Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 17, Issue 2, 2017
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ECONOMIC ANALYSIS OF DIFFERENT COLD STORAGE TYPES: A CASE STUDY OF ISPARTA PROVINCE, TURKEY

Vecdi DEMİRCAN, Mehmet Ali KOYUNCU

Suleyman Demirel University, Agriculture Faculty, Department of Agricultural Economics, Department of Horticulture Science, Isparta-Turkey, Email: vecdidemircan@sdu.edu.tr

Corresponding author: vecdidemircan@sdu.edu.tr

Abstract

The objective of this study was to carry out an economic comparison of different types of cold storage facilities for apple. Primary material of the study was comprised of original data acquired from cold storage facilities in Isparta province which is ranked number one in Turkey in the field of apple storage. Analyses were carried out by classifying the enterprises into three groups according to their cold storage types as those with normal atmosphere (NA), those with controlled atmosphere (CA) and those as cold storage facilities with a mixture of normal and controlled atmosphere (NA+CA). It was determined that the average capacities were 7,500 tons, 4,540 tons and 2,400 tons, respectively for NA+CA, NA and CA facilities. Capacity usage ratio was determined as 85.42% for CA facilities, 79.74% for NA facilities and 77.60 % for NA+CA facilities. It was determined that Golden Delicious ranked first among the apple types stored in all cold storage types. It was determined that the ratio of Golden Delicious among the apples stored in the facilities was 52.49 % for NA, 52.89% for NA+CA and 69.86 % for CA facilities. NA+CA facilities were determined to have the highest average annual operating cost among the examined facilities. Average total cost per enterprise among NA+CA facilities was determined as 355,869 USD, 192,131 USD for NA facilities and 121,282 USD for CA facilities. When the enterprises were compared with regard to net income per ton, it was observed that CA cold storage facilities were more profitable. Net income per ton was calculated to be 27 USD for CA facilities, 21 USD for NA+CA facilities and 17 USD for NA facilities. It was determined that total costs and total income were equal and that break-even point was reached when 41.62% of the capacity is used for CA cold storage facilities, 43.94% for NA+CA facilities and 45.75% for NA facilities. Facilities make profit after this point.

Key words**:** *apple, cold storage facilities, cost, profit*

INTRODUCTION

Cold storage is keeping and processing the product under conditions that will enable the preservation of its quality for future consumption, processing or marketing in order to gain higher revenues (Erkan, 2013) [5]. The history of storage dates as back as humanity itself. Humans have given significant importance to preserving, protection and storage of agricultural products for consumption in coming days, weeks and months or to make commercial use of them. Products were first stored simply in cups, wells and cellars without temperature and humidity control. Whereas today, storage activities have also developed rapidly thanks to science and technique. The storage of horticultural crops is now carried out in modern facilities by way of machines, controlling heat and moisture components in order to minimize their spoilage and rotting. Thanks to these developments; horticultural crops can now be stored for longer periods, quality losses due to storage is decreased, commercial revenue from stored goods is higher, it is possible to find fresh fruits and vegetables in all seasons and this activity creates new employment opportunities in many sectors from packaging to transportation (Sargınand Okudum, 2016) [13].

Turkey provides economic options for the production of many horticultural crops in the world thanks to its suited climate conditions. Turkey is among important producer countries in the world with a fruit and vegetable production reaching 47 million tons (TUİK, 2015) [14]. However, there are significant losses in horticultural crops produced in Turkey during and after harvesting. The ratio of these losses varies between 5-10% in developed countries according to product and

