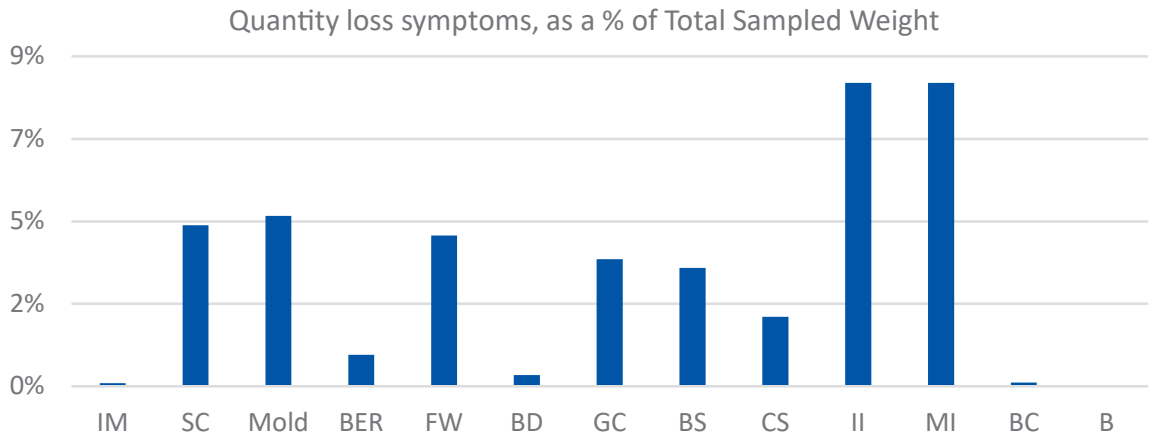


Source: Data collected from sampling.

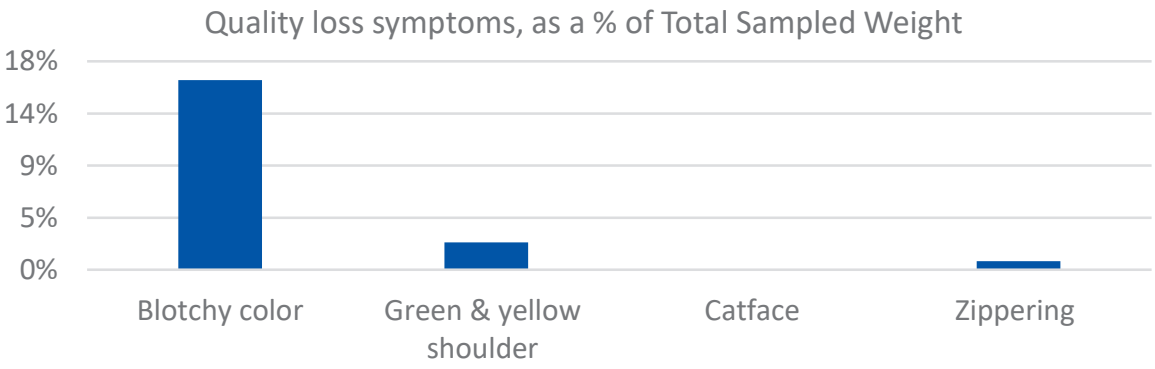
As shown in Figure 15 below, the dominant types of loss symptoms observed are mechanical injury and insect injury, 8 percent each, in the case of quantitative loss. As for quality loss, blotchy colour was the major symptom reported in 16 percent of the sample.

The losses at wholesale market-level show the cumulative effect of the lack of sorting operations in the farms to exclude fruits with different defects, mainly insect injury. Also, palm crates play a great role in increasing mechanical injury, as does the practice of harvesting at fully red colored stage. Often, fruits de-livered after sunset to wholesale markets spend overnight compressed inside their packages until they are sold the next morning which increases rotted fruit percentage. The greater the distance between produc-tion area and wholesale markets, the greater the damage, especially in unpaved roads. Overfilling, incor-rect stacking, open vehicle transportation with rough handling during loading and unloading all lead to high losses in wholesale markets.

Figure 15: Quantity and quality loss symptoms of tomato at wholesale-level in 2017.



Legend: IM = Immature green; SS = Sun scaled; Mold = Fungi injuries; BER = Blossom end rot; FW = Fruit worm; BD = Bird dam-age; GC = Growth Cracking ; BS = Bacterial spot' CS = Cloudy spot; II = Insect injuries; MI = Mechanical injuries; BC = Bacterial canker; B= Blight



Source: Data collected from sampling.

5.1.2.2. Wholesale market level survey assessment

According to wholesalers' opinion, tomato losses at wholesale markets correspond to about 5.7 percent. These losses are mainly attributed to the time lag between harvesting the crop and delivering it to the wholesalers. However, low market demand for tomatoes and delays in selling, can lead to further decay and rot if wholesalers end up storing the product longer than its shelf life, that is up to 3 days. As shown in Figure 16, losses in quality and quantity can reach up to 16 percent of the product.

Figure 16: Relation between tomato losses in wholesale markets and delay in selling

Source: Data collected from survey.

Several wrong practices contribute to losses in wholesale markets, such as long periods of tomato crates exposure to direct sunlight prior to loading on the transportation trucks, and poorly equipped or non-refrigerated transportation vehicles. Among wholesalers who claimed facing marketing problems relevant to losses, Table 15 shows the frequency of responses about the different challenges, while Table 16 lists the suggested solutions.

Table 15: Marketing problems leading to losses at wholesale markets.

Main marketing problems	Percentage
Competition of "random" unauthorized markets in the vicinity of wholesale markets	16.1
Long time from farms to market (harvest to sale)	16.1
High price at retailers	12.9
High rate of infections affecting product quality	14.5
Use of palm crates	11.4
High cost of packaging	6.5
High cleaning fees at wholesale market premises	6.5
High transportation costs	4.8
Shortage of skilled labor	3.2
Lack of information about tomato production volumes	3.2
Irregular tomato supply throughout the year	3.2

Source: Data collected from survey.

