A literature search was carried out using scientific databases (Web Of Science, Scopus, Science Direct, Emerald, Springer and IEEE).

A general overview on the topic was obtained by searching for predefined keywords, namely ‘‘Sustainable Agricultural supply chain” in combination with “waste”, “perishable”, “Deterioration” , “inventory” , “Deteriorating” and “Food loss”. Studies in English from 2007 to 2017 and an excessive forward-backward search without limitation was subsequently performed.

The study of supply chain has been active not only from the economical objective -increase the profit by decreasing the cost- but extended under the umbrella of sustainability which encounter the combination of environmental, social, health and economic aspects to make us live in a better world (Trust & Kingdom, 1999)

Food supply chain is one of the most important supply chains to study all of its details, challenges and connections for the sake of human beings and for life.(Besik & Nagurney, 2017)

The sustainable development is essential in the agri-food industry because of the big effect of this industry on the environment, the consumption of natural resources, and the general health of any community.(Cagliano, Worley, & Caniato, 2016)

The United Nations’ Food and Agricultural Organization (FAO) has shocked us with a report that annually one third of the produced food for humanity usage is lost or wasted around 1.3 billion tons during its journey from farm to fork. (J. Gustavsson, Cederberg, & Sonesson, 2011); however other parts of the world suffer from over-supply and obesity so this unethical and imbalance inequalities triggered researchers and public attention to find solutions for food losses and wastes(Aschemann-Witzel et al., 2017)

Agricultural supply chain is considered as the raw material for several industries. (Shukla & Jharkharia, 2013).

Fruits and vegetables are considered as the most organic products with the highest share among other products as meat, diary, bakery and sweets which reinforce the idea of sustainable agricultural enhancement (Oroian et al., 2017)

Vegetables and fruit need concentration as they have high value of handling and storage needs.(Handayati, Simatupang, & Perdana, 2015). Also as they are considered as raw or minimally processed foods; in order to maintain their edibility the most important factor is the refrigeration process by a proper temperature along the supply chain; consequently power blackouts and/or equipment defects endanger quality of fruits and vegetables. (Raak, Symmank, Zahn, Aschemann-Witzel, & Rohm, 2017),

(Soto-Silva, Nadal-Roig, González-Araya, & Pla-Aragones, 2016) studied the papers addressing the fresh fruits supply chain and from 1976 to 2015 and concluded the only 28 papers discussed this issue and only 6 papers was concerned with inventory issue.

Over the past years from reality and literature developed and developing countries are working on different avenues to fulfill their population needs of food which is considered as largest manufacturing sector (Lemma, Kitaw, & Gatew, 2014). Food waste in the early stages of supply chain is the main problem for developing countries while for developed countries food loss and waste is more common in the later stages or the supply chain.(Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015)

Since the agri-food supply chains exerts the perishability and fast deterioration phenomena companies rethink their activities to reduce cost and sustain their performance. (Kouki, Babai, Jemai, & Minner, 2016)

Food losses are defined as “*loss or damage in early parts of the supply chain, as for example during harvesting, transport or storage*” while Food waste is defined as “*food items ready for human consumption but not consumed, as for example when processed foods or meals are wasted in retail, catering, or in the consumer household*”.(Aschemann-Witzel et al., 2017)

The measure of food waste is define according to target problem; as it is considered greater when addressing a social problem rather than an environmental one; and discussing the issue of food waste increase the awareness between producers and customers regarding consumption or production. (Chaboud & Daviron, 2017) so the United Nations set a target to reach a more sustainable world by 2030. (Nations, 2015)

The main contribution of this study is how to improve the inventory system of agri food supply chain with minimizing food waste, sustain the chain and minimize the cost with all the facing challenges specially inflation.

**Economic aspect:**

Validity of any product has a great impact on the customer's willingness to pay and consequently the profit as the demand rate to any product would certainly decrease as this product gets closer to its expiration date. (Tsiros & Heilman, 2005) (Fauza, Amer, Lee, & Prasetyo, 2016)

Uncertainty is the worst factor in a decision model; the agri food supply chain exerts uncertainty in all stages and phases, there is always a tradeoff between profit maximization (cost minimization) and customer satisfaction and this uncertainty makes even this trade much harder. (Kouki & Jouini, 2015)

Inflation is the increase in the rates of the goods.