post-harvest operations and between 20-40% in developing countries (Kader, 2002; Erkan, 2012) [6, 9]. When these loss ratios are considered, approximately more than 10 million tons of raw fruits and vegetables either lose their market value or get spoiled before they reach the consumers. The most important point to take into consideration with regard to post-harvest procedures is to ensure that fruits and vegetables are processed in environments that will preserve the quality and nutritional value of the products. Post-harvest quality of horticultural crops can only be preserved by cold storage and the continuity of the cold chain (Erkan, 2013) [5].
According to 2014 data, world cold storage capacity is 552 million cubic meters, and India ranked one with a share of 23.73%. India is followed by USA (20.83%), China (13.77%), Japan (5.98%) and England (4.53%). Turkey is ranked number 14 in the world with a cold storage capacity of 6.8 million cubic meters (GCCA, 2014) [7]. The study was carried out in Isparta which is one of the most important provinces in Turkey with regard to cold storage capacity. According to 2016 data, there is a total of 108 cold storage facilities and a cold storage capacity of 430,000 tons (Anonymous, 2016) [3]. Almost all of the cold storage facilities in Isparta province are used for apple storage. The city of Isparta has ecological conditions suited for growing apples. According to 2015 data, apple production of Turkey is 2.57 million tons, and the share of Isparta in Turkish apple production is about 17% (TÜİK, 2016) [14].
The objective of this study was to carry out the economic analyses for the different types of cold storage facilities of Isparta province which is ranked number one in Turkey with regard to apple storage. To this end; cold storage facilities having only rooms with normal atmosphere (NA), controlled atmosphere (CA) and both of these rooms as mixed (NA+CA) were compared with regard to storage capacity, capacity utilization rate, length of storage time for apples, ratio of loss, temperature and humidity ratios, technical properties, cost, income and profitability indicators. In addition, the effects of storage on apple sales price were also examined with regard to break-even point determining the minimum capacity for the facilities.

MATERIALS AND METHODS

The main material of the study was comprised of original data acquired from cold storage facilities in the city of Isparta which were collected via survey method. In addition, various study results and reports on the subject were also used. Survey data were collected during May-June 2016 period.
The number and capacities of cold storage facilities according to type were asked from Isparta Food, Agriculture and Livestock Provincial Directorate. According to the records, it was determined that there is a total of 108 cold storage facilities in the city of Isparta. Equal number of facilities were taken into consideration for each cold storage type since cold storage facilities with normal atmosphere (NA), those with controlled atmosphere (CA) and those with mixed normal and controlled rooms (NA+CA) since the objective of the study was to carry out an economical comparison between cold storage facilities. It was determined according to the records that there are 8 cold storage facilities with controlled atmosphere in the study area. However, 3 of these cold storage facilities with controlled atmosphere were not taken into consideration since they were going to start operation in 2017. Accordingly, 5 cold storage types of each were taken into consideration for a total of 15 cold storage facilities with normal atmosphere (NA), with controlled atmosphere (CA) and cold storage facilities with normal and controlled rooms after which data were collected via face-to-face interviews.
Cold storage facilities with normal atmosphere are storages with which only the temperature and relative humidity can be controlled without intervening with the air composition. Gas tightness is not important since these storages have only temperature and humidity control. It is sufficient for storages with normal atmosphere to have a good thermal insulation. The ratio of the gases in the environment can also be controlled in

cold storage rooms with controlled atmosphere in addition to temperature and relative humidity. These gases are carbondioxide and oxygen which are effective on the respiration rate of the product. The basic principle for these cold storages is to decrease the respiration rate of the products by decreasing the oxygen ratio in the environment while increasing the carbondioxide ratio. Hence, the products may be stored at a higher quality for longer periods of time. Gas composition in the cold storages varies with regard to the type and variety of the product (Ormeciand Demircan,2013) [11].
Some of the information included in the survey forms prepared for the facilities have been given below:
-Area of the enterprise (m^2), number of cold storage units, period of activity
-Capacity, amount of stored apples and duration of storage
-Temperature and humidity values according to apple varieties
-Technical properties of the facilities (the coolant used, isolation and construction materials etc.)
-Enterprise costs (personnel, energy, repair and maintenance, insurance, tax, etc.)
-Enterprise income.
MS Excel software was used for the analysis of the data acquired from the enterprises via survey method. Tables were prepared according to the analysis results and these tables were interpreted according to absolute and comparative distribution using basic and weighted averages methods.
Gross income values of the cold storage facilities were calculated by taking into consideration the unit storage prices during the active season. Net income was calculated by subtracting the total costs from gross income.
The minimum capacities that enterprises should operate at were determined via break-even point analyses.

$$Q = \frac{FC}{P - VC} \qquad (1)$$

Q: Minimum capacity break-even point value that the enterprises should operate at (kg/enterprise, tons/enterprise)
FC: Total fixed costs (USD $enterprise^{-1}$)
P: Unit storage price (USD kg^{-1})
VC: Total variable cost per unit (USD kg^{-1}) (Yurdakul, 1999) [15].
Values of fixed cost were taken into consideration when determining the depreciation values for cold storage enterprises. Depreciation rates were accepted in this study as 2% for building capital, 6.66% for generators and weigh-bridges, 3.33% for climate control system, 20% for plastic cases given to rent, 20% for equipment in the administrative building, pallet trucks, trucks and the rest of the permanent equipment, 10% for the power distribution unit, 25% for the pick-up truck and forklift (Anonymous, 2016b) [4]. Real interest ratio for the building and machinery capital was calculated as 2.25%.
The values for the capitals of examined cold storage facilities such as building, machinery-equipment and vehicles were determined as a result of interviews carried out with the enterprise owners or managers.

