The economic impacts of the post-harvest losses of tangerines and Seville oranges crops in Iraq (Baghdad Governorate: As a case study)

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Abstract

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This study aims to calculate the percentage of loss and its causes of the horticultural crops tangerines and Seville oranges in Baghdad governorate for the 2020 agricultural season and estimate the economic impacts of losses both crops tangerines and Seville oranges at the study samples level. The research followed both methods descriptive and the quantitative mathematical in estimating the loss of horticultural crops from tangerines and Seville oranges trees and calculating the economic impact of this loss. The results showed that the percentage of losses of tangerines and Seville oranges crops on the level of wholesalers was about 12% and 13% respectively; causing economic losses estimated at about 3184.41 Euro. The results also displayed that the rate of total cash losses, average total lost areas, average wasted water, and average wasted fertilizers, at the level of plantation owner were estimated at 234.8 Euro, 2.9 ha, 17469.6 m^3 and 580 kg for each of them, respectively. In light of these results, it is necessary to identify the most important factors that reduce or limit agricultural waste for achieving the dominant strategic goal of food security.

Keywords: Post-Harvesting losses; Food Security; Horticultural crops; Iraq

Introduction

Agri-waste during the agricultural production process up to the final consumer represents a large stock of the agricultural gap. Agricultural waste is a negative phenomenon that needs an actual method in which everyone participates, whether farmers, an agricultural advisor, or even the agricultural policymakers at the government (Hodges et al., 2011). However, it affects economically inevitable loss, directly and negatively affecting the farmer's income and consumers. Furthermore, given that many holders are small farmers, reducing it may have an immediate and significant impact on their livelihoods. To reduce agricultural losses, it is necessary to track its impact and follow the stages of this waste, such as harvesting, transportation, handling, storage, or final marketing of the crop (Yusuf & He, 2011).

Agri-Waste is one of the critical issues in developing countries, which appears as a result of the conditions of those countries and the lack of technology through which to reduce these wastes (Kader, 1991). Most of the previous studies indicated that the contribution of the technology component to productivity reaches a high percentage of the total contribution of all the elements involved in the development process. This confirms the importance of technology's role in solving the economic and social problems that most people suffer from, especially the developing ones (Qamra, 2008).

Fruit crops are the most vulnerable to loss, especially during the post-harvest phase, because most of them are perishable crops after harvest and have a limited marketing and storage life. After harvesting, the losses occur in the fruit crops as a quantitative loss whose percentage varies according to the crop and the application of techniques in cultivation, harvesting, and handling (Sayed, 2015). Moreover, the qualitative loss represented a reduction in the quality of the

product in general, such as wilting, crinkling, loss of luster, the decline of color, loss of the distinctive flavor of the crop.

The agricultural sector in Iraq faces many challenges. The most important is limited natural resources such as water and agricultural land, especially in recent years. As well as the high values of agricultural inputs, which take a large share of agricultural revenue with the absence of farmers support, led to not applying the scientific technologies such as fertilizers, seeds, etc. then did not get the benefits of using it. In addition, another problem appears that is the absence of a transparent price policy that reassures the farmers of marketing the products at a fair price, which exposes them to borrowing and default (Ali & Jabara, 2021). As well as climate changes leading to temperature differences and water shortages in periods of cultivation and poor post-harvest treatment, resulting in an increase in wastage of crops, which negatively affected the marketing chain of these crops (Ministry of Iraqi Agriculture, 2021).

Reducing the percentage of losses of crops generally and horticultural crops particularly, whether during the production step or the subsequent post-harvest and marketing transactions, it may be equivalent in its economic feasibility to the reclamation and cultivation of large areas that drain a lot of economic and water resources (Mahmoud et al., 2010). However, this aspect has not yet received sufficient attention from those in charge of agricultural policymakers or from agricultural development projects.

This study aims to calculate the percentage losses of the tangerines and Seville oranges crops in Baghdad governorate during the 2020 cultivation season and determine the fundamental reasons affecting these losses, then estimate the economic effects of the loss of the crops at the studied sample.

