Plant Archives Vol. 20, No. 2, 2020 pp. 9491- 9504 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EVALUATION OF CHILLING HOURS EFFECT ON SOME FRUIT CROPS YIELD IN EGYPTIAN LANDS

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Abstract

In Egypt, land resources which classified into new and old are limited. This work studied the effect of chilling hours on yield of the most important fruit crops in both old and new lands by productivity evaluation during the time period of (2009/2010-2018/2019). This research is based on a method of descriptive and quantitative economic analysis using means, the relative importance, growth rates, T test and general trend equations simple and multiple regression. Results found that in general, total cultivated area of old lands decreased at a rate of about 0.2%, while new lands increased by about 2.5% during the period (2009/2010-2018/2019). At the same period of time, fruit crop areas that cultivated in new lands are greater than in old lands by about 63.9% and 36.1% respectively from total fruit crops areas. During above study period and in old lands: According to the lowest chilling hours by about 264 hours; grapes, apple, peach, apricot and pear respectively recorded lowest yield values of fruit crops which were in 2010/2011 by about 7.46, 7.56, 7.16, 3.04 and 4.24 tons /feddan respectively, while the highest yield values of fruit crops were in 2017/2018 by about 9.07, 9.08, 8.72, 7.07, and 7.87 ton / feddan respectively according to the highest chilling hours by about 1008 hours. While, in new lands: Lowest yield values in 2010/2011 were by about 8.97, 9.24, 3.38, 6.44 and 5.65 tons / feddan, respectively for the same fruit crops according to the lowest chilling hours of 120 hours. But highest yield values were in 2017/2018 by about 9.71, 11.03, 8.90, 7.56 and 6.46 tons / feddan, respectively according to the highest chilling hours of about 768 hours.
Keywords : Yield evaluation, chilling hours, fruit crops, old and new lands.

Introduction

Contradiction between the rapidly growing population and limited land resources represents obstacle to achieve sustainable development (Fan et al., 2020). Land resources considered as the most important inputs of the production process in agricultural sector (FAO, 2016). However, agriculture is a major source to achieve food security and it is the main user of land and water globally. Also it is one of the most sectors affected by local and global changes (Iglesias et al., 2012).

In Egypt, cultivable land resources are limited, where cultivated area has reached about 9.2 million feddans[1] in 2018/2019 (CAPMAS, 2018/2019). It was classified into the old lands that are located closed to the banks of the Nile Valley and Delta which represent about 5.98 million feddans and the new lands that are reclaimed lands and are generally less fertile located outside the Nile Valley and Delta (FAO, 2016) which represent about 3.2 million feddans in 2018/2019 (CAPMAS, 2018/2019).

In addition to climate change, especially for developing countries it is a serious threat to food security, as a change in temperature and the amount of rain affecting the soil fertility as well as the crops that grow in it (FAO, reprot, 2015). It represents the change in the climatic characteristics surrounding the earth as a result of current increases in the concentration of gases resulting from combustion processes in the atmosphere called greenhouse gases (El-Khaliefa et al., 2018; G. Malla, 2008), where officially declared World Meteorological Organization (WMO) and United Nations Environment Program (UNEP) in 1985 that carbon dioxide is the main cause of global warming and that will increase average world temperature according to Intergovernmental Panel on Climate Change (IPCC) by about 0.3°C per decade during the next century (Chang Gil Kim, 2008). High temperatures cause not to get most of agricultural crops, especially deciduous fruit trees by affecting flowering and contraction rates (Lotfi et al., 2014 and Erica et al., 2020), two important indicators of productivity levels and crops production.

Deciduous fruit trees go into a dormancy in winter that is a temporary suspension controlled by genetic factors in particular and is represented in the vegetative and flower buds stop growing and blossoming and leaves fall off. Buds are come out dormancy period, they should be exposed to accumulative hours of chill (lower temperatures about 7.2° C) required to break dormancy varies by the type and region (Geraldo et al., 2009; Erica et al., 2020). With insufficient chill, buds may drop and few if any flowers are produced

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[1] One feddan is 0.42 hectare,

because without flowers there is no fruits (Hafez et al., 2015; Mohamed et al., 2017).