Most of the inventory models, developed so far, did not include the inflation and time value of the money as parameters of the system. (Jain, Sharma, & Rani, 2014)

Global economic crises led to large scale inflation in developing countries which led to the increase of poverty level.(Yang, Lee, & Zhang, 2013).

Egypt was suffering from inflation since ever but in the last year due to the Egyptian pound floating exchange rate against all foreign currencies and since our country is a consuming rather than a producing one ; inflation is doubled or maybe tripled and is felt in all of our daily life routine.

Consequently inflation and time value of money can no more be neglected in the inventory policies.

(Chakraborty, Garai, Jana, & Roy, 2017) in their review of literature out of 15 papers from 2000 till 2017 only 5 papers (including his own) have discussed the supply chain of deteriorating goods (fruit juice company) under inflation; (Chakraborty et al., 2017) has studied an inventory system for three layer supply chain retailer, supplier and manufacturer and proposed three models one under inflation and other with no inflation the last was close to real life in a random fuzzy environment.

As a kind of business traction, a new paying sequence is getting more and more common, which is called credit period. In this sequence buyers are allowed some grace period after receiving products to pay for it instead of paying directly upon receiving. But if the buyer crosses this period, he would pay interest as well. (Jain et al., 2014)

(Yang et al., 2013) studied the inventory model of perishable product to determine the optimal order quantity under inflation when the supplier offers a credit period dependent on the purchasing quantity.

(Rajoria, Saini, & Singh, 2014) discussed the retailer inventory model to determine the optimum replenishment policy for a constantly deteriorating item with both constant and stock dependent demand in an inflation environment.

(HUANG, 2014) introduced an inflationary model for perishable products with the prioritization of a low-carbon environment.

(Jain et al., 2014) made a cost analysis for credits of the supplier in an inflationary environment for multi perishable items with constant deteriorating rate and the demand is stock dependent.

(Kouki & Jouini, 2015) studied in the inventory management the effect of deteriorating item life time variability on the operating cost

**Social Aspect:**

According to the definition given by FAO, food waste “refers to the removal from the food supply chain of food which is fit for consumption, by choice, or which has been left to spoil or expire as a result of negligence by the actor-predominantly, but not exclusively the final consumer at household level”(FAO, 2014)

According to problem definition and objective food losses and wastes are measured as in social problems the quantity of food lost and/or wasted can be considered as a big issue other than environmental problems; so discussing the food losses and wastes issue not only help to preserve food safety but increase the awareness among customers and producers.(Chaboud & Daviron, 2017).

Food losses affect badly the environment and humanity in more than a way. It causes extensive depletion of resources used in food production such as water, land and fossil fuels. It also contributes in increasing the greenhouse gasses, as the food industry is causing over 20% of the total greenhouse gasses emission. And above all food losses deprive the poor in the developing regions of the opportunity to get their needs of food. (Munesue, Masui, & Fushima, 2015) (FAO, 2011)

It is common for food products that the deterioration over the planning horizon affects the quality or value of the products; however since it is still within the acceptable consumption or production standards, the quantity of products is unaffected.(Fauza et al., 2016)

(Garrone, Melacini, & Perego, 2014) defined surplus food and food waste as following Surplus Food is the edible food that is produced, manufactured, retailed or served but for various reasons is not sold to or consumed by the intended customer; while food waste is the surplus food that is not recovered to feed people, to feed animals, to produce new products (e.g. jams or juices), new materials (e.g. fertilizers) or energy; however though surplus food is a recovery way for food value but still is considered as waste as it used for non-human consumption but better than total disposal.(Aschemann-Witzel et al., 2017)

(Garrone, Melacini, Perego, & Sert, 2016) claimed that food wastes can be controlled by the effective management of surplus food which is essential from the social perspective.