Materials and Methods

Conceptual Framework

Horticultural crops, in general, are exposed to loss in various stages, starting from production, harvesting, transportation, storage, and marketing, to the final use and consumption of those crops. In light of this escalation, the cost of waste represents an increasing burden on the economy without benefiting from it, which constitutes a waste of the resources used to produce those crops (El-Ghonamy, 2017). According to the previous studies, agricultural waste is defined as the amount of waste or loss that occurs in production, quantitatively and qualitatively, due to many elements (Al-Dhalea & Al-Faar, 2012). This leads to a shortage of food available for consumption or apparent changes to the commodity regardless of the weight change. From a consumer's perspective, it makes it lower quality and be unfit

for human consumption (Draz et al., 2017). The Food and Agriculture Organization of the United Nations (FAO, 2014) defines waste as reducing the amount of edible food intended for human consumption at the end of the food chain: singular trade and final consumption.

Loss in the agricultural sector expresses any quantitative or qualitative deficiency in the crop resulting from wasting available inputs (land, fertilizers, pesticides, etc.). This concept differs from damage, which expresses corruption or physical damage to the commodity for many reasons (Zaki & Elham, 2015). It is responsible for its deterioration, as agricultural production is exposed to the loss of a large part of it, whether field or horticultural, in its marketing behavior from the places of production to the areas of consumption. This represents a shortage of national agricultural and individual income, as a result, wastage in the use of productive resources available (Al-Jahwi, 1995). Agricultural losses that occur in horticultural crops include several types of losses, which can be clarified as follows (Awad, 2016):

- Economic Losses: represent a decrease in the monetary value of agricultural commodities and losses in the quantities of scarce economic resources used in the production process.
- Quantitative Losses: it is the decrease of the weight and quantitative of the crop.
- Qualitative (Quality) Losses: rely on objective considerations and personal judgment and are therefore difficult to estimate or measure, but often can be calculated by comparing them to international quality levels.
- Food losses: it combines quantitative and qualitative losses, making the commodity from the consumer's point of view less quality and unfit for human consumption.
- Fruit crops are usually affected after harvest and during storage by multiple factors that deteriorate (Figure 1). Among these factors (Ghazzawy et al., 2019), some are due to internal causes specific to the crop, such as respiration, ethylene production, water loss, physiological damage, and others. Others are caused by external factors like heat, humidity, pathological and fungal infections (Laota, 2014).

Study sample and analysis method

In order to achieve the goals of the study, it relied on the primary data by questionnaires designed by authors to collect the required data. The field survey data included two types of producers of tangerines and Seville oranges crops in Baghdad governorate who were randomly selected. They are orchard owners and wholesalers in the local markets. The data was collected through a personal interview with fifty orchard farmers

Fig. 1. Flowchart of the factors causing loss and waste in horticultural crops after harvesting
Source: Laota, 2014
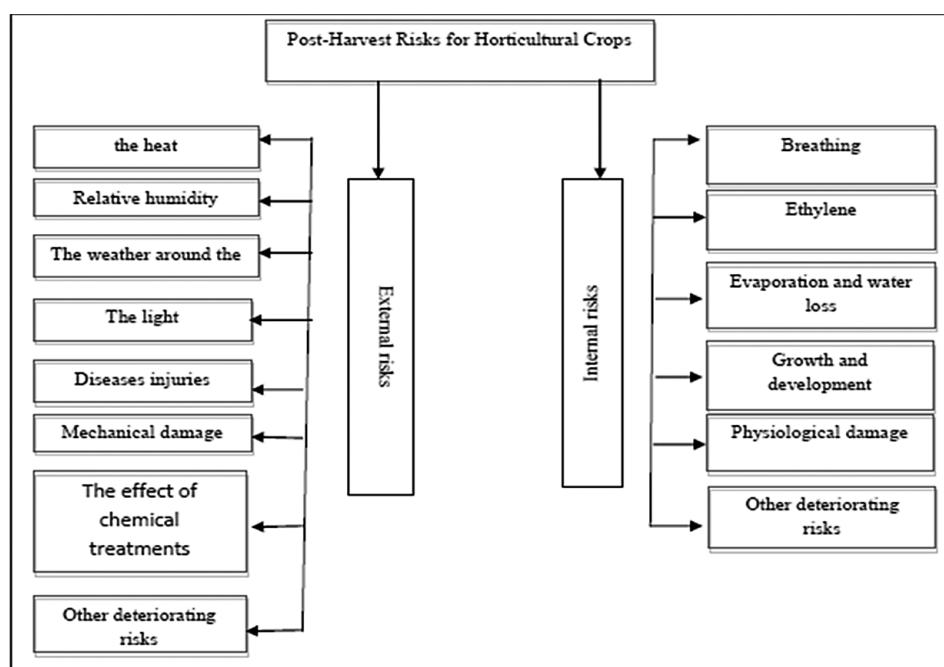
distributed in the agricultural departments of the Baghdad governorate. An interview also was conducted with fifty wholesale brokers to receive the horticultural crops marketed to the local wholesale markets located in the same governorate.

