Citrus production and its future in Turkey
II-Lemon production.

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RESUME - La production de citrons est très restreinte à des zones
sub-tropicales dans le monde. Les facteurs principaux qui agissent
sont la sensibilité aux diverses maladies et les exigences écologiques
du citronnier. La Turquie a un potentiel important en ce qui concerne
la production de citrons. Celle-ci est passée de 78.500 tonnes en
1965 à 283.000 tonnes en 1980. La majorité est produite en région
méditerranéenne. Il est prévu que cette sous-région maintiendra son
potentiel dans les années prochaines. La progression prévue est d'en-
viron 5.300 tonnes par an dont approximativement 4.300 tonnes
dans la sous-région de Méditerranée orientale. Le taux d'augmenta-
tion dans la zone égéenne serait de 800 tonnes/an. On peut dire que
la production de citrons a facilement augmenté de 1948 à 1980,
et on prévoit que cette allure se maintiendra dans l'avenir.

INTRODUCTION

Lemon growing is markedly restricted to a small portion
of the world because of its sensitivity to low temperatures.
Also, lemons are more threatened by fungal diseases (mostly
by *Phytophthora* and *Deuterophoma tracheiphila*) than
other citrus fruits. Therefore lemon production is more
risky than other commercial citrus fruits. Lemons cons-
titute only 5 % of the world citrus production whereas
oranges are 66 %, mandarines 15 %, grapefruits 8 %, and
others (including limes) 6% (BUCH, 1981 ; ANONYMOUS,
1982 a and b). However, the world market for lemons is

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very large and will surely grow. In fact in spite of these
limiting factors, world's lemon and lime production has
rapidly increased and reached to 4,870,000 tons in 1980
(FAO, 1981).

According to MYERS and GRIERSON (1978) 60 % of
the lemon production comes from [1] Italy, USA, Mexico,
Turkey and India. Turkey was a lemon importer in 1940's ;
however the lemon production increased from 70,513
tons in 1960 to 283,000 tons in 1980 (SIS, 1979 and
1982).

The rate of increase in lemon production in Turkey,
has been relatively higher than the other producing coun-
tries. For example, among the important lemon produ -
cing countries such as Italy and Mexico, the production
rate of growth has slowed down significantly and in the
near future it is expected that this trend will continue.
Among the important reasons for this situation is that the

cultivated area of lemon in these countries have reached to the marginal limit (MYERS and GRIERSON, 1978 ; MISSIAEN, 1980). On the other hand presently in Turkey, as for the other citrus fruits, only a small portion of the lemon production potential is used. As a matter of fact, lemon production in Turkey in 1980 has quadruplicated the production of 1961. It may be said that Turkey has a good chance of developing this production branch in comparison to other lemon producing countries.

There are some researches on the lemon area, number of trees grown and the amount of production in Turkey. However, there are not sufficient researches in investigating the production areas by regions and projections for the future.

The purpose of this study is to evaluate the increase in the lemon production areas, number of trees and amount of production by regions and to forecast the possible development by the year 2000 in Turkey.

MATERIAL AND METHOD

Taking into account ecological and structural characteristics of the lemon growing in Turkey, the study area under consideration is divided into regions and subregions as follows :

Mediterranean region : It is the area beetween Samandağ, in Hatay and Kaş in Antalya. This region includes the citrus areas in Hatay, Adana, İçel and Antalya provinces coastal areas and the towns of Kozan, and Kadirli. This region is divided by the Kaledran stream into two subregions called East and West Mediterranean.

Aegean region : This region includes the coastal plain of Muğla, Aydın, İzmir, Balıkesir provinces plus the area of Büyük Menderes Valley and the town of Ödemiş.

Black Sea region : This region extends along the Black Sea coast from Sürmene (Trabzon) to Russian border in the East.

Data from the State Institute Statistics (SIS) and Food and Agricultural Organization were used (SIS, 1971 ; 1975 ; 1978 a and b ; 1980 ; 1981 ; 1982 and FAO, 1981).

The information obtained from these sources were tabulated and evaluated. For forecasts for the years 1985, 1990, 1995 and 2000, regression method have been used as suggested by econometrics. However, tables ; 1,3 and 5 show that the share of the Black Sea region's lemon production is negligible. In this region, as a result of rapid development in tea culture, lemon production areas have decreased. For these reasons the Black Sea region has been omitted from the analyses.