Surplus food can be donated with the aid of nonprofit organizations (NGOs) and foodbanks which can be a useful tool in this process to connect supplier and receiver (Garrone et al., 2016), or with special promotions to other outlets as school canteens, jail, orphan or elders houses (Raak et al., 2017); in case the reuse of food in not an option food can be recycled; recycling food waste can be defined as “reducing the amount of food waste entering waste stream”(Griffin, Sobal, & Lyson, 2009)

**Environmental Aspect:**

The food supply chain exerts different types of wastes along the manufacturing process, the FAO declared that one third (1.3 billion tons) of produced food for human consumption is lost or wasted (J. Gustavsson et al., 2011).

Decreasing the food waste plays an important role in sake of environmental aspect (Garrone et al., 2014); which results in that the usage of energy, water and emission of gases was not in vain.(Raak et al., 2017)

(Shukla & Jharkharia, 2013) have studied literatures over 20 years from 1989 until 2009; they addressed the major operational issues (as demand forecasting, production planning , Inventory management and transportation) and noted that most of authors considered the inventory deteriorates at constant rate, only few authors considered it functional deterioration rate, on the other hand studies was concerned with maximizing profit and minimizing the cost while neglecting the social and environmental effect.

Organization of the United Nations (FAO) have classified wastes types according to phases of manufacturing as follows:

* **Agricultural wastes.**
* **Postharvest wastes.**
* **Processing wastes.**
* **Distribution wastes.**
* **Consumption wastes**.

Figure cited from (Mariani, 2007) indicating the environmental impact of typical food chain

Figure no.1 is cited from (Mariani, 2007) indicating the environmental impact of typical food chain.

The significant wastes can be summed in the CO2 emissions, water and perished/lost food.

(Zhong, Xu, & Wang, 2017) discussed that food waste was addressed by 8 papers out of 28 papers (from 1997 to 2016) but it was rarely mate with other aspects as (food quality, supply chain efficiency, food safety & value chain analysis )

In specific for fruits and vegetables supply chain the visual quality (size & shape) plays and important role in the food waste as it is the main quality measurement for the consumer. (Raak et al., 2017)

The carbon footprint is expressed as the total amount of greenhouse gases emitted over the lifecycle of a product; it is measured in units of carbon dioxide in kilograms to visualize the additives to global warming. (Hoekstra & Mekonnen, 2008)

Food production process, and along the entire food supply chain, is causing greenhouse emissions. Food wastes make those gasses emitted in vain. (Scholz, Eriksson, & Strid, 2015), It is known that more than 30% of greenhouse gas emissions are generated by all consumer purchases from the food and drinks sector. (Rojas et al., 2011)

(Galal & El-Kilany, 2016) developed a simulation model using ExtendSim to determine the effect of changing the order quantity in a two echelon agri food supply chain on the service level , costs and carbon emissions, the conclusion was decreasing the order quantity will maintain the service level as required but will decrease costs and carbon emissions.

(Mouron, Willersinn, Möbius, & Lansche, 2016) studied the environmental impact for 1 kg of potatoes consumed as French fries and account for 2.05 kg of CO2 equivalents and discussed the importance of minimizing the amount of frying oil and electricity usage.

(Scholz et al., 2015) studied the food waste (excluding bread products) in six Swedish supermarkets for three years (2010 to 2012) for five departments meat, deli, cheese, dairy, fruit & vegetables and as per fig no. 2 cited from their study fruits and vegetables contribute 85% (almost 1340 ton) of the total wasted mass (1570 ton) while the rest of lost mass waste distributed between other departments; on the other hand fruits and vegetables carbon footprint wastage was 47% (almost 1140t CO2e) of the total wasted carbon footprint (2500t CO2e).

Figure Relative distribution of wasted mass and wastage CF for the five supermarket departments studied cited from Scholz, Eriksson, & Strid, 2015

Suboptimal can be defined as “*the food the consumer sense as relatively undesirable when compared to otherwise similar food because close to, at or beyond best-before date or because it deviates (sensually or visually) from the optimal*” (Aschemann-Witzel et al., 2015), (Raak et al., 2017) in their study for 13 German food processing companies (fruits & vegetables, bakery, dairy, meat, sweet & snacks and convenient food) included two types of suboptimal and food waste; the first one that results from material loss during the processing stage the other one from the customer point of view due to personal sensory, date, labelling, spoilage and mechanical damage during the logistic stage.