The research followed both methods descriptive and the quantitative mathematical in estimating the loss of horticultural crops from tangerines and Seville oranges trees and calculating the economic impact of this loss. The missing quantities of the production of tangerines and Seville oranges crops were estimated at the level of orchard owners based on the following equation (Al-Qahtani & Adel, 2007; Al-Badour, 2010; Gharde et al., 2018):

Amount of Production Loss = Expected or Targeted Production – Marketed Production

Besides that, the missing quantities of production of the tangerines and Seville oranges crops were also estimated at the level of the wholesale markets according to the following equation (Al-Awadi, 2011; Jamila & Al-Omari, 2015):

Quantity of Marketed Losses = The Quantities Purchased from the Owners of the Orchards – Quantities Sold to the Retail or Individual Sellers

Results and Discussion

First: the productive and economic indicators of the tangerines and Seville oranges crops
Indicators of productivity of Tangerines and Seville oranges crops in Iraq

As shown in Table 1, by studying the evolution of the number of trees and production of the tangerines crop in Iraq for 2000–2019. The number of Tangerines trees ranged between a minimum of about 58 100 trees for the years 2000–2004, and a maximum of about 305 944 trees in 2013, with an average annually, was estimated about 210 000 trees. The number of tangerines trees increased during the study period, with an annual growth rate estimated at 7%. The production during the same period ranged between a minimum of about 2675 t in 2015 and a maximum of about 58 900 t in 2005, with an annual average of 8%.

Table 1 also shows, by studying the development of the number of trees and production of the Seville oranges in Iraq during 2000–2019, Seville oranges trees ranged minimum about 44 800 trees during 2001–2004 and a maximum of about 753 329 trees in 2019, with an annual average estimated at 517 000 trees. The number of Seville oranges trees tended to increase during the study period, with an annual growth rate estimated at 16%. The production during the same period ranged between a minimum of about 6788 t in 2007 and a maximum of about 680 000 t in 2005, with an annual average of 46 000 t. Seville oranges production tended towards a relative increase during the study period, with an annual growth rate estimated at 1%.

Economic indicators of the tangerines and Seville oranges crops of the study sample
By reviewing the economic indicators per hectare of

Table 1. Evolution of the numbers of fruit trees and production of Tangerines and Seville oranges fruit in Iraq for period (2000–2019)

Years	Seville oranges trees		Tangerines trees	
	Production, t	Number of trees	Production, t	Number of trees
2000	12 000	44 900	14 800	58 100
2001	11 900	44 800	15 000	58 100
2002	11 700	44 800	15 100	58 100
2003	9100	44 800	6300	58 100
2004	8000	44 800	3000	58 100
2005	680 500	613 900	58 900	244 600
2006	7100	647 900	2800	262 600
2007	6788	656 234	2938	284 173
2008	7946	664 955	3327	275 714
2009	8656	674 075	3675	283 845
2010	8586	683 569	3668	293 043
2011	11 066	690 687	3630	303 963
2012	13 019	703 666	3678	304 311
2013	17 132	714 182	4437	305 944
2014	17 838	703 722	4670	304 167
2015	16 042	619 068	2675	202 751
2016	16 886	622 447	2711	203 111
2017	17 025	629 094	2743	202 611
2018	17 393	734 796	2990	202 401
2019	21 498	753 329	4167	234 291
*Total	920 175	10 335 724	161209	4 198 025
*Average	46 008.75	516 786.2	8060.45	209 901.25
*Annual Growth Rate	0.012	0.155	- 0.081	0.075

Source: Ministry of Agriculture/ Planning and Follow-up Department.
*Estimated by authors based on SPSS program

the tangerines crop, as shown in Table 2, the productivity was about 0.16345 t, with an average price of about 541.3 Euro per ton, and the total revenue per hectare 88.5 Euro. In contrast, the total costs of producing a hectare amounted to about 30.4 Euro, achieving a net return of about 58.1 Euro per hectare, and the profitability of the spent Euro was about 0.0013 Euro, while the return on the investment of one Euro was about 0.002 Euro.