Egypt is characterized by production of fruit crops, especially from deciduous fruit trees that have economic and nutritional significance, whether for domestic consumption or for export. It has been produced about 11.9 million tons from fruit crops of a fruit area reached about 1.5 million feddans in old and new lands, where fruit area amounted to about 0.5 and one million feddans in old and new lands respectively in 2018/2019 (Agricultural Statistics Bulletin, 2018/2019). The most deciduous fruit crops are from export crops and the research will study some of these crops (grapes, apple, peach, apricot and pear) according to the amount of production during the study period in old and new lands (Agricultural Statistics Bulletin, 2009/2010-2018/2019).

The research problem represents in continuous decline in yield of the most important fruit crops, both in the old and new lands. Does type of land have an effect on yield of fruit crops? Are chilling hours could affect yield decline?

So, this research aims to evaluate productivity of some fruit crops in old and new lands during the period (2009/2010-2018/2019). The objectives of the research are:

1-Identifying the currently cultivated area in Egypt.

2-Describe of economic indicators of fruit crops.

3-Evaluation the impact of chilling hours on fruit crops yield.

4-Estimating the relationship between some indicators affecting the production of fruit crops.

Material and Method

Methodology and Data Resources

Methodology

This research is based on a method of descriptive and quantitative economic analysis using means, the relative importance, growth rates, T test and general trend equations simple and multiple regression in order to estimate the relationship between the indicators affecting the production of fruit crops. This will take place after ensuring the accuracy of the data used a number of diagnostic tests such as homogeneity, normality and autocorrelation.

Suggested multiple regression equations of fruit crops in old and new lands from the following logarithmic formula:

$$ln\ \hat{P}_t = \alpha + \beta_1 ln\ A + \beta_2 ln\ C + \beta_3 ln\ H + \varepsilon_t$$

Where:

$ln\ \hat{P}_t$ = Estimated production of fruit crops at time t.

ln A = Cultivated area of fruit crops.

ln C = Costs that used to Produce fruit crops.

ln H = Chilling Hours at 7.2° C.

α = The intercept term.

$\beta_{1, 2, 3}$ = Parameters of independent variables.

ε_t = Random error.

Data Resources

Data for this research are obtained from published and unpublished data of Egyptian Ministry of Agriculture and Lands Reclamation (Agricultural Statistics Bulletin; 2009/2010-2018/2019), (Central Laboratory for Agricultural Climate; 2009/2010-2018/2019), (Cost Bulletin; 2009/2010-2018/2019), Central Agency for Public Mobilization and Statistics (CAPMAS; 2009/2010-2018/2019), data of International Network and previous studies related to the subject of the study.

Results and Discussion

Currently cultivated area in Egypt

Land resources are become a main strategic goal of development plans (MALR, 2020). Table 1 shows that total cultivated area in Egypt during the study period (2009/2010-2018/2019) reached to about 8.9 million feddans with significant annual growth rate of about 0.66%. These cultivated areas were divided into old lands were about 6.1 million feddans represent about 68.2% from total cultivated areas. Old lands decreased at a rate of about 0.2% during the study period. Maximum area was in 2009/2010 by about 6.2 million feddans while the minimum area was 5.98 million feddans in 2017/2018, that may be due to urban expansion that built on highly productive soils or fragmentation in land ownership according to (Hanna and Osman,1995; Sundqvist and Andersson, 2006; FAO, 2016; Radwan, et al., 2019).

Therefore, the trend towards reclamation in new lands were about 2.8 million feddans during 2009/2010- 2018/2019 represent about 31.8% from total cultivated areas with significant annual growth rate of 2.5%. Maximum area was 3.2 million feddans in 2018/2019 while the minimum area was 2.5 million feddans in 2011/2012. This indicates continuation of in reclaiming and cultivating processes that contribute to increasing agricultural production during the study period and can achieve agricultural development under the limitation of resources in these lands according to (Adriansen, 2009; Othman et al, 2014; Hassan et al, 2015).

So, maintain limited land resources are very important to optimize agricultural yields.