(Kulikovskaja & Aschemann-Witzel, 2017) studied the Danish food retails and observed that most retails tend to use the price reduction of suboptimal food; and claimed that promotional offers like buy 3 for 2 increase the consumer over purchase and food waste in households.

(Jenny Gustavsson & Stage, 2011) in his study for retail waste for fruits and vegetables pointed out that packaging has small effect of reducing wastes at retails but the effect might appear at households to protect fragile fruits and vegetables from bruising and spoiling.

(Eriksson, Strid, & Hansson, 2012) studied fresh fruits and vegetables wastes and losses in six Swedish retails and declared that 5.4% wasted fresh fruits and vegetables occur in the journey from supplier to customer passing by the retail store these percentages are divided as following 3.01% pre-store waste (rejected by store due to noncompliance with quality), instore waste 0.99% (waste occurring after purchase from the supplier), un recorded in-store waste 0.3%( originated from two sources: underestimated mass when recording unpackaged waste and unrecorded of wasted items) , while last is missing items of 1.1% (theft and mass loss due to evaporation).

One of the solution (Raak et al., 2017) they suggested in their study to decrease food waste was the by-product implementation; in fruits can be used in juices or as dried fruit in cereals , however it is a risky challenge as the consumer can refuse to use these by-product as it contains recycled products not only this but to conclude that the producer has financial motivation rather than environmental one.

(Besik & Nagurney, 2017) discussed a shorter supply chain consisting of farmers directly selling apples to customers and the captured the quality degradation in the process

Also (Takeo TAKENO, Shota KASAI, Mitsuyoshi HORIKAWA, 2013) studied the farmer market in Japan; and discussed the price elasticity of five agricultural products (tomato, cabbage, prune, grapes and radish); they collected the sales records and got the mean shelf time (time of sale minus time of arrival) for each price group and they plotted a graph which can aid the farmers to determine the best price at a suitable shelf time.

As when price increase the shelf time increase as illustrated in figure 3

Figure Price elasticity of demand based on shelf time cited from Takeo TAKENO, Shota KASAI, Mitsuyoshi HORIKAWA, 2013

In the earlies of the second century Arjen Hoekstra has introduced the concept of water footprint which can be defined as “*the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business*.” (Hoekstra & Mekonnen, 2008)

(Hoekstra & Mekonnen, 2008) have addressed the idea of virtual water chain as illustrated in Figure no. 4 and classified water footprint into operational water footprint and supply chain water footprint; operational in the amount of direct real water used for producing and processing of the product, while supply chain water footprint is the total amount of indirect water used to produce all the good and services that form the input of the business.

Decreasing water footprint such important as decreasing the carbon footprint.

Figure 4 Virtual Water Chain cited from (Hoekstra & Mekonnen, 2008)

**References:**

Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-Related Food Waste: Causes and Potential for Action. *Sustainability*, *7*(6), 6457–6477. http://doi.org/10.3390/su7066457

Aschemann-Witzel, J., de Hooge, I. E., Rohm, H., Normann, A., Bossle, M. B., Grønhøj, A., & Oostindjer, M. (2017). Key characteristics and success factors of supply chain initiatives tackling consumer-related food waste – A multiple case study. *Journal of Cleaner Production*, *155*, 33–45. http://doi.org/10.1016/j.jclepro.2016.11.173

Besik, D., & Nagurney, A. (2017). Quality in Competitive Fresh Produce Supply Chains with Application to farrmer’s Marketss.