The trend relationships which could be linear, logarithmic, semi-logarithmic, parabolic or exponential have been investigated (DRAPER and SMITH, 1966 ; KMENTA, 1971 ; SCHMALENSEE, 1973). Among these relationships, the ones with the high determination coefficient (R^2) and low standard deviations (SD) have been selected and used for forecasting.

Also, an (r) test has been applied to the functions (LA MONT et al, 1977). The equation for the (r) test is given below :

$$r_{test} = \left[\frac{t^2}{t^2 + df} \right]^{1/2}$$

where t = t value
df = degrees of freedom

To reflect the effects of various projects which were put into application since 1970 by the government to increase production and export, the data prior to 1974 and after 1974 have been analyzed with a dummy variable (D). Since an uncommon value in lemon production observed in 1977 in the East Mediterranean region, the 1977 values were excluded from the analysis.

The two models selected for the study are in the following forms :

a) Linear equation :

$$Y_{ij} = a + bx_{ij} + E_{ij}$$
$$Y_{ij} = a + bx_{ij} + bD + E_{ij}$$

b) Exponential function :

$$Y = a_e^{bx_{ij}} + E_{ij}$$

where i = 1,2 .... 5 (lemon production regions and subregions)

1. Turkey
2. East Mediterranean subregion
3. West Mediterranean subregion
4. Mediterranean region
5. Aegean region

X . Trend variable (time)

where J = 0 .... 15 (0 : 1965 .... 35 : 2000)
D = Dummy variable
D = O   1965-1973
D = 1   1974-1980

In order to standardize the predictions of subregions to Turkey's total, the correction factor given below was used :

$$\hat{Y}_{id} = \hat{Y}_i \mp \left[(TT \cdot \Sigma \hat{Y}_i) \frac{\hat{Y}_i}{\Sigma \hat{Y}_i} \right]$$

$\hat{Y}_{id}$ = Corrected forecast value

$\hat{Y}_i$ = Forecast value

TT   = Turkey's total forecast

RESULTS AND DISCUSSION

Land use in lemon production by regions in Turkey.

Lemon areas by regions and subregions in Turkey are given in Table 1. The lemon area has increased from 3,637 hectares in 1965 to 11,767 hectares in 1980. Approximately 95 % of the lemon production area is in the Mediterranean region. When lemon production in subregions are considered, it can be seen that East Mediterranean is the most important subregion. On the other hand, lemon areas in the Aegean and Black Sea regions consist only relatively small portion of the total lemon area.

In the period 1965-1980, lemon areas in the Aegean region has shown an increase but the share of this region has declined from 6.9 % to 5.0 % of the Turkey's total. However, in the same period, the share of the Mediterranean region in total has grown markedly. Black sea region has become an insignificant region as far as the lemon production is concerned.

The predicted area for lemon production by the year 2000 is given in Table 2. According to the forecast the expected lemon areas would be 13,184 ; 14,986 ; 18,592 hectares in 1985, 1990 and 2000 respectively.

When the rate of increase is taken as 100 in 1965, it is expected to reach 362, 412 and 511 in years 1985, 1990 and 2000 respectively.

With respect to the subregions, the highest rate of increase in lemon area would be in Mediterranean region, especially in the East Mediterranean subregion. The major reason for this is that ecologically the most suitable land is in this subregion and lemon growing has been traditional for many years. In the Aegean region, a negligible increase is expected in comparison to Turkey's total (figure 1).

The estimated regression equations are given below :

Turkey's total :

$$\hat{Y}_1 = 3605.27 + 360.53\, X_1 + 2367.88\, D \quad R^2 = 95.82^{xxx}$$

East Mediterranean subregion :

$$\hat{Y}_2 = 2467.82 + 311.47\, X_2 + 2399.29\, D \quad R^2 = 95.96^{xxx}$$

West Mediterranean subregion :

$$\hat{Y}_3 = 894.57 + 33.35\, X_3 \qquad\qquad R^2 = 93.88^{xxx}$$

Mediterranean region :

$$\hat{Y}_4 = 3348.98 + 344.88\, X_4 + 2371.93\, D \quad R^2 = 96.03^{xxx}$$

Aegean region :

$$\hat{Y}_5 = 224.30\, e^{0.04391977\, X_5} \qquad\qquad R^2 = 76.74^{xx}$$

TABLE 1 - The area of lemon production by regions in Turkey (hectares).