Table 1: The general trend functions of total cultivated area during the period (2009/2010 – 2018/2019)

Lands	Equation	R^{-2}	F	Mean	Growth Rate%	T	%
Old lands	$\hat{Y}_t = 6.15 - 0.010\ X_t$	0.086	1.84^{NS}	6.1	0.2	-1.3^{NS}	68.2
New lands	$\hat{Y}_t = 2.5 + 0.069\ X_t$	0.899	80.9^{***}	2.8	2.5	8.9^{***}	31.8
Total	$\hat{Y}_t = 8.6 + 0.059\ X_t$	0.836	46.9^{***}	8.9	0.66	6.8^{***}	100

Notes: $\hat{Y}$ dependent variable X_t time by years. Cultivated area:1000 Feddans
(***) statistically significant difference at the 0.001.
($^{N.S}$) Non significant difference.
Source: Data analyses from table (A) using SPSS.25

Description of economic indicators of fruit crops in old and new lands

Fruit crops represent about 17.5% from total cultivated area in Egypt during the study period, where fruit area represents about 469 thousand feddans in old lands and about 830 thousand feddans in new lands, that indicates the fruit area in new lands are more than in old lands by about 63.9% and 36.1% respectively from total fruit area (Agricultural Statistics Bulletin, 2009/2010-2018/2019).

Cultivated area of fruit crops

According to table 2, grapes are the largest cultivated area in old and new lands by about 54 and 114 thousand feddans during the study period followed by peach, apple, apricot and pear in new lands are better than old lands by about 61.4, 55, 13, and 6.5 thousand feddans respectively. However, this indicates necessity to continue expanding cultivation of these crops in new lands compared to old ones, where the fruit crops cultivated in new lands represented the largest percentage of the total cultivated area by about 67.8%, 91.6%, 97.9%, 89.1% and 65.9% for grapes, apple, peach, apricot and pear respectively.

Additionally, the significant annual growth rate was about 6.2%, 5.5% and 3% for pear, apple and grapes respectively in new lands and about 11% for grapes in old lands, while decreasing by about 16% and 9% for apricot and apple in old lands and about 5.4% for peach in new lands.

So, according to cultivated area of fruit crops in new lands are higher than in old lands during the study period, this is consistent with (Othman et al, 2014 and Hassan et al, 2015). This refers to the quality of these crops and need to expand their cultivation in new lands.

Production of fruit crops

Table 3 shows that production of fruit crops in new lands is greater than in old lands during the study period, as they were estimated at about 1071, 576, 312, 88.7, and 39.4 thousand tons (Agricultural Statistics Bulletin, 2009/2010-2018/2019) for grapes, apple, peach, apricot, and pear respectively in new lands. It was also estimated that at significant annual growth rate for grapes by about 3.3% and 3% in new and old lands respectively. Both apple and pear had significant annual growth rate by about 6.6% and 6.6% in new lands, but apple in old lands had significant annual decrease rate by about 8.1% in old lands.

This means that increases in cultivated area in new lands led to an increase in the production of fruit crops as these crops are suitable for cultivation in these lands during the study period according to (Zaki, 1992 and Mohamed et al., 2017).

By expanding the cultivated areas by reclaiming desert land, where quantity produced of fruit crops in new lands represented the largest percentage of total production of fruit crops by about 70%, 93.2%, 96.7%, 91.8% and 64.4% for grapes, apple, peach, apricot and pear respectively.

Table 2 : Descriptive statistics of cultivated area of fruit crops during (2009/2010-2018/2019)

Crops	Lands	Mean	Standard Deviation	Minimum	Maximum	Growth Rate%	% from total area
Grapes	Old	54	2.1	51.5	56	11^{**}	32.2
	New	114	11.6	99	129	3^{***}	67.8
Apple	Old	5	1.3	3.1	6.8	-9^{***}	8.4
	New	55	9.5	43.9	66	5.5^{***}	91.6
Peach	Old	1.3	0.21	1.01	1.6	$0.5^{N.S}$	2.1
	New	61.4	12.2	40.9	79.2	-5.4^{*}	97.9
Apricot	Old	1.6	0.72	0.7	2.5	-16^{***}	10.9
	New	13	0.42	12.5	13.7	$0.1^{N.S}$	89.1
Pear	Old	3.4	0.27	2.9	3.8	$-0.4^{N.S}$	34.1
	New	6.5	1.4	4.9	8.6	6.2^{***}	65.9

(***) statistically significant difference at the 0.0001. Cultivated area:1000 Feddans
(**) statistically significant difference at the 0.001
(*) statistically significant difference at the 0.005
($^{N.S}$) Non significant difference
Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, (2009/2010-2018/2019) using SPSS 25.