One of the main problems facing wholesalers is the unfair competition of "random markets", meaning un-licensed and unauthorized sales activity at street or pop-up sales stands placed in the vicinity of wholesale markets. This affects the volume of products entering and sold inside the wholesale markets, therefore most wholesalers participating in the assessment ask for closure of the "random markets". Wholesalers also prioritize the need for investments in processing factories and marketing infrastructure.

Table 16: Proposed solutions for marketing problems at the wholesale markets.

Main marketing problems	Percentage
Close "random markets"	13.4
Increase processing facilities	10.4
Provide marketing infrastructures	10.4
Train farmers on good agricultural practices (GAPs)	8.7
Oversight and control pesticides sale and use	8.7
Regulate the markets	11.3
Market development and establish crops Stock Exchange	7.8
Market expansion	6.9
Establish market information center (area, production…)	7.8
Decrease market cleaning fees	5.2
Increase market channels	4.2
Improve storage facilities (cold chain…)	5.2

Source: Data collected from survey.

5.1.3.Retail market level assessment

The findings of sampling and survey assessments at the Retail market level are summarised below in sec-tions 5.1.3.1 and 5.1.3.2 respectively.

5.1.3.1.Retail market level sampling assessment

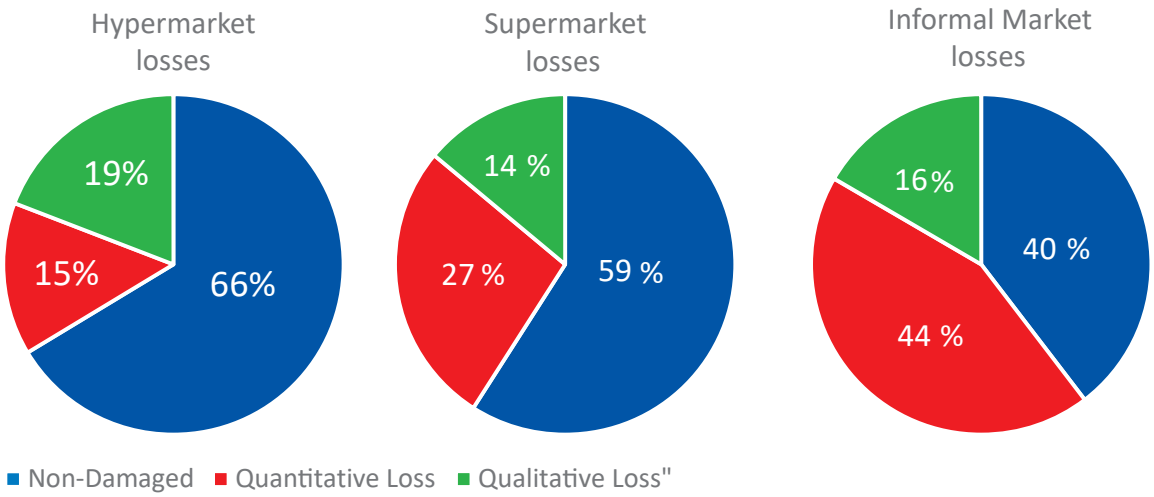
At retail market-level, losses disaggregated by type of retail market are presented in Table 17 and Figure 17. Lower levels of loss were found in hypermarkets and supermarket as opposed to informal markets (combined quantitative and qualitative loss of 34 percent and 41 percent, compared to 61 percent), be-cause usually some sorting and grading activity takes place when the tomatoes are packed for formal mar-kets. While at informal markets, the tomatoes are displayed for retail in the palm crates used for transpor-tation without any sorting or discard of damaged fruits.

Table 17: Retail market-level quantitative and qualitative tomato losses in 2017.

	Hypermarket		Supermarket		Informal market	
	kg	%	kg	%	kg	%
Total Sampled Weight	18.46		18.5		634.57	
Non-Damaged	12.25	66	10.93	59	251.3	40
Quantitative loss	2.68	15	7.58	27	277.93	44
Qualitative loss	3.53	19	2.58	14	105.34	17

Source: Data collected from sampling.

Figure 17: Share of losses by type in tomato sampled at retail market-level in 2017.



Source: Data collected from sampling.

In hypermarkets and supermarkets most symptoms of quality loss are due to careless handling. Sometimes the display shelves or area are kept at an ambient temperature of about 17 °C to be suitable for all dis-played fruits and vegetables, but this increases

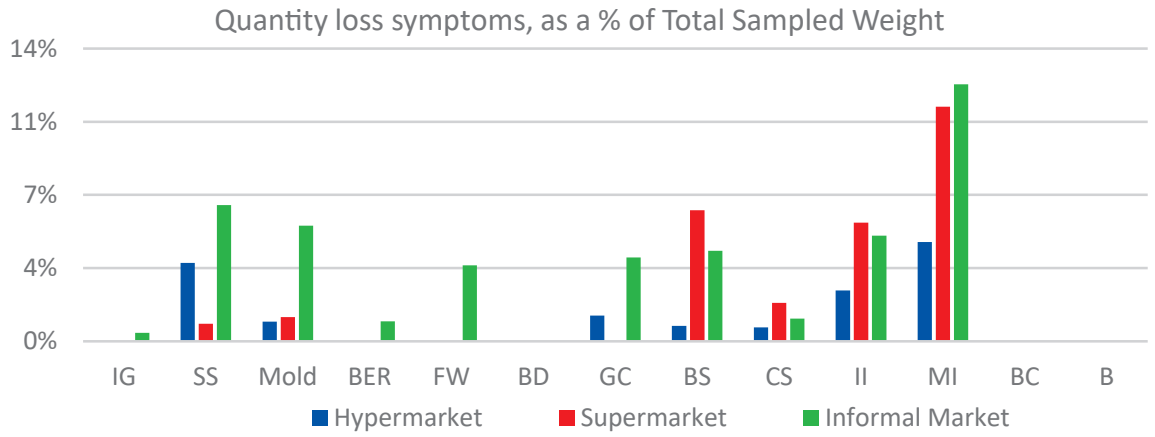
pathogen activity. Some markets do have cooled storage for extra stocks of fruits and vegetables, but these are kept at a temperature between 0 to 4 °C which is not suitable for tomato (optimally kept at 7 to 10 °C). Only some hyper and supermarkets have areas for resorting and repackaging.