Years	Turkey's total	Mediterranean			Aegean	Black Sea
		East Mediterranean	West Mediterranean	Total Mediterranean		
1965	3 637	2 404 (66.1) (1)	933 (25.7)	3 337 (91.8)	250 (6.9)	50 (1.3)
1970	5 197	3 877 (74.6)	997 (19.2)	4 874 (93.8)	267 (5.1)	56 (1.1)
1975	9 000	7 449 (82.8)	1 178 (13.1)	8 627 (95.9)	333 (3.7)	40 (0.4)
1980	11 767	9 751 (82.9)	1 373 (11.6)	11 124 (94.5)	590 (5.0)	53 (0.5)

(1) - the amount of share (%)

TABLE 2 - The forecasted lemon production areas (hectares) by year 2000 in Turkey (1).

Years	Turkey's total (3)	Mediterranean			Aegean (4)
		East Mediterranean (3)	West Mediterranean	Total Mediterranean (3)	
1985	13 184 (362) (2)	11 083 (461)	1 560 (167)	12 643 (379)	541 (216)
1990	14 986 (412)	12 595 (524)	1 720 (184)	14 315 (429)	671 (268)
1995	16 789 (462)	14 080 (586)	1 877 (201)	15 957 (478)	832 (333)
2000	18 592 (511)	15 531 (646)	2 031 (218)	17 562 (526)	1 030 (412)

1 - correction factor is used   3 - dummy variable is used

2 - the rate of increase : 1965 = 100   4 - exponential function is used
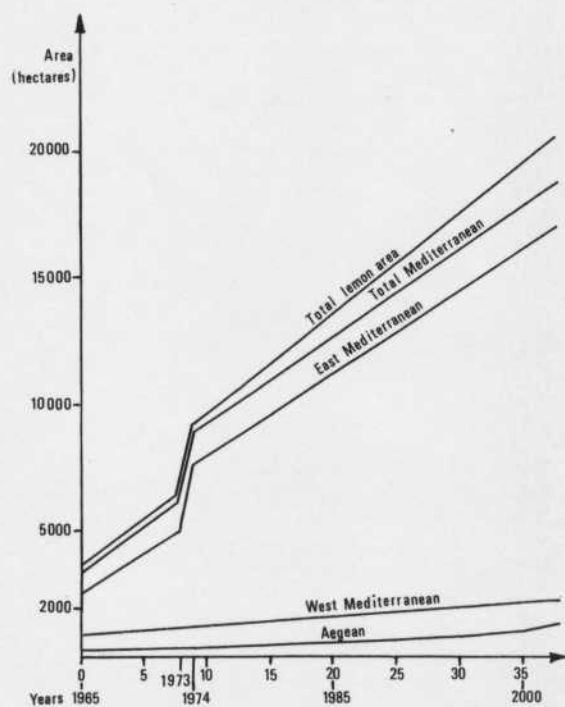
Figure 1 - LEMON AREA PROJECTIONS IN TURKEY BY YEAR 2000.

The outlook for the number of lemon trees in Turkey

The number of lemon trees by regions in Turkey are given in Table 3. The number of lemon trees were 1,1 million in 1965 and increased close to 3,5 million in 1980. Around 95 % of the lemon trees are grown in the Mediterranean region. East Mediterranean subregion has the biggest share when analyzed within the regions. Aegean and Black Sea regions share about 5 % and 0.5 % respectively.

The forecasted values for the number of lemon trees in Turkey are given in Table 4. The forecasted results are very similar to the one's made for the lemon producing areas. The equations used for the forecasts are given below :

Turkey's total :

$$\hat{Y}_1 = 1081.40 + 108.20\,X_1 + 709.43\,D \qquad R^2 = 95.81^{xxx}$$

East Mediterranean subregion :

$$\hat{Y}_2 = 740.27 + 93.49\,X_2 + 716.01\,D \qquad R^2 = 95.95^{xxx}$$

West Mediterranean subregion :

$$\hat{Y}_3 = 266.46 + 9.26\,X_3 \qquad R^2 = 93.21^{xxx}$$

Mediterranean region :

$$\hat{Y}_4 = 1004.37 + 103.55\,X_4 + 710.22\,D \qquad R^2 = 96.01^{xxx}$$

Aegean region :

$$\hat{Y}_5 = 67.31\,e^{0.043972 X_5} \qquad R^2 = 76.93^{xx}$$

TABLE 3 - The number of lemon trees by regions in Turkey (1000 trees).