Table3 : Descriptive statistics of fruit crops production during (2009/2010-2018/2019)

Crops	Lands	Mean	Standard Deviation	Minimum	Maximum	Growth Rate%	% from total production
Grapes	Old	451	46	384	524	3^{***}	30
	New	1071	120	928	1211	3.3^{***}	70
Apple	Old	42.2	10.3	25.9	55.9	-8.1^{***}	6.8
	New	576	118	407	721	6.6^{***}	93.2
Peach	Old	10.5	1.9	8.1	13.7	$1.2^{N.S}$	3.3
	New	312	52	261	416	$2.3^{N.S}$	96.7
Apricot	Old	7.9	3	4	12.7	$-10.5^{N.S}$	8.2
	New	88.7	4.8	83.9	100.3	$0.8^{N.S}$	91.8
Pear	Old	21.8	4.6	13.7	29.7	$2.3^{N.S}$	35.6
	New	39.4	8.7	29.9	55.4	6.6^{***}	64.4

(***) statistically significant difference at the 0.0001. production: 1000 tons
($^{N.S}$) Non significant difference
Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, (2009/2010-2018/2019) using SPSS 25.

Yield of fruit crops

Yield is the most important indicator of success of agricultural production (MALR, 2020). Table 4 shows the yield fluctuates between low and high during the study period in old and new lands where the yield of grapes, apple and apricot were the highest in new lands by about 9.4, 10.4 and 6.8 ton /feddan respectively but the yield of peach and pear were the highest in old lands by about 7.9 and 6.4 ton /feddan respectively (Agricultural Statistics Bulletin, 2009/2010-2018/2019).

It also estimated the significant annual growth rate for apple and peach were about 11%and 7.7% in new lands but in old lands it was significant annual growth rate for grapes and apricot by about 2% and 5.5% respectively.

According to yield of grapes, apple and apricot in new lands, the largest percentages were about 53.1%, 55.5% and 56.2% respectively, but in old lands the largest percentages for peach and pear were about 59.8% and 51.2% respectively from total yield of fruit crops.

So, there are fruit crops that differ in their yield according to the types of lands (Erica et al., 2020), where some crops achieved a high yield in old and new lands, but they were the best in new lands (Othman et al, 2014 and Hassan et al, 2015).

Table 4 : Descriptive statistics of fruit crops yield during (2009/2010-2018/2019)

Crops	Lands	Mean	Standard Deviation	Minimum	Maximum	Growth Rate%	% from total yield
Grapes	Old	8.3	0.6	7.5	9.1	2^{**}	46.9
	New	9.4	0.3	8.97	9.7	$0.4^{N.S}$	53.1
Apple	Old	8.4	0.4	7.6	9.1	$0.7^{N.S}$	44.5
	New	10.4	0.5	9.2	11	11^{*}	55.5
Peach	Old	7.9	0.4	7.2	8.7	$0.8^{N.S}$	59.8
	New	5.3	1.6	3.4	8.9	7.7^{**}	40.2
Apricot	Old	5.3	1.2	3	7.1	5.5^{*}	43.8
	New	6.8	0.3	6.4	7.6	$0.8^{N.S}$	56.2
Pear	Old	6.4	1.1	4.2	7.9	$2.7^{N.S}$	51.2
	New	6.1	0.3	5.7	6.5	$0.4^{N.S}$	48.8

(**) statistically significant difference at the 0.001 Yield: ton / feddan
(*) statistically significant difference at the 0.005
($^{N.S}$) Non significant difference
Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, (2009/2010-2018/2019) using SPSS 25.

Production cost of fruit crops

Production cost plays an important role in agricultural production, which directly affects farmers' incomes and their standard of living (MALR, 2020).Table 5 shows the total costs of fruit crops were almost at the same in old and new lands during the study period, where the costs were increased by about L.E17.5, 13.8, 15.9, 16.1 and 17.4 thousands by significant annual growth rate of about 10.1%, 12%, 8.7%, 10.7% and 8.7% respectively in old lands and about L.E 17.9, 14.3, 15.9, 17.9 and 17.7 thousands (Cost Bulletin, 2009/2010-2018/2019) by significant annual growth rate of about 10.5%, 11.1%, 11%, 10.1% and 11.4% respectively in new lands for grapes, apple, peach, apricot, and pear.

As a result, the costs were almost at the same in old and new lands, it would be better to expand cultivation of fruit crops in new lands, as their yield is greater than in old lands (Shebl and Greda, 2018 and Mohamed et al., 2017).