RESULTS AND DISCUSSIONS

When the enterprises were compared with regard to the area they occupy, it was determined that NA+CA cold storage facilities occupy a greater area. Area per enterprise for NA+CA facilities was determined as 11,000 m^2, whereas the values for NA and CA facilities were determined as 7,300 m^2 and 7,000 m^2, respectively. Similar results were determined with regard to the number of cold storage rooms. Whereas the number of cold storage rooms in NA+CA facilities was 23, the number of rooms for NA facilities was determined as 13.4 and for CA facilities as 8.6. Whereas NA+CA facilities only had NA rooms when they were first set-up, it was determined that they had higher number of storage rooms and occupied a greater area in comparison with other facilities due to the fact that CA rooms were added in later years. When cold storage facilities were compared with regard to the period of activity, it was determined that CA cold storage facilities are newer. Whereas CA facilities continue operation since 1.8 years,

the active periods of time were determined as 8.6 years for NA facilities and 20.2 years for NA+CA facilities (Table 1).

Table 1. Total area, number of cold room and activity period of enterprises

	Storage type		
	NA	NA+CA	CA
Total area(m^2)	7,000	11,000	7,300
Number of cold room (units)	13.4	23.0	8.6
Activity period (year)	8.6	20.2	1.8

When different cold storage types were compared with regard to capacity, it was determined that NA+CA facilities have greater capacity. It was determined that the average capacity of NA+CA facilities was 7,500 tons, for NA facilities it was 4,540 tons and for CA facilities it was 2,400 tons. Apple is stored in all cold storage facilities examined. When a comparison was made in terms of capacity utilization rate, it was determined that CA facilities had greater capacity utilization rates. The capacity utilization rates for CA, NA and NA+CA facilities were 85.42%, 79.74% and77.60%, respectively (Table 2). Ormeci Kart and Demircan (2013) [11] carried out a study in which it was determined that the average storage capacity for cold storage facilities was 4,978.43 tons, capacity utilization rate was 84.52% and average capacity per enterprise was 7,125 tons for cold storage facilities, whereas usage ratio was 96.49%. Gencoglan et.al., (2016) [8] carried out another study in which it was determined that 33.3% of the enterprises had a storage capacity below 1,500 tons, that 16.7% had capacities of 1,500 tons, whereas 50% had capacities of over 1500 tons. No difference was determined between the storage types with regard to the time when the apples entered the cold storages. Generally, apples are placed in cold storage during September-October. It has been determined that apples are stored for longer periods in CA rooms. Apples are stored during 10 months (September-June) in CA rooms, whereas they are stored during 8 months (between September-April) in NA rooms. Product loss in the examined facilities was determined to be greater for NA rooms. This loss was determined as 6.5% for NA rooms and as 3.3% for CA rooms (Table 2). Nural et.al. (2016) [10] carried out a study in which product loss was determined to vary between 1-5% for 44% of the citrus storage facilities and that product loss varied between 6-10% for 37% of the enterprises.

Amount of apple stored with regard to variety has been given in Table 3. It was determined that Golden Delicious ranked number one among all apple varieties stored in all storage types. The ratio of Golden Delicious was determined as 52.49% among the apple varieties stored in NA facilities, whereas the ratios were determined as 52.89% and 69.86% for NA+CA and CA facilities, respectively. Red apple groups (Starking Delicious, Redchief, Scarlet Spur) were ranked as second among the stored apple varieties. Starking Delicious comprises majority of the red variety of apples stored. The ratio of red varieties was determined as 40.61% in NA facilities, as 31.99% in NA+CA facilities and as 20.55% in CA facilities.