Table 2. Economic Indicators of Tangerines and Seville Oranges Crops of the Study Sample on Season 2020

Economic Indicators	Unit	Tangerines	Seville Oranges
Fruit Trees	number	1535	125142
Productivity	ton / hectare	0.16345	0.262075
Average Price	Euro/ ton	541.3	234.7
Total Revenue	Euro/ hectare	88.5	61.5
Total Cost	Euro/ hectare	30.4	26.9
Net Revenue	Euro/ hectare	58.1	34.61
Profitability of the Spent Euro	Euro	0.0013	0.00087
Roi Spent Euro	Euro	0.002	0.0015

Source: Estimated by Authors Based on Data from Questionnaire According to The Following Equations:
Total Revenue = Productivity Average Price
Net Revenue = Total Revenue Rate – Total Cost Rate
Profitability Euro Spent = Net Revenue ÷ Total Cost Average
Return on Spent Euro Investment = Total Revenue ÷ Total Costs
Where each one Euro is equal to 1500 Iraqi Dinar (ID)

While the economic indicators for one hectare of Seville oranges, as shown in Table 2, found that the productivity amounted to about 0.262075 t, with an average price of 234.7 Euro per ton, and the total revenue of the hectare was about 61.5 Euro, where the total costs of producing a hectare amounted to about 26.9 Euro, with a net return of 34.61 Euro per hectare. The profitability of the spent Euro was 0.00087 Euro, while the return on investment per Euro was about 0.0015 Euro.

Second: Estimating the percentage of post-harvest loss and its causes of tangerines and Seville oranges crops of the study sample in Baghdad
Estimation of the percentage of post-harvest loss and its causes of the tangerines and Seville oranges crops of orchard owners

Table 3 indicates that the average total area cultivated of tangerines and Seville oranges crops of the study sample was amounted to about 5.51 and 4.7 hectares of each crop,

respectively, the results showed that the owners of the selected orchards sample had lost about 38%, 17% as a loss of the expected total production rate of tangerines and Seville oranges crops estimated at 0.900 and 1.232 t of each crop, respectively. The average total quantities loss of tangerines and Seville oranges crops are about 0.343 and 0.209 t of each crop, respectively.

Table 4 also shows the opinions and viewpoints of orchard owners about the reasons that led to the losses in the both crops tangerines and Seville oranges, with the relative importance of these reasons. The results showed that there are multiple causes of losses which can be summed up as follows: the cause of disease and insects ranked first by 82%, which the number of farmers who referred to this cause was about 41 farmers out of 50, followed by the causes of unavailability of advanced and suitable storage places and devices in the orchard, exposure of the crop to extreme cold, deformation of fruits and their small size of 48%, 46%, 40% respectively. In contrast, poor picking up by workers was

Table 3. Quantity and the percentage of post-harvest losses of tangerines and Seville Oranges crops of orchards owners in the study sample

Yield	Area Rate, hectare	Productivity, t	Expected Production Rate, t	Marketed Production Rate, t	Loss Rate, t	Loss Percentage, %
Tangerines	5.51	0.16345	0.900	0.557	0.343	38
Seville Oranges	4.7	0.262075	1.232	1.023	0.209	17

Source: Estimated by authors based on data of questionnaire and according to the following equations:
The Expected Production Rate = Rate of the Area Cultivated × the Actual Productivity Rate of the Crop
Loss Rate = Expected Production Rate – Marketed Production Rate of the crop
Loss Percentage = (Waste Rate ÷ Expected Production Rate) × 100

Table 4. The relative importance of the losses reasons of the tangerines and Seville oranges crops according to the opinions of the orchard's owners

No	Reasons of Losses	Number of Farmers	Percentage of Farmers, %
1	Poor picking on the part of the workers	6	12
2	Not paying attention to crop service operations and harvest dates	18	36
3	Lack of interest in storing and sorting crops after harvesting	16	32
4	Infestation by diseases and insects	41	82
5	Increasing the degree of fruit ripening	18	36
6	Putting the product in unsuitable containers	16	32
7	Exposure to extreme cold	23	46
8	Bad weather during and after harvest	9	18
9	Loading problems and not transferring the product to the wholesale markets on time	19	38
10	Falling fruits during the process of picking and harvesting and not benefiting from them	15	30
11	Wrong packing	15	30
12	Lack of advanced and suitable storage places and devices in the orchard	24	48
13	Fruit distortion and small size	20	40
14	Lack of training and guidance courses for harvesting the crop	13	26

Source: Estimated by Authors Based on Questionnaire Data

ranked last by 12%, where the number of farmers who referred to this reason were six farmers out of 50.