Table 5: Descriptive statistics of the total cost of fruit crops during (2009/2010-2018/2019)

Crops	Lands	Mean	Standard Deviation	Minimum	Maximum	Growth Rate%
Grapes	Old	17518	5205	7742	26789	10.1***
	New	17896	5429	8092	26951	10.5***
Apple	Old	13782	4878	7515	21270	12***
	New	14266	4826	7853	22177	11.1***
Peach	Old	15978	4190	10562	21807	8.7***
	New	15937	5226	8669	25176	11***
Apricot	Old	16125	5258	8596	25342	10.7***
	New	17973	5580	10903	27934	10.1***
Pear	Old	17397	4865	11025	26162	8.7***
	New	17734	5873	9257	26890	11.4***

(***) statistically significant difference at the 0.001 Cost: L.E. / feddan

Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Cost Bulletin, (2009/2010-2018/2019) using SPSS 25.

The impact of chilling hours on fruit crops yield

Yield is an indicator of the efficiency of production inputs in the production process, so according to the most previous studies there are many factors affect yield of agricultural crops were used of unimproved varieties, irrigation, diseases of the crops, high labor costs, rainfall rates, desertification, number of workers (Suleiman et al, 2016; Othman et al, 2014; Hassan et al, 2015).

Chilling hours are the another important factor could affect the yield by increasing or decreasing values because fruit crops need for specific chilling hours for buds to come out of dormancy period for less than 7.2° C (Curtis., 2019; Kaufmann and Blanke, 2019; El-Sheikh, 2001) and that differ according to the type of land and this could effect on fruit yield either increase or decrease.

Old Lands

Table 6 shows that the lowest and the highest of chilling hours affect the fruit crops during the study period in old lands where the lowest yield values of fruit crops were in 2010/2011 by about 7.46, 7.56, 7.16, 3.04 and 4.24 tons /feddan (Agricultural Statistics Bulletin, 2018/2019) for grapes, apple, peach, apricot and pear respectively according to the lowest chilling hours by about 264 hours, while the highest yield values of fruit crops were in 2017/2018 by about 9.07, 9.08, 8.72, 7.07, and 7.87 ton / feddan for grapes, apple, peach, apricot and pear respectively according to the highest chilling hours by about 1008 hours.

It also noted that in 2011/2012 and 2016/2017 the chilling hours by about 1296 hours were higher than 1008 hours in 2017/2018. This let to low yield of fruit crops in old lands. This indicates that increasing chilling hours by a value more than to be plant needs could lead to a yield decrease.

New Lands

Table 7 shows that the lowest and the highest of chilling hours which were the lowest yield values in 2010/2011 by about 8.97, 9.24, 3.38, 6.44 and 5.65 tons / feddan for grapes, apple, peach, apricot and pear respectively, according to the lowest chilling hours of 120 hours. The highest yield values were in 2017/2018 by about 9.71, 11.03, 8.90, 7.56 and 6.46 tons / feddan (Agricultural Statistics Bulletin, 2018/2019) for grapes, apple, peach, apricot and pear respectively according to the highest chilling hours of about 768 hours.

It also noted that total chilling hours in new lands were lower than in old lands and at the same time new lands produced higher yield especially in crops grapes, apple and apricot than in old lands during the period study. This leads to suitability to cultivate these crops in new lands, where applied in some studies in sandy soil under drip irrigation system according to (Fahmy et al., 2018; Sharaf et al., 2015; El-Yazal and Rady, 2018).

Table 6: Total chilling hours at 7.2° C and yield of fruit crops in old lands (Yield: ton / feddan)

Years	Chilling Hours at 7.2° C	Grapes	Apple	Peach	Apricot	Pear
2009/2010	264	7.74	8.24	8.05	5.15	7.09
2010/2011	264	7.46	7.56	7.16	3.04	4.24
2011/2012	1296	7.61	8.33	7.39	5.30	5.08
2012/2013	672	8.27	8.61	7.89	5.32	7.80
2013/2014	504	8.07	8.78	7.93	4.18	6.44
2014/2015	768	8.65	8.29	8.12	5.04	5.98
2015/2016	504	8.87	8.58	7.96	5.12	6.79
2016/2017	1296	8.70	7.79	7.96	6.24	6.73
2017/2018	1008	9.07	9.08	8.72	7.07	7.87
2018/2019	432	8.61	8.42	7.58	6.66	6.48

Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, (2009/2010-2018/2019) and unpublished data from Central Laboratory for Agricultural Climate, (2009/2010-2018/2019).