Years	Turkey's total	Mediterranean			Aegean	Black Sea
		East Mediterranean	West Mediterranean	Total Mediterranean		
1965	1 091	721 (66.1) (1)	280 (25.7)	1 001 (91.8)	75 (6.9)	15 (1.0)
1970	1 559	1 163 (75.6)	299 (19.2)	1 462 (93.8)	80 (5.1)	17 (1.1)
1975	2 700	2 233 (82.7)	355 (13.1)	2 588 (95.8)	100 (3.7)	12 (0.5)
1980	3 530	2 925 (84.8)	412 (11.7)	3 337 (94.5)	177 (5.0)	16 (0.5)

1 - the amount of share (%)

TABLE 4 - The forecasted number of lemon trees by regions in Turkey by year 2000 (1000 trees). (1)

Years	Turkey's total (2)	Mediterranean			Aegean (3)
		East Mediterranean	West Mediterranean	Total Mediterranean	
1985	3 955	3 338	454	3 792	163
1990	4 496	3 796	489	4 294	202
1995	5 037	4 246	541	4 787	250
2000	5 578	4 718	550	5 268	310

1 - correction factor is used
2 - dummy variable is used
3 - exponential function is used

The outlook for the amount of lemon production by regions in Turkey.

The amount of lemon production in Turkey by regions for the 1965-1980 period is given in Table 5. The lemon production was 78,500 tons in 1965 and it increased to 283,000 tons in 1980.

An important portion of the lemons produced in Turkey are grown in the Mediterranean region. In 1980 around 99 % of the lemons were produced in this region. The biggest share of the production was in the East Mediterranean subregion and about 91 % of the Turkish total production was produced in this area.

The share of the lemon production in the Aegean and Black Sea regions are very little. In 1965-1980 period about 1 percent of the total lemons were produced in the Aegean region. The share of the Black Sea region was negligibly low for the same period.

The forecasted lemon production by year 2000 are given in Table 6. The average increase in production is expected to be 5319.32 tons per year. According to the forecasts the amount of production is expected to reach 315,638 ; 342,234 and 395,428 tons for the years 1985, 1990 and 2000 respectively.

When the forecasts are analyzed, it is clear that the Mediterranean region will keep its dominant place. Ho-

wever, the rate of expected increase will be more in the East Mediterranean subregion when compared with the West Mediterranean subregion.

During the 1965-1980 period East Mediterranean subregion had the highest rate of increase in Turkey. The rate of increase in lemon production was 392 for East Mediterranean whereas it was 361 for Turkey for the same period. An increasing trend is expected in this region. The reason for this increasing rate of increase is the suitable land conditions and the potential for lemon production.

The largest increase in Aegean region is expected to be around the southern coastal parts and Büyük Menderes valley where ecological conditions are suitable for lemon production. It is also expected that the Black Sea region will become a negligible area in lemon production (figure 2). The reason for this decline is the rapid increase in tea production in this region.

The estimated functional relations used for the lemon production forecasts by regions are given below :

Turkey's total :

$$\hat{Y}_1 = 94674.84 + 5319.32\,X_1 + 114576.68\,D$$
$$R^2 = 95.68^{xxx}$$

East Mediterranean subregion :
$$\hat{Y}_2 = 84344.18 + 4484.71\,X_2 + 113250.36\,D$$
$$R^2 = 95.25^{xxx}$$

TABLE 5 - The amount of lemon production by regions in Turkey (tons).

Years	Turkey's total	Mediterranean			Aegean	Black Sea
		East Mediterranean	West Mediterranean	Total Mediterranean		
1965	78 500	65 652 (83.6) (1)	11 600 (14.8)	77 252 (98.4)	998 (1.3)	25 (0.3)
1970	126 000	113 455 (90.0)	11 050 (8.8)	124 505 (98.8)	1 440 (1.1)	55 (0.1)
1975	290 000	269 627 (93.0)	18 423 (6.3)	288 050 (99.3)	1 836 (0.6)	114 (0.1)
1980	283 000	257 564 (91.0)	21 638 (7.6)	279 202 (98.6)	3 709 (1.3)	89 (0.1)

1 - The amount of share (%).