Estimation of post-harvest loss percentage and its causes of the tangerines and Seville oranges crops of wholesalers (wholesale markets)

The percentage of loss in fruit crops in wholesale markets is low compared to its counterpart of orchard owners or single sellers because intermediaries considered the link between the product and retail sellers in the subsidiary markets, as the exchange process takes place relatively quickly period. However, the nature of fruit crops is perishable and for other reasons, there is a loss of them on the level of wholesalers because of the exposure of the product to unexpected weather conditions and delays in the processes of discharging and selling those crops to individual sellers. The data presented in Table 5 indicate that the average total quantity purchased by wholesalers for the study sample during the season amounted to about 32, 10.5 t for each of tangerines and Seville oranges crops, respectively, with losses percentage was about 12% and 13%, respectively.

Table 6 also shows the opinions of wholesalers on the reasons that led to this loss of the two crops, as it found that eight main reasons can be reviewed according to their importance and as shown in Table 6. The reasons of the lack of interest of the orchard owners in conducting the sorting and grading operations, the exposure to the unexpected weather conditions inside the market due to the open supply, and the poor loading and unloading of the crop during transportation, are the most important reasons for the losses according to their opinions at rates of about 50%, 50%, and 30% respectively, while the reasons of using inappropriate packages by the owners of the orchards, the delay in the sale process to retail owners (single sellers) due to the high prices, and the transportation which happen by using open cars that are not equipped with modern tools of preservation, are ranked in the following orders by ratios amounted to about 18%, 18%, and 14% of each reason, respectively.

Third: the economic impacts of the post-harvest losses of tangerines and Seville oranges crops of the study sample in Baghdad

The existence of post-harvest losses of the tangerines and Seville oranges crops has negative economic impacts at all levels, starting with the orchard's owners and ending with retail or individual sellers, these losses or economic effects can be clarified as follows:

The economic effects of post-harvest losses of the tangerines and Seville oranges crops of orchard owners.

Concerning the tangerines crop in the study sample, the results are shown in Table 7 indicate that the average value of loss of the tangerines estimated at 185.7 Euro, with an average of about 0.343 t. This waste represents an average

Table 5. Quantity and percentage of post-harvest losses of tangerines and Seville oranges crops of wholesalers in the study sample

Yield	Average Purchased, t	Average Sold, t	Post-Harvest Losses Rate	Post-Harvest Losses, %
Tangerines	32.3210	28.4050	3.916	12
Seville Oranges	10.526	9.1450	1.381	13

Source: Estimated by Authors based on data of questionnaire and according to the following equations:
Post-Harvest Losses Rate = Average Purchased – Average Sold of the crop
Post-Harvest Losses % = (Post-Harvest Losses Rate / Average Purchased) × 100

Table 6. The relative importance of reasons of post-harvest losses of tangerines and Seville oranges crops according to the opinions of the wholesalers

No	Reasons	Number of Brokers	Percentage of Brokers, %
1	The use of unsuitable containers by gardeners	9	18
2	The orchard owner's lack of interest in conducting sorting and grading operations	25	50
3	Poor loading and unloading of the crop during transportation	15	30
4	Poor transportation network	3	6
5	Transportation is carried out by convertible cars that are not equipped with modern preservation tools.	7	14
6	Exposure to unexpected weather conditions inside the market due to open supply	25	50
7	Delay in the sale process to retailers (single sellers) due to high prices	9	18
8	Sorting packages of crops by individual sellers	5	10

Source: Estimated by Authors Based on Data of Questionnaire

production of the wasted area estimated at 2.1 hectares. Based on the water need for the cultivated dunums of the tangerines, the average amount of irrigation water wasted in the cultivation of this area is estimated at 12650.4 m³. While the amount of fertilizer lost was estimated at about 420 kg, which represents economic losses of essential resources, which are land, irrigation water and fertilizers that could have been used to produce other crops.