Table 7: Total chilling hours at 7.2° C and yield of fruit crops in new lands (Yield: ton / feddan)

Years	Chilling Hours at 7.2° C	Grapes	Apple	Peach	Apricot	Pear
2009/2010	144	9.67	10.16	4.41	6.61	6.14
2010/2011	120	8.97	9.24	3.38	6.44	5.65
2011/2012	504	9.03	10.18	4.41	6.71	5.70
2012/2013	168	9.67	10.62	4.42	7.01	6.31
2013/2014	144	9.06	10.98	4.66	6.84	6.15
2014/2015	456	9.59	10.33	4.70	6.67	6.22
2015/2016	192	9.43	10.42	5.28	6.67	6.10
2016/2017	600	9.38	10.90	5.96	6.57	6.12
2017/2018	768	9.71	11.03	8.90	7.56	6.46
2018/2019	744	9.54	10.54	6.80	6.96	5.75

Source: Collected and calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, (2009/2010-2018/2019) and unpublished data from Central Laboratory for Agricultural Climate, (2009/2010-2018/2019).

It was shown from table 7 that in new lands, chilling hours were less than the old lands and at the same time produced high yield of fruit crops. But in some years especially in old land the chilling hours were the highest and that let to low yield of fruit crops because the chilling hours were more than what crops need. This result leads to a decrease in yield (Chavarria e al., 2009; Moriondo et al., 2011; Kumar and Gautam, 2014), that high temperatures cause changes in the quality and quantity fruit crops yield (Hafez et al., 2015; Fischer et al., 2016).

So, studies resorted to using many natural or chemical treatments to break dormancy that were happened because the crops did not get its chilling requirement during the period study. Using dormancy-breaking chemicals (as Dormex that used to breakage of dormancy in fruit crops deciduous) was most effective in bud break and increasing yield in warm climates (El-Sheikh, 2001; Lotfi et al., 2014; Fahmy et al., 2018; El-Yazal and Rady, 2018; El Masri et al., 2018; Maged et al., 2019; Demiral and Ülger, 2019) and improvement in the nutritional characteristics and contributes to increasing the yield of fruit crops, especially in old land in Egypt, which suffers from low yield because the high chilling hours more than fruit crops needs.

Also, table 8 uses T test to ensure that new lands are the best lands, by showing significant differences between the yield of fruit crops in old and new lands. According to land type, it was found difference that was in direction of the new lands because the yield of most crops is higher than the old lands during the study period.

Table 8: Estimate T test of lands

	Land	Chilling Hours	Grapes	Apple	Peach	Apricot	Pear
Mean	Old	701	8.3	8.4	7.9	5.3	6.4
	New	384	9.4	10.4	5.3	6.8	6.1
T test		2.1^{*}	-5.5^{***}	-9.5^{***}	5^{***}	-3.9^{**}	1.1^{NS}

Note: *(5%), **(1%) level of significance and (NS) Non significant difference.
The results using SPSS 25.

Estimating the relationship between some indicators affecting **the** production of **fruit crops.**

Using the multiple regression analysis to estimate the relationship between the production (P) and the previous indicators (cultivated area (A), costs (C) and chilling hours (H)) to ensure that they agreed with the statistical and economics logic. It was found at the best form of equations were logarithmic according to the value of the coefficient R^2 and F in new and old lands during the period study.

Old lands

Table 9. represents results of equations (1, 2, 3, 4 and 5) which agreed with the economics logic of the effect on the amount of fruit crops production.

This indicates that there is a positive relationship happened between the production and their indicators, where any change in the cultivated area, costs and chilling hours by 1% leads to a positive increase in production by about 2.1%, 0.1% and 0.01% respectively for grapes; about 1.2%, 0.2% and 0.02% for apple, about 1.1%, 0.1% and 0.04% for peach; and about 0.7%, 0.15% and 0.2% for apricot and about 1.8%, 0.2% and 0.1% for pear.

It was noted that the cultivated area represented a significant effect, which shows this type of lands have the most role in determining the quantities produced of fruit crops in old lands (Erica et al., 2020).