Consumers prefer tomatoes with full red color, forcing traders and markets to source tomatoes harvested at full red stage when ripening is already advanced. Consumers themselves indirectly cause loss by roughly handling fruits when comparing and choosing the ones to buy.

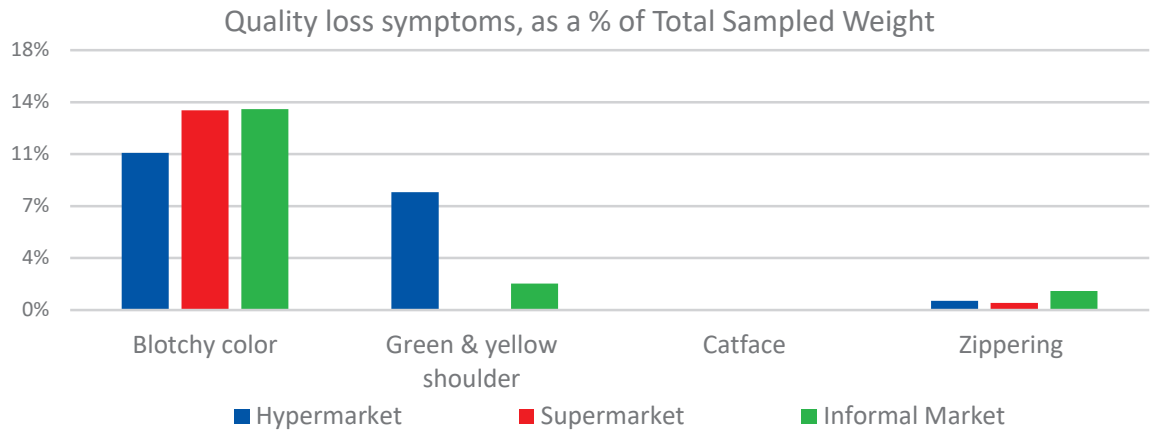
In informal markets, vendors sell tomatoes in hot weather temperatures and displayed in high piles within palm crate, which increases mechanical damage and rot. Some venders may sort and grade tomato into different prices according to their own concept of quality but will try and sell all of their stock without dis-carding anything. The cumulative effect of mechanical damage, bacterial infection and fungal molds is experienced in informal retail markets.

As shown in Figure 18 and stated above (Box 2), the biggest problem related to quality loss during each successive step of the sampled value chain is the lack of potassium fertilization, which appears in the form of blotchy color fruit. A possible or partial explanation is the rise in prices of potassium fertilizer, which reduces its use by farmers.

Figure 18: Quantity and quality loss symptoms of tomato at retail market-level in 2017.



Legend: IM = Immature green; SS = Sun scaled; Mold = Fungi injuries; BER = Blossom end rot; FW = Fruit worm; BD = Bird damage; GC = Growth Cracking ; BS = Bacterial spot' CS = Cloudy spot; II = Insect injuries; MI = Mechanical injuries; BC = Bacterial canker; B= Blight



Source: Data collected from sampling.

Fruit color

Tomato fruits must be harvested at an early stage (pink stage 4) for a longer shelf-life and to minimize damages during post-harvest handling. As a climacteric fruit which will continue ripening after harvest, the later the harvest the more sensitive tomatoes become to mechanical damage and more sensitive to injury by microorganisms (bacteria, fungi). Moreover, tomato respiration rate and ethylene production are in-creasing as the fruit ripens (red or over-red color stage) which leads to losses in firmness and more sensi-tivity to mechanical injuries.

However, as shown in table 18, over 80 to 100 percent of tomatoes in the sample were harvested in red color stage, which increases the vulnerability to losses. This reflects a lack of awareness about the optimum har-vest stage among producers, traders and consumers. The exception observed in the hypermarkets sampled is likely due to supplies from export-oriented companies which harvest at pink stage and have quality control systems in place. Export-oriented companies will channel their surplus or rejected exports to the do-mestic market, usually to hypermarkets.

Table 18: Fruit color degree at farm, wholesale, and retail markets in Nubaria and Sharqia.

Color level	Farm		Wholesales Market	Retail Markets		
	Nubaria	Sharqia		Hyper markets	Super markets	Informal markets
(%) Immature Green color	0	0	0	0	0	0
(%) 50-75% colored	19.25	0	6.91	30.19	1	1.83
(%) Red color	80.75	100	93.09	69.81	99	98.16
(%) Over red	0	0	0	0	0	0

Source: Data collected from sampling.

Fruit temperature

Finally, high fruit temperature increases the respiration rate and thus rate of deterioration and water loss. The optimum storage conditions for ripe tomato is 7 to 10 °C at 90 to 95 percent relative humidity, at which shelf life can be 4 to7 days. Table 19 shows that temperatures on farms, wholesale and retail markets were much higher than the optimum.

Table 19: Fruit temperature at farm, wholesale, and retail markets in West Nubaria and Sharqia.

	Farm		Wholesales Market	Retail Markets		
	Nubaria	Sharqia		Hyper markets	Super markets	Informal markets
Fruit Temperature °C	33.32	33.23	32.44	22.37	24.11	26.59

Source: Data collected from sampling.