As for Seville oranges at the sample, the results are presented in Table 7 also. The average value of the loss of the Seville oranges is estimated at 49.1 Euro, with an average amount of about 0.209 tons. Based on the rationed rate or the water need for the cultivated acres of the Seville oranges crop, the average amount of irrigation water wasted in the cultivation of this area is estimated at 4819.2 m³. While the amount of fertilizer lost was estimated at about 160 kg, which represents economic losses for essential resources, land, water, fertilizers and capital that could have been used for producing other crops in the study sample.

The economic impacts of post-harvest losses of the tangerines and Seville oranges crops of wholesalers (wholesale markets)

Concerning the tangerines crop on wholesalers' level, the

results presented in Table 8 show that the average value of the loss of the tangerines crop is estimated at 2652.31 Euro, with an average quantity loss of about 3.9 t. As for the Seville oranges on intermediary's level, the results are presented in Table 8 too. The average value of the loss of the Seville oranges crop is estimated at 532.1 Euro, with an average quantity loss of about 1.4 t. These values of wastage represent economic losses for a principal resource, which is capital, which could have been used to purchase other crops or expand on the purchased quantities of the fruit under study.

Conclusions

By estimating the post-harvest loss of tangerines and Seville oranges at the level of plantations owners in Baghdad Governorate, it points out that the rate of losses had reached about 0.343, 0.209 t for each of crop, respectively, indicating there are wastes in the aspect of areas planted with those crops estimate at about 10.21 hectares. The results also displayed that the rate of total cash losses, average total lost areas, average wasted water, and average wasted fertilizers, at the level of plantation owner were estimated at 234.8 Euro, 2.9 ha, 17469.6 m³, and 580 kg for each of them, respectively, which means there are economic losses for rare resources;

Table 7. Economic losses of post-harvest losses of tangerines and Seville oranges of the orchard's owners in the study sample

Indicators	Tangerines	Seville Oranges	Total
Average Amount of Losses, t	0.343	0.209	0.552
Average Marketed Selling Price, t/ Euro	541.3	234.7	–
Productivity, t/ hectare	0.16345	0.262075	–
Average Value of Losses, Euro	185.7	49.1	234.8
Average Lost Area, hectares	2.1	0.8	2.9
Average Water Requirement, m³/ hectare	6024	6024	–
Amount of Water Lost, m³	12650.4	4819.2	17469.6
Average Fertilizer Needs, kg/hectare	200	200	–
Amount of Fertilizer Lost, kg	420	160	580

Source: Estimated by authors based on data of questionnaire and according to the following equations:
Post-Harvest Losses Rate = Average Amount of Losses × Average Marketed Selling Price
Average Lost Area = Post-Harvest Losses Rate / Productivity
Amount of Water Lost = Average Lost Area × Average Water Requirement
Amount of Fertilizer Lost = Average Lost Area × Average Fertilizer Needs

Table 8. Economic losses of post-harvest losses of tangerines and Seville oranges of wholesalers of the study sample

Yield	Average Amount of Losses, t	Average Wholesale Price Per Ton, Euro	Average Value of Losses, Euro
Tangerines	3.916	677.3	2652.31
Seville Oranges	1.381	385.3	532.1
Total	5.297	–	3184.41

Source: Estimated by authors based on data of questionnaire and according to the following equation:
Average Value of Losses = Average Amount of Losses × Average Wholesale Price per Ton

cash currencies, acreage, water, and fertilizers, it was possible to take advantage of them to farm and produce other horticultural crops at the level of study regions. With regard to the estimated results of the post-harvest losses for tangerines and Seville oranges crops at the level of wholesalers in Baghdad Governorate during the 2020 agricultural season, it became clear that the average amount of losses amounted to about 4, 1.4 t for each of crop, respectively, causing economic losses estimated at about 3184.41 Euro, represent a rare resource also, namely cash moneys that could have been used to buying other horticultural crops or increase the purchased quantities of current crops. In light of these results, the study recommends conducting more studies and research related to lose and waste and identifying the most important factors that reduce or limit agricultural waste to achieve the dominant strategic goal of food security.

References

Al-Awadi, F. (2011). An economic study of marketing losses for some horticultural crops in Egypt (a field study). Agricultural Economics Research Institute, Agricultural Research Center, *36*(3), 1040 – 1053.

Al-Badour, M. (2010). Estimating post-harvest losses of some vegetable crops in Jordan. *The Jordanian Journal of Agricultural Sciences, 6*(1), 1-10.