Cagliano, R., Worley, C. G., & Caniato, F. F. A. (2016). The Challenge of Sustainable Innovation in Agri-Food Supply Chains (pp. 1–30). http://doi.org/10.1108/S2045-060520160000005009

Chaboud, G., & Daviron, B. (2017). Food losses and waste: Navigating the inconsistencies. *Global Food Security*, *12*(June 2016), 1–7. http://doi.org/10.1016/j.gfs.2016.11.004

Chakraborty, D., Garai, T., Jana, D. K., & Roy, T. K. (2017). A three-layer supply chain inventory model for non-instantaneous deteriorating item with inflation and delay in payments in random fuzzy environment. *Journal of Industrial and Production Engineering*, *34*(6), 407–424. http://doi.org/10.1080/21681015.2017.1361229

Eriksson, M., Strid, I., & Hansson, P. A. (2012). Food losses in six Swedish retail stores: Wastage of fruit and vegetables in relation to quantities delivered. *Resources, Conservation and Recycling*, *68*, 14–20. http://doi.org/10.1016/j.resconrec.2012.08.001

FAO. (2011). ENERGY-SMART FOOD FOR PEOPLE CLIMATE. Issue Paper, 66. http://doi.org/2/3/2017

FAO. (2014). Definitional Framework of Food Loss, 1–18. Retrieved from http://www.fao.org/fileadmin/user\_upload/save-food/PDF/FLW\_Definition\_and\_Scope\_2014.pdf

Fauza, G., Amer, Y., Lee, S. H., & Prasetyo, H. (2016). An integrated single-vendor multi-buyer production-inventory policy for food products incorporating quality degradation. *International Journal of Production Economics*, *182*, 409–417. http://doi.org/10.1016/j.ijpe.2016.09.009

Galal, N. M., & El-Kilany, K. S. (2016). Sustainable agri-food supply chain with uncertain demand and lead time. *International Journal of Simulation Modelling*, *15*(3), 485–496. http://doi.org/10.2507/IJSIMM15(3)8.350

Garrone, P., Melacini, M., & Perego, A. (2014). Opening the black box of food waste reduction. *Food Policy*, *46*, 129–139. http://doi.org/10.1016/j.foodpol.2014.03.014

Garrone, P., Melacini, M., Perego, A., & Sert, S. (2016). Reducing food waste in food manufacturing companies. *Journal of Cleaner Production*, *137*, 1076–1085. http://doi.org/10.1016/j.jclepro.2016.07.145

Griffin, M., Sobal, J., & Lyson, T. A. (2009). An analysis of a community food waste stream. *Agriculture and Human Values*, *26*(1–2), 67–81. http://doi.org/10.1007/s10460-008-9178-1

Gustavsson, J., Cederberg, C., & Sonesson, U. (2011). Global food losses and food waste – Extent, causes and prevention. *FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome*.

Gustavsson, J., & Stage, J. (2011). Retail waste of horticultural products in Sweden. *Resources, Conservation and Recycling*, *55*(5), 554–556. http://doi.org/10.1016/j.resconrec.2011.01.007

Handayati, Y., Simatupang, T. M., & Perdana, T. (2015). Agri-food supply chain coordination : the state-of-the-art and recent developments. *Logistics Research*, *8*(1), 1–15. http://doi.org/10.1007/s12159-015-0125-4

Hoekstra, A. Y., & Mekonnen, M. (2008). The water footprint of food. *Water for Food*, *109*(9), 49–60. http://doi.org/10.1016/B978-0-12-799968-5.00007-5

HUANG, Y. (2014). CICTP 2014: Safe, Smart, and Sustainable Multimodal Transportation Systems © ASCE 2014 782, (2), 782–792.

Jain, M., Sharma, G. C., & Rani, V. (2014). Cost Analysis for a Supplier in an Inflationary Environment with Stock Dependent Demand Rate for Perishable Items, *2014*.

Kouki, C., Babai, M. Z., Jemai, Z., & Minner, S. (2016). A coordinated multi-item inventory system for perishables with random lifetime. *International Journal of Production Economics*, *181*, 226–237. http://doi.org/10.1016/j.ijpe.2016.01.013

Kouki, C., & Jouini, O. (2015). On the effect of lifetime variability on the performance of inventory systems. *International Journal of Production Economics*, *167*, 23–34. http://doi.org/10.1016/j.ijpe.2015.05.007

Kulikovskaja, V., & Aschemann-Witzel, J. (2017). Food Waste Avoidance Actions in Food Retailing: The Case of Denmark. *Journal of International Food and Agribusiness Marketing*, *0*(0), 1–18. http://doi.org/10.1080/08974438.2017.1350244

Lemma, Y., Kitaw, D., & Gatew, G. (2014). Loss in Perishable Food Supply Chain: An Optimization Approach Literature Review. *International Journal of Scientific & Engineering Research*, *5*(5), 302–311.