Harvested fruits and vegetables preserve their fresh qualities for longer periods when stored in proper conditions. The proper conditions can be attained by adjusting the temperature and relative humidity. There is a temperature value and relative humidity for every fruit and vegetable at which they can be stored properly (Akdemir, 2002) [1]. The average temperature and relative humidity values for the apple varieties stored have been given in Table 4. It was determined that the average storage temperature for Golden Delicous and red apple varieties varied between -1 and 0 Cº in NA rooms and between -0.5 and 0 Cº in CA rooms. Whereas it was determined that the Grany Simit variety is stored at 0Cº in both conditions (NA and CA). When a comparison was made with regard to relative humidity, the relative humidity ratios for Golden Delicous, red varieties and Grany Simit varied between 85-90% in NA rooms and between 90-95% in CA rooms.

NA+CA facilities were determined to have the highest annual operating costs among the types of facilities examined. Average operating cost per facility was determined as 355,869 USD for NA+CA facilities, as 192,131 USD for NA facilities and as

121,282USD for CA facilities. The reason why average operating costs are higher for NA+CA facilities is due to their greater capacities. Personnel wages, machinery depreciation and electricity costs were the highest three costs for all storage types. The ratios for personnel wages, machinery depreciation and electricity cost were determined as 26.79%, 20.78% and 18.27% for NA facilities, respectively.

Table 2. Capacity utilization rate and apple storage period of enterprises

	Storage type		
	NA	NA+CA	CA
Capacity (ton enterprise^{-1})	4,540	7,500	2,400
Stored apples (ton enterprise^{-1})	3,620	5,820	2,050
Capacity utilization rate (%)	79.74	77.60	85.42
Entry period of apple for storage	September-October	September-October	September-October
Storage period of apple	September-April	NA: September-April KA: September-June	September-June
Loss ratio (%)	6.5	NA=6.3; CA=3.5	3.3

Table 3. Amount of stored apples according to varieties (ton)

Apple varieties	**Storage type**					
	NA	%	NA+CA	%	CA	%
Golden Delicious	1,900	52.49	3,078	52.89	1,530	69.86
Red varieties	1,470	40.61	1,862	31.99	450	20.55
Granny Smith	250	6.91	880	15.12	70	3.20
Other	0	0.00	0	0.00	140	6.39
Total	3,620	100.00	5,820	100.00	2,190	100.00

Table 4. Storage temperature and humidity according to apple varieties

Apple varieties	**Storage type**					
	NA		NA+CA		CA	
	C°	Relative humidity (%)	C°	Relative humidity (%)	C°	Relative humidity (%)
Golden Delicious	-1 - 0	85-90	NA:-1 - 0 KA:+0.5 - 0	NA:85-90 KA:90-95	-0.5 - 0	90-95
Red varieties	-1 - 0	85-90	NA:-1 -0 KA:+0.5 - 0	NA:85-90 KA:90-95	-0.5 - 0	90-95
Granny Smith	0	85-90	NA:-1 -0 KA:+0.5 - 0	NA:85-90 KA:90-95	0	90-95

Table 5. Enterprise Costs

Cost items	**Storage type**					
	NA		NA+CA		CA	
	USD enterprise^{-1}	%	USD enterprise^{-1}	%	USD enterprise^{-1}	%
Personnel	51,480	26.79	97,815	27.49	31,987	26.37
Electricity	35,099	18.27	56,954	16.00	28,344	23.37
Fuel- oil	1,689	0.88	8,609	2.42	2,351	1.94
Machine maintenance	3,444	1.79	10,265	2.88	728	0.60
1-MCP application	12,715	6.62	17,285	4.86	-	-
Insurance	2,781	1.45	6,126	1.72	3,126	2.58
Tax, levies and fees	1,126	0.59	2,358	0.66	132	0.11
Sanitation	530	0.28	563	0.16	331	0.27
Office supplies	364	0.19	629	0.18	265	0.22
Communication	364	0.19	960	0.27	430	0.35
Water	-	-	861	0.24	662	0.55
Other costs	-	-	662	0.19	-	-
Machinery depreciation	39,932	20.78	79,412	22.32	27,021	22.28
Building depreciation	16,715	8.70	28,318	7.96	10,556	8.70
Machinery interest	4,206	2.19	8,841	2.48	608	0.50
Building interest	18,805	9.79	31,858	8.95	11,876	9.79
Ground rent	2,881	1.50	4,354	1.22	2,864	2.36
TOTAL	192,131	100.0	355,869	110.0	121,282	100.0

These ratios were calculated as 27.49%, 22.32%and 16%, respectively for NA+CA facilities and 26.37%, 22.28% and 23.37% for CA facilities (Table 5). It was determined as a result of the study carried out by Ormeci Kart and Demircan (2014) [11] that depreciation, electricity and personal wages are ranked number one among total costs for classical and modern cold storages.