Al-Dhalea, A. & Al-Faar, Sh. (2012). An economic study of the productive losses of wheat as the most important cereal crop in Beheira Governorate. Mansoura University. *Journal of Agricultural Economics and Social Sciences*, *3*(9), 1285-1297.

Ali, S. & Jabara, O. (2021). An economic study of post-harvest losses for wheat farmers in Iraq Baghdad Governorate – Case Study. *Iraqi Journal of Agricultural Sciences, 52*(5), 1267- 1275.

Al-Jahwi, M. (1995). Loss of the most important agricultural food commodities in the A.M.A. The National Symposium on Agricultural Product Loss in Arabian Countries, Arabian Development Organization. *Workshop Papers, number 5.*

Al-Qahtani, S. & Adel, M. (2007). Post-harvest purification and its relationship to marketing losses and agricultural economic resources for the most important vegetable and fruit crops in the Kingdom of Saudi Arabia. Research No. 160, Research Center of the College of Food and Agriculture Sciences, King Saud University.

Awad, M. (2016). Evaluation of agricultural losses before and after the harvest of some vegetable and fruit crops in the State of Qatar for the period (2013-2015). PhD thesis, College of Agricultural Sciences, University of Algezira.

Draz, S., Al-Subaie, F. & Abou El, M. E. (2017). Farmers' knowledge of the causes of wastage in wheat in Damietta Governorate. *Journal of Agricultural Economics and Social Sciences, 8*(12), 963-972.

El-Ghonamy, A. (2017). An economic study of the waste of Egyptian rice crop in Beheira governorate. Mansoura University, Egypt. *Journal of Agricultural Economics and Social Sciences*, *8*(6), 351-355.

Food and Agriculture Organization (FAO) (2014). Global food losses and food waste – extent, causes and prevention by Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R. & Meybeck, A. Rome http://www.fao.org/docrep/014/mb060e/mb060e00.pdf

Gharde, Y., Singh, P., Dubey, R. & Gupta, P. (2018). Assessment of yield and economic losses in agriculture due to weeds in India. *Journal of Crop Protection, 107*, 12–18. www.elsevier.com/locate/cropro.

Ghazzawy, H. S., Alhajhoj, M. R., Sallam, A. A. M. & Munir, M. (2019). Impact of chemical thinning to improve fruit characteristics of date palm cultivar Khalas. *Iraqi Journal of Agricultural Sciences, 50*(5), 1361-1368.

Hodges, R., Buzby, J. C. & Bennett, B. (2011). Post-harvest losses and waste in developed and less developed countries: opportunities to improve resource use. *Journal of Agricultural Science, 149*(S1), 37-45.

Jamila, A. & Al-Omari, A. (2015). Estimation of post-harvest losses for guava and fig crops in Alexandria Governorate. *Journal of Agricultural Economics and Social Sciences, 6*(9), 1421-1430.

Kader, A. (1991). Post-harvest Technology of Horticulture Crops. First edition, University of California, Division of Agriculture and Natural Resources, Publication 3311.

Laota, T. (2014). Workshop Integrated Post-harvest and Storage Risks Management for Horticultural Exports. Biological, Environmental and Agricultural Statistical Training Center (IBESTAT). https://www.agro-lib.site/2019/11/blog-post_260.html.

Mahmoud, A., Al-Awadi, A. & Kamel, A. (2010). An economic study of the marketing losses of some horticultural crops in Egypt. *The Egyptian Journal of Agricultural Economics, 20*(1), 1-13.

Ministry of Iraqi Agriculture, Planning and Follow-up Department (2021). Report of Cultivation and Production of Horticultural Crops in Iraq for period 2000-2019.

Qamra, S. (2008). The effect of post-harvest technology on marketing losses and agricultural economic resources of the most important vegetables and fruits produced in Alexandria Governorate, Agricultural Economics Research Institute, Agricultural Research Center, *33*(5), 3785-3796.

Sayed, S. (2015). An economic study of post-harvest losses of the most important fruit crops in Fayoum Governorate. *Journal of Agricultural Economics and Social Sciences, 6*(11), 1925- 1935.

Yusuf, B. & He, Y. (2011). Design, development and techniques for controlling grains post-harvest losses with metal silo for small and medium scale farmers. *African Journal of Biotechnology, 10*(65), 14552-14561.

Zaki, H. & Elham, M. (2015). Post-harvest treatments, net post-harvest technology. new.reefnet.sy › index.php.