5.1.3.2.Retail market level survey assessment

From the survey conducted at the retail market level, the average loss level perceived by retailers is 7.4 percent. Losses at this value chain stage are mainly attributed to delays in sales, cumulative effect of rough handling from farms to final consumers, poor packaging and fragility of palm crates, as well as improper storing conditions in open-air uncovered markets.

5.2.Summary of food loss assessment findings

Although not strictly comparable, Table 20 summarizes the tomato losses results reported through survey and sampling methods. Losses in 2017 were higher than 2016 survey and sampling exercise (the latter is reported in Annex 4). The 2017 sample results show that quantitative and qualitative loss together exceeds 50 percent of the tomato crop at each stage of the value chain.

Table 20: Comparison between incidence of loss (survey and sampling based) at three critical points of the tomato value chain in Nubaria and Sharqia

Value Chain Level (CLP)	% Loss from 2016 Survey	% Loss from 2017 Sampling - quantity loss	% Loss from 2017 Sampling - quality loss
Farm level	18	35	12
Wholesale market Level	6	40	19
Retail Market Level	7	44	17

Source: Data collected from sampling and survey.

The differing perceptions of value chain stakeholders clearly lead to widely varying results. Survey respondents – farmers, wholesalers, and retailers – reported perceiving a much lower level of losses as compared to the technical experts in postharvest who conducted sampling and identified quantity and quality symptoms. This reflects a lack of awareness about loss and the way the tomato value chain works, which does not recognize the value in investing in food quality through postharvest operations like sorting, grading, and discarding losses. Instead, damaged products accumulate along the value chain from farm to traders and wholesalers until they reach retail markets.

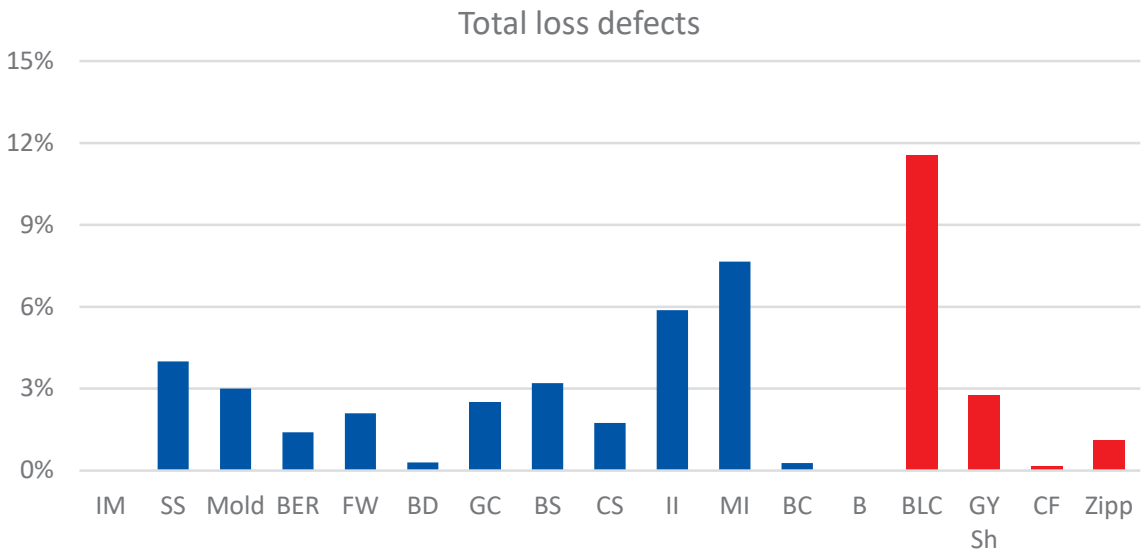
It is worth mentioning that the 2017 sampling included new varieties and that samples were taken from the same villages sampled in 2016 but in some cases from different farmers, which may also cause variation.

Loss percentages can be highly influenced by contextual or seasonal factors, such as climate, outbreak of pest and disease, agriculture practices, change in cost of inputs, as well by conditions of the study, such as the time of day or time of harvest season, selection of the farms, etc. Nonetheless, repeating the study in the future will allow to generate wider evidence of food losses in the tomato value chain in Egypt, which can be used as a basis for formulation of food loss reduction strategies.

Figure 19 shows the frequency of quantitative and qualitative loss defects based on 2017 sampling across the three critical loss points. Generation of evidence will help tackling the most frequent causes of loss, which are related to low access to agricultural inputs, poor pest control management practices, and rough handling by multiple value chain actors.

Figure 19: Total loss defects observed through sampling at all CLPs, 2017

In blue, quantity loss defects; in red, quality loss defects



Source: Data collected from sampling.

Legend: IM = Immature green; SS = Sun scaled; Mold = Fungi injuries; BER = Blossom end rot; FW = Fruit worm; BD = Bird dam-age; GC = Growth Cracking ; BS = Bacterial spot' CS = Cloudy spot; II = Insect injuries; MI = Mechanical injuries; BC = Bacterial canker; B= Blight; BLC= Blotchy color; GY Sh = Green and Yellow Shoulder; CF = Catface; Zipp = Zippering

6. Conclusions and recommendations

Tomato losses represent a multidimensional problem, with negative effects on the economy and the envi-ronment, as well as on food availability, health, well-being and nutritional status of people. Reduction of post-harvest losses and waste would be of great significance for farmers and consumers simultaneously. Tomatoes are an integral ingredient in Egyptian cuisine and diets; reducing the high rates of tomato losses within the food chain would lead to improved nutrition, food security and job creation for local population, through increasing added value for fresh tomato and exports (especially for dried tomato).