Table 9: Regression equations of fruit crops in old lands

Fruit crops	Equations	No.	R^2	F
Grapes	$ln\ \hat{P}_t = -2.7 + 2.1ln\ A + 0.06ln\ C + 0.01ln\ H$ $(4.5)^{**}$	1	0.94	16.1^{**}
Apple	$ln\ \hat{P}_t = -0.3 + 1.2ln\ A + 0.21ln\ C + 0.02ln\ H$ $(7.7)^{***}$	2	0.99	81.6^{***}
Peach	$ln\ \hat{P}_t = 1.1 + 1.1ln\ A + 0.09ln\ C + 0.04ln\ H$ $(8.8)^{***}$	3	0.97	29.2^{***}
Apricot	$ln\ \hat{P}_t = 2 + 0.66ln\ A + 0.15ln\ C + 0.18ln\ H$ $(2.6)^{*}$	4	0.92	11.8^{*}
Pear	$ln\ \hat{P}_t = -2.1 + 1.8ln\ A + 0.26ln\ C + 0.06ln\ H$	5	0.72	$2.2^{N.S}$

The results of regression using SPSS 25 program.

New lands

Table 10. represents results obtained from equations of fruit crops in new lands which were all indicators in equations (a, b, c, d and f) agreed with the economic logic of the effect on the amount of fruit crops production.

This indicates that there is a positive relationship resulted between the production and their indicators, where any change in the cultivated area, costs and chilling hours by 1% leads to a positive increase in production by about 1%, 0.01% and 0.01% respectively for grapes; about 0.7%, 0.3% and 0.05% for apple, about 0.3%, 0.1% and 0.15% for peach; about 0.9%, 0.1% and 0.03% for apricot and about 0.9%, 0.12% and 0.1% for pear.

It was noted that the cultivated area represented a significant effect, which showed that the type of land has the most role in determining the quantities produced of fruit crops in new lands (Othman et al, 2014 and Hassan et al, 2015).

Table 10: Regression equations of fruit crops in new lands

Fruit crops	Equation	No.	R^2	F
Grapes	$ln\ \hat{P}_t = 2 + 1.01 ln\ A + 0.01 ln\ C + 0.01 ln\ H$ $(5.5)^{***}$	a	0.96	26.1^{***}
Apple	$ln\ \hat{P}_t = 1.2 + 0.7 ln\ A + 0.25 ln\ C + 0.05 ln\ H$ $(2.7)^{*}$ $(1.9)^{*}$	b	0.99	97^{***}
Peach	$ln\ \hat{P}_t = 2.7 + 0.3 ln\ A + 0.09 ln\ C + 0.15 ln\ H$	c	0.73	$2.3^{N.S}$
Apricot	$ln\ \hat{P}_t = 1.3 + 0.9 ln\ A + 0.08 ln\ C + 0.03 ln\ H$	d	0.71	$2^{N.S}$
Pear	$ln\ \hat{P}_t = 0.9 + 0.9 ln\ A + 0.12 ln\ C + 0.08 ln\ H$ $(4.1)^{***}$	f	0.98	53^{***}

The results of regression using SPSS 25 program.

Conclusion

This work aims to evaluate effect of chilling hours on fruit crops yield in Egyptian lands. It was proved that yield of fruit crops (grapes, apple, peach, apricot and pear) were greater in new lands than in old lands, where chilling hours needed in new lands were less than old lands. It means that new lands were more suitable to cultivate the mentioned fruit crops. This helps decision-makers to expand the cultivation of export fruit crops in the new lands and this contributes to increase agricultural development in Egypt.

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APPENDIX

Table A. The total cultivated area and fruit crops in Egypt during (2009/2010-2018/2019)

Cultivated area:1000 Feddans				fruit crops		1000 tons
Years	**old**	**New**	**total**	**Total area**	**fruit area**	**production**
2009/2010	6156	2627	8783	1407	1127	8803
2010/2011	6118	2623	8741	1377	1140	8370
2011/2012	6071	2548	8619	1404	1175	8748
2012/2013	6019	2780	8799	1542	1221	9519
2013/2014	6151	2761	8912	1624	1285	9684
2014/2015	6119	2869	8988	1653	1311	10527
2015/2016	6156	2939	9095	1674	1352	11154
2016/2017	6148	2954	9102	1669	1385	11129
2017/2018	5985	3148	9133	1659	1502	12007
2018/2019	5989	3204	9193	1653	1485	11945
mean	**6091**	**2845**	**8937**	**1566**	**1298**	**10189**

Source: Calculated from Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, bulletin of the agricultural statistics, (2009/2010-2018/2019).