The examined enterprises were compared with regard to net income per ton according to storage types. Since net income is a net value, it is an important criteria that is used to measure the success of an enterprise. When the enterprises were compared with regard to net income per ton, it was observed that CA cold storage facilities can be more profitable. Whereas net income per ton for CA facilities was 27 USD, it was found to be 21 USD for NA+CA facilities and 17 USD for NA facilities. The reason why CA facilities are more profitable is that they have greater capacity utilization rates, storage prices and storage times (Table 6).

Break-even point gives the production volume at which the enterprise makes profit after covering all expenses. Thus, this point also indicates the minimum capacity required for the enterprise to operate (Yurdakul, 1999) [15]. Break-even points for the examined enterprises have been given in Table 7. Break-even points for CA, NA and NA+CA cold storage facilities were 999,2077 and 3,296 tons, respectively. It was determined that total expenses equaled total income and that break-even point was reached for CA cold storage facilities when 41.62% of the capacity was used, for NA+CA facilities when 43.94% of the capacity was used and for NA facilities when 45.75% of the capacity was used. The enterprises made profit after this point. It was determined that CA facilities reached break-even point earlier than other facilities. Ormeci Kart and Demircan (2014) [12] carried out a study in which it was determined that the break-even point was 2,680 tons for classical cold storage facilities and as 2,848 tons for modern cold storage facilities.

When the harvest period and after storage prices of apples were compared according to variety, the greatest change was observed in the Granny Simit variety. Harvest period price of Granny Simit variety was 0.27 USD kg^{-1} which reached 0.32 USD kg^{-1}a with an increase of about 20.99% at the end of storage period. The price increase in Golden Delicious and red apple varieties took place as 19.19% and 16.95%, respectively during the same period. Accordingly, it can be put forth that storage resulted in an increase of about 17-21% in the apple prices with regard to varieties (Table 8).

Table 6. Income of Enterprises

	Storage type		
	NA	NA+CA	CA
Gross income (USD enterprise^{-1})	254,305	476,490	176,159
Gross income (USD ton^{-1})	70	82	86
Costs (USD enterprise^{-1})	192,131	355,869	121,282
Costs (USD ton^{-1})	53	61	59
Net income (USD enterprise^{-1})	62,174	120,621	54,877
Net income (USD ton^{-1})	17	21	27

Table 7. Break-even points in enterprises

	Storage type		
	NA	NA+CA	CA
Capacity (ton enterprise^{-1})	4,540	7,500	2,400
Fixed costs (USD enterprise^{-1})	82,538	152,783	52,925
Stored apples (kg enterprise^{-1})	3,620,000	5,820,000	2,050,000
Price per unit storage (USD kg^{-1})	0.07	0.08	0.09
Variable costs (USD enterprise^{-1})	109,593	203,086	68,358
Variable cost per unit (USD kg^{-1})	0.03	0.04	0.03
Break-even point (kg enterprise^{-1})	2,077,208	3,295,743	998,956
Break-even point (ton enterprise^{-1})	2,077	3,296	999
Break-even point capacity usage (%)	45.75	43.94	41.62

Table 8. Change of apple sale prices in harvest period and after storage

Apple varieties	**Apple sales prices (USDkg^{-1})**		
	Harvest	After period	Change storage
Golden Delicious	0.33	0.39	19.19
Red varieties	0.39	0.46	16.95
Granny Smith	0.27	0.32	20.99

The technical properties of examined facilities have been given in Table 9. Pre-cooling is the cooling of fruits prior to the storage in the shortest amount of time possible. This is important for preserving the quality of the fruits during storage.

Ormeci Kart and Demircan (2013) carried out a study in which price after storage increased by 43.47% for extra apples in comparison with the harvest period price, by 48.05% for first grade apples and by 50.76% for second grade apples.