TABLE 6 The forecasted lemon production by regions in Turkey by year 2000 (tons). (1).

Years	Turkey's total (3)	Mediterranean			Aegean (4)
		East Mediterranean	West Mediterranean	Total Mediterranean	
1985	315 638 (402) (2)	286 665 (437)	24 791 (214)	311 446 (403)	4 192 (420)
1990	342 234 (436)	307 994 (469)	28 312 (244)	336 306 (435)	5 928 (593)
1995	368 831 (470)	328 699 (501)	31 762 (274)	360 161 (467)	8 370 (838)
2000	395 428 (504)	347 914 (530)	35 718 (308)	383 632 (447)	11 796 (1181)

1 - correction factor is used
2 - the rate of increase 1965 = 100
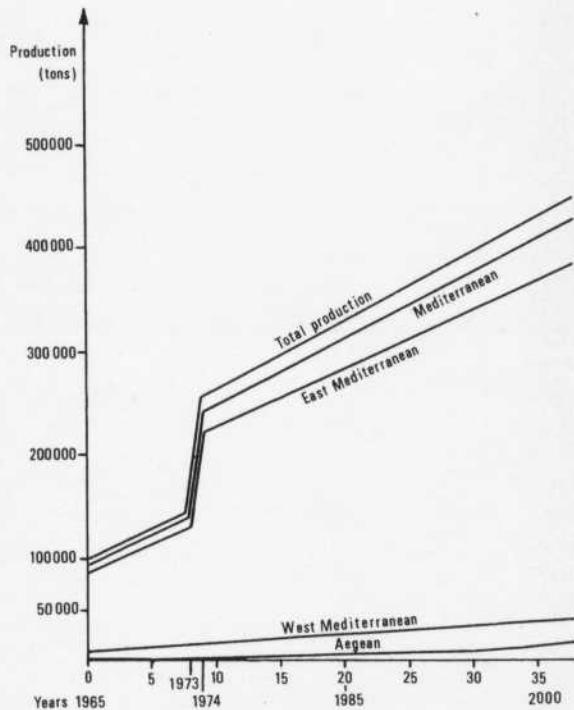3 - dummy variable is used
4 - exponential function is used

Figure 2 - LEMON PRODUCTION PROJECTIONS IN
TURKEY BY YEAR 2000.

West Mediterranean subregion :

$$\hat{Y}_3 = 9357.10 + 724.86\ X_3 + 991.54\ D \quad R^2 = 87.97^{xxx}$$

Total Mediterranean

$$\hat{Y}_4 = 93701.28 + 5209.57\ X_4 + 114241.00\ D$$
$$R^2 = 95.53^{xxx}$$

Aegean region :
$$\hat{Y}_5 = 1036.85\ e^{0.0699474\ X_5} \qquad R^2 = 81.30^{xxx}$$

There have been some studies on the expected growth
of lemon production in Turkey. For instance, using 1948-
1963 period time series data the rate of production in-
crease was estimated to be 5447.4 tons per year (ÖZSAN,
1967). Since the rate of production increase for the 1965-
1980 period was that calculated to be 5319.32 tons per
year, it could be concluded that the rate of lemon produc-
tion increase indicates a steady growth since 1948.

Some researches have reported that Turkey has a better
chance of increasing lemon production in comparison to
other countries. WOLF (1977) mentioned that Brasil,
Mexico, Egypt and Turkey are the countries which may
increase lemon production by year 2000. In recent years
the greatest rate of increase in lemon production was in
Greece, Morocco, Turkey and Spain (MISSIAEN, 1980 ;
BUCH, 1981 ; ANONYMOUS, 1982 b).

In various studies for forecasting world's lemon produc-
tion, the average deviation was -12 % and it was -27 %
for Turkey (BUCH, 1981). The actual production in 1981
was 290,000 tons and according to this study the fore-
casted production is 294,360 tons in Turkey (SIS, 1982).
The actual production in 1981 deviated by -1,5 % from the
forecasted value. On the other hand the average deviation
was + 1.27 % for the 1965-1980 period, for this study.
According to the results obtained from this research it
could be said that our projections are more reliable for
lemon production in Turkey.

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