The most important function of post-harvest processes is to preserve what has already been produced and reduce the gap between the yield at the farm level and the actual volume that reaches the consumer. Alt-hough it is difficult to obtain solid accurate figures, it is generally conceded that considerably less energy and other inputs are required to prevent food loss rather than to produce an equal amount of food that will be lost or wasted.

This study found very high levels of loss in the tomato subsector, exceeding 50 percent when considering quantitative loss together with qualitative loss. However, the reality that "everything sells" on the market reflects the interlinked problem of food loss with an immature or traditional tomato sector. The economic transition started in Egypt in 2016 is having an effect on costs of production and operations, and tomato value chain actors are

beginning to show signs of changing their behavior in order to preserve profit margins and generate new income streams.

6.1. The main constraints facing reduction of food loss in the tomato subsector

The tomato subsector in Egypt is mostly traditional, small-scale, and informal, and known to be a "crazy" sector with daily shifts in demand, costs and prices and little stability needed for planning or forecasting development in the subsector. At the same time, the tomato subsector experiences substantially high lev-els of food losses as shown from the findings of this report. Reducing tomato losses, therefore, is a com-plex matter related to better postharvest operations and improving the overall functioning of the value chain. Table 21 below aims at grouping into categories the main constraints in the tomato value chain leading to loss.

Table 21: Categories of tomato value chain constraints.

Category	Finding Constraints
• Technology/Product Development	• Inappropriate or non-existent tools/machinery/ technologies • Weak training and extension services for small-scale growers • Lack of technical skills (trained labors) • Lack of information on product demand • Low awareness and capacity regarding good postharvest practices and loss reduction • Raise awareness of producers and handlers about biological and envi-ronmental factors that cause deterioration, senescence and negatively affect the quality, including climate change.
• Inputs suppliers	• Insufficient number of suppliers • High cost of inputs (fertilizers, pesticides, electricity) for small-scale farmers and expensive equipment • Low quality of pesticides (adulterated) • Weak regulations on the quality aspects of local and/or imported inputs.
• Market Access	• Lack of linkages to large traders (exporters) • Lack of marketing organizations to aggregate small producers • Weak agricultural cooperatives • Lack of awareness and use of contract farming • Lack of information on product demand • Lack of marketing techniques or methods, and insufficient number of market outlets • Unmet market opportunities • High transportation costs, poor road networks in some areas • Shortage of market information for small farmers
• Management and Organzation	• Land fragmentation and inability of producers to get organized to benefit from economies of scale • Lack of specific training for various stakeholders in value chain (financial management, internal organization, production skills, etc.) • Poor organization of large traders or suppliers • Lack of communication and cooperation between different stakeholders • Very low levels of value addition • Insufficient access to financial services, especially for small-scale farmers
• Marketing infrastructure	• Lack of marketing infrastructure (packing houses…) • Lack of storage facilities along the chain • high cost of storage facilities when available • Low awareness of low-cost food loss prevention techniques (e.g. evapo-rative cooling and placing the crop in the shade away from direct sun-rays), and lack of associated infrastructure

6.2. Addressing the constraints through a series of recommendations

This section highlights integrated strategic actions that can be implemented through development projects to unlock the problem of losses. A list of recommendations categorized by CPL can be reviewed in Annex 6.

Promote good pre- and post-harvest practices

Raising the awareness of value chain actors about good pre-harvest and post-harvest practices is one of the most important actions for preventing and reducing losses. Several interventions can be carried out in this regard including,

- Raise farmers' awareness on good pre-harvest and post-harvest practices (especially integrated pest management and fruit handling) through tailored extension services, technical field visits, and continuous training, whose delivery (time, location, trainer selection) should also be customized to women needs. Introduce alternative training tools, including illustrated publications and leaflets, educational movies and theatre plays, slide sets, etc.,

- Conduct of on-site trainings to improve the workers' capabilities to identify maturity, defects and perform sorting and grading.

- Emphasize simple, natural cooling techniques that are affordable for small-scale farmers and effective to improve the quality of the product or reduce losses (e.g. keeping the product in shaded places, harvesting during early morning hours, ensuring store ventilation during the night, etc.)

- Build the capacity of all value chain actors through targeted educational programs that highlight the business-oriented implementation of good postharvest practices and losses reduction techniques.

Establish postharvest training and services centers

This center will serve farmers, exporters, traders, students and local authorities. It can be designed to demonstrate low cost and hight postharvest technologies to help improve the sector including cooling, processing and other services such as:

- Production and postharvest technical assistance

- Information sharing and training sessions
  Awareness-raising, training, and even regulations formulation can be used to improve the transportation loading and unloading systems and avoid over-loading of crates while preventing losses during transportation.

- Training to enhance the role of women
  The role of women in the tomato subsector, and in reducing tomato losses, can be enhanced by ena-bling them to adopt value addition techniques and promote their

active involvement and participation in all post-harvest activities. This includes tailoring postharvest training program delivery to include women's needs, for example choosing training times that allow them to combine household chores and care work with agricultural work burden or selecting training venues in compliance with social norms and potential restrictions to women's movement. Moreover, boost women's capacities in managing agro-processing activities (marketing, finance, food safety & hygiene, etc.) that help them generate income, while playing a key role in loss reduction.

- Tools and crates
  Special attention should be paid to promote better options to package tomato distributed to local market channels, given the particularly high level of loss associated with the traditional use of palm crates as containers in the field and for transportation along the value chain in uncovered, over-loaded vehicles.

Establish direct marketing centers

Due to the poor vertical integration among the different tomato value chain actors, and to create an alternative to the role of intermediaries and traders, a solution can be to establish local direct marketing centers in proximity to the production areas in order to create linkages among actors within the value chain for a better flow of information to better address the constraints.