Table 9. Technical features of enterprises

	Storage type		
	NA (%)	NA+CA (%)	CA(%)
Do you apply pre-cooling?			
Yes	0.00	0.00	0.00
No	100.00	100.00	100.00
Is there a quality control lab?			
Yes	0.00	0.00	0.00
No	100.00	100.00	100.00
Is there a packing facility?			
Yes	40.00	60.00	0.00
No	60.00	40.00	100.00
Used refrigerant			
Ammonia	100.00	100.00	100.00
Used insulation material			
Sandwich panel	80.00	100.00	100.00
Strafor	20.00	0.00	0.00
Used building material			
Steel	80.00	60.00	80.00
Concrete	20.00	80.00	20.00
How is the room temperature controlled?			
Automatic	100.00	100.00	100.00
How is the room humidity controlled?			
Wet the floors	100.00	100.00	100.00
Do you apply disinfectant before storage?			
Yes	80.00	100.00	60.00
No	20.00	0.00	40.00
Do you use any treatment to apples after harvest (waxing, wrapping etc.)?			
Yes	0.00	0.00	0.00
No	100.00	100.00	100.00
Do you apply 1- MCP?			
Yes	100.00	80.00	0.00
No	0.00	20.00	100.00
How do you ventilate the cold rooms?			
Manuel	100.00	100.00	0.00
Full Automatic	0.00	0.00	100.00
Which box type do you use?			
300-400 kg Wood	40.00	40.00	0.00
30 kg Wood	40.00	20.00	0.00
24 kg Wood	20.00	20.00	0.00
320 kg Plastic	0.00	60.00	80.00
21 kg Plastic	40.00	100.00	60.00
How do you stack the apple boxes?			
Forklif	100.00	100.00	100.00
Do you store other fruits with apple in the same room?			
Yes	0.00	0.00	0.00
No	100.00	100.00	100.00
Who owns the stored apple?			
Hirer	90.06	65.64	97.00
Enterprise owner	9.94	34.36	3.00
Do you see any physiological disorder during storage?			
Yes	60.00	60.00	0.00
No	40.00	40.00	100.00

There are no facilities where pre-cooling operation is carried out in the examined enterprises. The reason for this is that apples are stored for long periods of time and that this procedure is applied mostly for fruits that are stored for very short periods of time. The examined enterprises did not have quality control laboratories. It was determined that mostly NA+CA enterprises had a packaging facility. The 60% of the NA+CA enterprises and 40% of the NA enterprises had a packaging facility. Packaging facility was not determined in CA enterprises. The reason for this is thought to be due to the fact that these enterprises have very small capacities. Ammonia was used as the coolant in all of the examined enterprises. It was determined that ammonia was preferred in the enterprises in the study region with large capacity which operate all year long. Alkan (2013) [2] put forth in the studies carried out in the city of Aydın that 68% of the cold storages were using Freon gas. When different storage types were compared with regard to the isolation material used, it was determined that sandwich panels were used in all CA and NA+CA facilities. This panel was used in 80% of the NA facilities while, in the rest of NA storages (20%) styrofoam was used. Both steel and reinforced concrete are used in the enterprises as construction material. However, as can be seen in Table 9, it can be stated that steel construction is more common. Gencoglanet.al. (2016) carried out a study in which it was determined that 83.3% of the cold storages had steel construction, whereas 16.7% were reinforced concrete. It was determined that room temperature is automatically controlled in all examined facilities and that room relative humidity was attained by watering the floors. It was determined that disinfection was carried out in most of the facilities in the study region prior to placing apples for storage.

It was determined that 1-MCP (1-methylcyclopropene) application was carried out in majority of NA rooms in the examined facilities. The 1-MCP was applied in these rooms in order to ensure that fruits stay harder and more acidic. Whereas it was put forth that 1-MCP was not used in CA rooms since the

required quality criteria could be attained by adjusting the optimum gas compositions of rooms. Ventilation is carried out manually in NA storage since the rooms are opened and closed frequently for product shipments. Since this is not possible in CA rooms, ventilation is carried out automatically. Indeed, manual ventilation is not possible in CA rooms since the gas composition of rooms is disrupted. It was determined that mostly large sized (320 kg) plastic cases are used in CA storages. Whereas all box types are used in NA storages. Gencoglan et.al. (2016) [8] carried out a study in which it was determined that 50% of the facilities used plastic boxes, 16.7% wooden boxes and 33.3% both when storing products. Forklifts are used in all facilities for the stowage of apple boxes. It was determined that no other product than apple is stored in NA and CA rooms. The majority of the apples stored in the facilities belong to apple growers on provision of rent. There were various physiological disorders in the apples stored in the NA rooms in the study region such as scald and bitter pit. However, such physiological disorders were not observed in CA rooms.