Mariani, M. (2007). FORUM CHINA - EUROPE “ Sustainable agri-food supply chains and systems ” Preparatory Document of the WT35. *Chart*, 1–17.

Mouron, P., Willersinn, C., Möbius, S., & Lansche, J. (2016). Environmental profile of the swiss supply chain for French fries: Effects of food loss reduction, loss treatments and process modifications. *Sustainability (Switzerland)*, *8*(12). http://doi.org/10.3390/su8121214

Munesue, Y., Masui, T., & Fushima, T. (2015). The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions. *Environmental Economics and Policy Studies*, *17*(1), 43–77. http://doi.org/10.1007/s10018-014-0083-0

Nations, U. (2015). Transforming our world: the 2030 Agenda for Sustainable Development, *16301*(October), 1–35.

Oroian, C., Safirescu, C., Harun, R., Chiciudean, G., Arion, F., Muresan, I., & Bordeanu, B. (2017). Consumers’ Attitudes towards Organic Products and Sustainable Development: A Case Study of Romania. *Sustainability*, *9*(9), 1559. http://doi.org/10.3390/su9091559

Raak, N., Symmank, C., Zahn, S., Aschemann-Witzel, J., & Rohm, H. (2017). Processing- and product-related causes for food waste and implications for the food supply chain. *Waste Management*, *61*, 461–472. http://doi.org/10.1016/j.wasman.2016.12.027

Rajoria, Y. K., Saini, S., & Singh, S. R. (2014). An Inventory Model with Time Dependent Demand Under Inflation and Trade Credits, 155–165. http://doi.org/10.1007/978-81-322-1768-8

Rojas, A., Valley, W., Mansfield, B., Orrego, E., Chapman, G. E., & Harlap, Y. (2011). Toward food system sustainability through school food system change: Think & eatgreen at school and the making of a community-university research alliance. *Sustainability*, *3*(5), 763–788. http://doi.org/10.3390/su3050763

Scholz, K., Eriksson, M., & Strid, I. (2015). Carbon footprint of supermarket food waste. *Resources, Conservation and Recycling*, *94*, 56–65. http://doi.org/10.1016/j.resconrec.2014.11.016

Shukla, M., & Jharkharia, S. (2013). Agri‐fresh produce supply chain management: a state‐of‐the‐art literature review. *International Journal of Operations & Production Management*, *33*(2), 114–158. http://doi.org/10.1108/01443571311295608

Soto-Silva, W. E., Nadal-Roig, E., González-Araya, M. C., & Pla-Aragones, L. M. (2016). Operational research models applied to the fresh fruit supply chain. *European Journal of Operational Research*, *251*(2), 345–355. http://doi.org/10.1016/j.ejor.2015.08.046

Takeo TAKENO, Shota KASAI, Mitsuyoshi HORIKAWA, M. S. (2013). Price Elasticity of Demand Based on Shelf Time and its Application for Fresh Agricultural Products (Theory and Methodology), 304–311.

Trust, T. K., & Kingdom, U. (1999). Definition of a Sustainable Food System, 2–3.

Tsiros, M., & Heilman, C. M. (2005). The Effect of Expiration Dates and Perceived Risk on Purchasing Behavior in Grocery Store Perishable, *69*(April), 114–129.

Yang, S., Lee, C., & Zhang, A. (2013). An Inventory Model for Perishable Products with Stock-Dependent Demand and Trade Credit under Inflation, *2013*.

Zhong, R., Xu, X., & Wang, L. (2017). Food supply chain management : systems , implementations , and future research. http://doi.org/10.1108/IMDS-09-2016-0391