Such centers will be responsible for the following:

- Marketing activities for various horticultural products and facilitating the farmers or the cooperatives direct access to high-paying markets (whether local or foreign).
- Facilitating the farmer's compliance processes to high-end markets requirements.
- Provision of extension services and capacity building programs to local producers.
- Facilitating the producers' access to valuable, up-to-date marketing information, storage and packaging facilities.

These centers can be private, public or linked to non-governmental organization depending on sound feasibility study. They can be formed with agricultural associations and cooperatives, gathering small-holders to provide services that may contribute to loss reduction (e.g. proper crop harvesting, cold storage units, packing lines, packing and packages, transportation and marketing facilities). The services of such centers should be sustainable to ensure the continuity especially when linked to a short term project.

Daily marketing information provided through digital tools

Overcoming the extreme fluctuations in price and volumes prevalent to the tomato value chain requires improving market knowledge and facilitating access to up-to-date market information for all the actors of the value chain. This could be achieved through a mobile application providing daily updates on prices for the main fruit and vegetable products on a series of alternative markets and marketing channels. This service could be provided by one of the national private communications companies.

Promote tomato value addition, particularly drying (dehydration)

One of the most accessible value addition techniques that can be adopted to control tomato post-harvest losses is tomato drying. The cost can range from EGP 10 000 to 200 000 (USD 562 to 11,236) for investment in a drying facility that can depend on solar (sun) drying or use artificial heating (mobile dryer) depending on the desired production capacity, efficiency and durability. Such units would not only control losses by providing new markets for different grades and varieties of tomatoes but would also contribute to generating higher incomes through value addition and creating employment in rural area.

Encourage new and better processing adapted varieties

In line with promoting tomato processing, there is a need for cultivation of tomato varieties more suitable for processing especially with higher total soluble solids (TSS). These new varieties can lead to longer shelf-life and be resilient to extreme temperatures. Summer season requires varieties that can endure hot air temperature, are less sensitive to sun burn, and have sufficient vegetative growth to shield the fruit from the sun.

Publications for consumers (nutritional problems, healthy food)

Prepare and deliver proper educational programs to raise consumers' awareness on nutrition and the advantages of healthy food consumption.. In the absence of local quality standards, consumers can play an important role in urging for better frameworks or regulations. Consumers' education can be delivered through media campaigns, TV, radio, social networks, posters, etc.

The recommended actions for reducing food loss and developing the tomato value chain presented in this section and in annex 6, were validated by technical experts and value chain stakeholders, and widely agreed to be necessary for improvements. There remain, however, areas for further study and analysis, such as the specific impact of introducing new technologies and practices on loss reduction, in terms of economic, environmental and social benefits. The business case and investment plan for certain interventions needs to be further specified, in conjunction with the dynamics of a changing cost structure for all value chain actors. Repetition of the tomato loss sampling exercise over time can help to generate a deeper understanding of the problem and factors associated with losses.

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Annex 1 – Development of tomato production in Egypt during the period 2001

Year	Tomato total area (1000 feddans)	Yield Ton/ feddan	Production (1000 Ton)	Consumption (1000 Ton)	Loss (1000 Ton)	Quantity Exported (1000 Ton)
2001	430.2	14.7	6329	6106	679	5
2002	454.9	14.9	6778	6106	679	5
2003	459.2	15.6	7140	6439	715	4
2004	464.4	16.4	7641	6919	769	7
2005	495.3	16.9	8391	7410	1010	22
2006	524.1	16.4	8576	7361	1299	8
2007	537.2	16.1	8639	6913	2304	59
2008	571.8	16.1	9204	6913	2304	59
2009	599.6	17.1	10279	7659	2553	142
2010	515.2	16.6	8545	6344	2115	142
2011	505.8	15.9	8054	6069	2023	81
2012	515.2	16.6	8571	6399	2133	124
2013	488.7	16.9	8269	5669	2429	612
2014	509.6	16.2	8265	5650	2422	245
2015	468.5	16.5	7727	5650	2422	91.5
Average	**502.6**	**16.2**	**8161**	**6507**	**1723**	**107**

Source: Author's compilation and calculation from MALR (2015), MALR (2016a), MALR (2016b).

Annex 2 - Tomato varieties, seasons and productivity

The main tomato varieties cultivated in Nubaria and Bangar El Sokar (outside the Nile valley) are Heinz 26, Heinz 27 and Alissa. Each of these varieties has a productivity of 30 tonnes/feddan. Other varieties culti-vated in the area are Pasha 1077, Heinz 9664, Heinz 9091. Table 22 shows the dates of cultivation and har-vesting in summer and winter.

Table 22: Planting and harvesting seasons in Nubaria district.

Season	Date of planting	Date of Harvesting
Summer season (Early)	**15 Mar – 15 Apr.**	**10 June – 15 June**
Summer season (Main)	**20Apr. – 20 May**	**15 Jul**
Summer season (Late)	**20 May – 15 June**	**1 Sept**
Winter	**15 Sept. – 15 Oct.**	**15 Dec.**

Source: Data collected from survey.

The main varieties in Sharqia region are Alissa, 59, and 186. Table 23 shows the average productivity per each variety, and Table 24 the dates of cultivation and harvesting in summer and nilli seasons.

Table 23: Main varieties of tomato in Sharqia governorate.

Variety Trade Name	Productivity (tonnes / feddan)
Alissa	**28**
59	**16 – 20**
186	**16 – 20**

Source: Data collected from survey.

Table 24: Planting and harvesting seasons in Sharqia governorate.

Season	Date of planting	Date of Harvesting
Early Summer season	**15 Feb – 1 Mar.**	**15 May – 15 June**
Nilli season	**15 Jul.**	**15 Oct.**

Source: Data collected from survey.