CONCLUSIONS

In conclusion, it was determined that NA+CA facilities have greater capacities but that CA facilities have higher capacity utilization rates. Only apple is stored in all the cold storage facilities examined. The apples are placed in cold storage during the months of September-October. However, it was determined that apples are stored for longer periods of time in CA facilities. Golden Delicious was determined to be ranked number one among the apple varieties stored in all depot types. NA+CA facilities were determined to have the highest operating expenses among the examined facilities. It was determined that personnel cost, machine depreciation and electrical costs are ranked in the top three for average operating expenses in all storage types. When the enterprises were compared with regard to net income per ton, CA cold storage facilities were determined to be more profitable. Break-even points were determined as 999 tons, 2,077 tons and 3,296 tons for CA, NA and NA+CA cold storage facilities, respectively. It was determined that storage results in an approximate increase of 17-21% in apple prices depending on the variety.

REFERENCES

[1]Akdemir, S., 2002, Research on determination of theeffect of refrigerantsand comparison of theeffects on coldstoredagricultural product (apple, cherry, sour cherry and grape). Trakya University Institute of Natural and Applied Sciences Agricultural Machinery Department, PhD. Thesis, 144 p., Turkey (in Turkish).

[2]Alkan, U., 2013, Determining and developing current state of cold storage constructions. Adnan Menderes University, Institute of Natural and Applied Sciences Master Thesis, 78p, Aydın (in Turkish).

[3]Anonymous, 2016a, Republic of Turkey Ministry of Food, Agriculture and Livestock, Isparta Directorate of Provincial Food Agriculture and Livestock, Isparta (in Turkish).

[4]Anonymous, 2016b, Depreciation rates. Republic of Turkey Ministry of Finance President of Revenue Management.
http://www.gib.gov.tr/fileadmin/user_upload/Yararli_Bilgiler/amortisman_oranlari.pdf.
Accessed: 5 September 2016.

[5]Erkan, M., 2013, The situation of cold storage in Turkey. Horticulture News, 2(2): 16-18 (in Turkish).

[6]Erkan, M., 2012, Horticulture – I, Unit 8. Storage of horticulture product and preparing for market. Anadolu University, Publication Number: 2372, p. 168-187 (in Turkish).

[7]GCCA, 2014, The Global Cold Chain Alliance. Global cold storage capacity report, file:///C:/Users/Windows/Desktop/SelectCharts_Media_2014IARWCapacityReport.pdf, Accessed: 13 December, 2016

[8]Gencoglan, S., Ozdemir, T., Gencoglan, C., 2016, Determination of the cold storage situation in Kahramanmaras. Fruit Science, 1 (Special):67-74 (in Turkish).

[9]Kader, A. A., 2002, Post-harvest biology and technology: an overview in post-harvest technology of horticultural crops. University of California, Agriculture and Natural Resources Publication number: 3311, USA.

[10]Nural, N., Ozdemir, A.E., Candır, E., 2016, Problemsand current status of natural storage in samandağ (Hatay) Region. Fruit Science, 1 (Special):62-66 (in Turkish).

[11]Ormeci Kart, M.C., Demircan, V., 2013, General features of cold storages and the effects of storage on apple price in Isparta Province, Turkey. Journal of Agriculture Faculty of Ege University,50 (1): 77-86, İzmir (in Turkish).

[12]Ormeci Kart M.C., Demircan, V., 2014, An

economic comparison of conventional and modern cold storage facilities in Turkey. Custos e @gronegócio on line, 10 (1):118-130.
[13]Sargın, S., Okudum, R., 2014, Construction and development of cold storages and the determining factors on them in Isparta province. Suleyman Demirel University Faculty of Arts and Sciences Journal of Social Sciences, 31:.111-132 (in Turkish).
[14]TUIK, 2016, Turkish Statistical Institute, http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18706, Accessed: 5 December 2016.
[15]Yurdakul, O., 1999, Preparation and evaluation of project. Çukurova University Publication, No: 147 A–48, Adana (in Turkish).