Annex 3 – List of main processors of tomato paste in Egypt

Region	Factory	Location	Capacity (Ton/Day)
Lower Egypt	CFI - Heinz	6th of October	500
	Delta Aromatic	6th of October	500
	Agthia (Elean)	Sadat	700
	P&J	Sadat	700
	Agiad	Nubaria	250
	Faragalla	Borg El Arab	350
	El Nagar	Borg El Arab	500
	PODCO	Borg El Arab	700
	Kaha	Kaha	700
	El Mirghany	Badr	700
	Foodico	Ismalia	170
	Misr Italia	Damietta	300
	Shams	Sharqia	?
Upper Egypt	El-Wady	Qena	300
	Experts	Beni Suief	150
	UEFOCO	Minya	800

Source: Author's compilation.

Annex 4 –Methodology and results of sampling conducted in 2016

A. Sampling methodology

Farm Level Sampling: Samples were collected from 12 farms in three villages (El-Ola, El-Zohour, and Village 5) in Bangar El Sokar, Nubaria. In Sharqia Governorate, two districts were studied (New Salhia and Kassas-sen) with samples collected from 12 farms. Three samples were collected from each of the farms, of a 20 to 22 kg palm crate for a total of 72 samples.

Wholesale Market: Four wholesale markets were chosen; Alexandria and 6th October markets near Nubar-ia, and El-Obour and El- Zagazig near Sharqia Governorate. Three samples of a 20 to 22 kg palm crate were taken from five dealers in each market, for a total of 60 samples.

Retail Markets: Three samples were collected from each of four hypermarkets (Carrefour and Lulu in Cairo; Hyper One and Spinneys in Giza) and five supermarkets (Khair Zaman, Ragab Sons, and El-Othim in Giza; Alpha market and Metro market in Cairo). Each of these sample weighed 1 kg. As for informal markets, three samples were collected from six dealers in local markets (Omrania and Giza markets in Giza; Madinet El-Salam, Madinet Nasr and Abbassia markets in Cairo), each sample a 20 to 22 kg palm crate package

To measure losses, taking a palm crate sample, each symptom would be sorted out and weighed and cal-culated as a percentage of the actual package weight. Since tomatoes often presented two or more symp-toms, some tomatoes would be sorted into several symptom categories. As a result, they are double counted, and results presented in table 25 and 26 cannot be summed without a risk of over-estimating the results.

B. Quantitative loss sampling results

Table 25: Quantity losses (%) for tomato in Sharqia governorate and Nubaria district (2016).

Sharqia Governorate						
Symptom of loss	Farm	Wholesales Market	Retail Markets			
			Hyper markets	Super markets	Informal markets	Total retail
Mechanical injuries	6.14	8.09	0.68	0	7.93	**8.61**
Insect injuries	7.35	3.43	1.73	1.12	4.13	**6.98**
Immature green	0.37	0.06	0.00	0.00	0.00	**0.00**
Bacterial spot	4.38	1.89	0.19	0.47	0.83	**1.49**
Bacterial canker	0.00	0.00	0.00	0.00	0.00	**0.00**
Growth Cracking	3.68	6.73	0.56	0.38	1.93	**2.87**
Bird damage	0.26	0.00	0.00	0.00	0.00	**0.00**
Fruit worm	0.04	0.00	0.00	0.00	0.00	**0.00**
Blossom end rot	0.54	0.83	0.00	0.00	0.00	**0.00**
Mold	4.02	3.57	1.04	0.00	4.41	**5.45**
Sun scaled	6.62	4.42	1.43	0.23	1.8	**3.46**
Cloudy spot	0.00	0.04	0.00	0.00	0.00	**0.00**
Blight	0.00	0.00	0.00	0.00	0.00	**0.00**

Nubaria District						
Symptom of loss	Farm	Wholesales Market	Retail Markets			
			Hyper markets	Super markets	Informal markets	Total retail
Mechanical injuries	6.12	10.12	1.02	0.00	10.91	**11.93**
Insect injuries	6.04	8.3	2.39	1.97	5.07	**9.43**
Immature green	0.19	1.51	0.00	0.00	0.00	**0.00**
Bacterial spot	2.53	1.21	0.00	0.00	0.00	**0.00**
Bacterial canker	0.38	0.93	0.00	0.00	0.00	**0.00**
Growth Cracking	1.1	1.56	1.01	0.83	2.28	**4.12**
Bird damage	0.41	0.06	0.00	0.00	0.00	**0.00**
Fruit worm	2.39	1.77	0.00	0.00	0.00	**0.00**
Blossom end rot	0.71	1.14	0.00	0.00	1.03	**1.03**
Mold	1.35	1.37	0.00	0.00	0.00	**0.00**
Sun scaled	5.39	2.31	0.9	0.00	1.48	**2.38**
Cloudy spot	0.00	1.38	0.00	0.00	0.00	**0.00**
Blight	0.00	4.98	0.00	0.00	0.00	**0.00**

C. Qualitative loss sampling results

High quality losses in Sharqia governorate might be due to absence of quality awareness for farmers and traders or poor agriculture practices (fertilization, irrigation, etc.) or lack of agricultural extension role, which leads eventually to the low price of the tomatoes.

Table 26: Quality losses (%) for tomato in Sharqia governorate and Nubaria district (2016).

Sharqia Governorate						
Symptom of loss	Farm	Wholesales Market	Retail Markets			
			Hyper markets	Super markets	Informal markets	Total retail
Green and Yellow Shoulder	10.59	3.84	0.00	0.00	0.00	**0.00**
Cat Face	0.00	0.87	0.00	0.00	0.00	**0.00**
Zippering	3.72	1.97	0.00	0.32	2.30	**2.62**
Blotchy Colors	20.95	8.22	0.21	0.00	2.22	**2.43**

Nubaria District						
Symptom of loss	Farm	Wholesales Market	Retail Markets			
			Hyper markets	Super markets	Informal markets	Total retail
Green and Yellow Shoulder	2.95	0.95	0.00	0.00	0.15	**0.15**
Cat Face	0.69	0.77	0.00	0.00	0.85	**0.85**
Zippering	1.39	1.09	0.00	0.32	0.00	**0.00**
Blotchy Colors	8.06	1.70	0.00	0.00	0.00	**0.00**

Annex 5 – Quantitative and qualitative loss symptoms

Box 1: List of quantity loss symptoms and their definitions.

Symptom of loss	Definition
Mechanical injuries	Bruising, cracking, wounds, scratches and holes result from rough handling after harvest
Blossom-end rot	A light tan patch on the blossom end of the green fruit. Over time, the area turns dark brown or black and may become sunken or leathery. Caused by deficient calcium supply.
Immature green fruit	Tomatoes harvested early before mature green stage, leads to failure of coloring after harvest.
Growth cracking	Radial growth cracks and concentric growth cracks (bursting) occur when the internal growth is faster than the skin growth. Caused by over-fertiliza-tion, extreme fluctuations in temperature and/or extreme fluctuations in soil mois-ture.
Insect injuries	Caused by feeding insects such as Tuta absoluta, as a result of poor insect control programs.
Fruit Worms	Worms (e.g. Helicoverpa armigera) usually cause a visible black hole at the base of the fruit stem. When the tomato is cut, tunneling is evident and the cavity may contain frays and decay as well as the worm/caterpillar itself.
Molds	Bacteria and fungi (e.g. Botrytis spp.) can enter through natural openings in the fruit or through wounds caused by mechanical injury, fruit spots, insect, cracking, blossom-end rot or other.
Sunscald	Usually begins on green fruit. White or yellow blisters develop on the sides that are facing the sun. With continued sun exposure, scalded areas become papery, flattened, and greyish white.
Cloudy spot	Tomatoes with damage from stinky bugs (Pentatomids) have pale yellow, irregular spots on the skin and white pithy areas under the skin at the puncture site.
Bird damage	Caused by bird feeding, wounds appear like very small daggers with holes exposing the pulp. Damage begins as fruit starts to ripen and continues throughout the ripening stage.
Early blight	Caused by Alternaria solani, it infects the area where the fruit attaches to the stem, resulting in a series of concentric rings. Infected can occur at any stage of development.
Bacterial spot	Disease caused by Xanthomonas campestris pv. Vesicatoria bacteria, results in black raised spots with yellow halos that later become scab-like spots. Damage severity increases with wetness of fruit and foliage from water or irrigation.
Bacterial canker	Infectious disease caused by Clavibacter michiganense. Symptoms are tiny black spots with whitish halos on ripe tomato fruit. There is no cure and it will kill the plant and spread to others, requiring extensive measures for dis-infection.

Box 2: List of quality loss symptoms and their definitions

Symptom of loss	Definition
Green & yellow shoulder	Characterized by the area around the stalk remaining yellow or green with internal white or green tissue. Associated with adverse weather conditions and soils with low potassium levels, low organic matter, and a high pH.
Catface	Catface is a deformity that occurs during the formation of the flower on the blossom-end of the tomato. Caused by cold temperatures, high nitrogen fertilization, or improper pruning.
Zippering	Zippering usually occurs when the anther of the tomato flower sticks to the developing fruit and produces a scar as the fruit grows, extending from the blossom end to the stem. Sometimes an open hole develops in addition to the scar.
Blotchy color	Parts of the fruit remain yellowish or orange, failing to ripen. It has several causes; temperatures below 60 , compacted soil and overly wet soil, viral diseases, whitefly infestation.

Annex 6 – Main technical recommendations to address causes of tomato loss, summarized by critical point level

At farm level:

- Apply Good Agricultural Practices and pest control programs in crop management.
- Purchase pesticides from certified shops.
- Provide proper in-field training for laborers on harvest practices.
- Promote harvesting at the pink stage (4) of ripening to avoid losses of over ripened fruits.
- Select varieties with longer shelf-life, suitable for processing, and climate resilient.
- Raise awareness about quality standards.
- Promote using plastic buckets as field packaging instead of palm crates.
- Coating of palm crates with a liner of paper or paperboard carton to smooth the edges.
- Protect harvested fruits from direct sun exposure.
- Customize a shaded area in the field for sorting, grading and packing operations.
- Ensure the availability of market information to farmers in timely manner.
- Strengthen agricultural extension services to ensure follow-up on farmers' practices.
- Encourage small farmers to establish cooperatives and leverage their negotiation and purchasing power to introduce refrigerated transportation systems.
- Use contract farming to leverage access to quality inputs, markets, and advisory.
- Raise farmers' awareness about the concept of food losses reduction through trainings.

At wholesale market level

- Avoid over-loading packages and vehicles, causing compression injury
- Promote the use of plastic instead of palm crates along the chain as longer-term investment (plastic crates are more expensive but more durable than palm crates).
- Transport in the early morning or late afternoon to avoid long exposure of products to direct sun-light.
- Cover open vehicles with breathable material, especially in summer.
- Use vehicles with shelves and refrigeration systems.
- Add ethylene absorbents in storage rooms or ventilation chambers to slow ripening.
- Introduce contracts with transporters and intermediaries to deliver fruits from farms to markets under contractual terms defining quality, quantity, and vehicle conditions.
- Raise wholesalers' awareness of food loss and waste control measures.

At retail market level

- Ensure open-air retail markets provide shade from direct sunlight and adequate ventilation.
- Careful display of fruits to avoid over-loading and preserve them from damage.
- Develop quality standards and control systems for the local market, and mechanisms to apply them.
- Explore new market channels (through export or processing) to limit losses in periods of excess production.
- Raise retailers' awareness of food loss and waste control measures, especially through proper storage and handling.
- Improve consumers' awareness on fruit quality, fruit handling at retailers' premises and at home, as well as food waste.

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