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General Situation of Beekeeping in the Eastern Anatolian Region of Turkey and ARIMA Model with the Help of Long-term Analysis

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Abstract: With this study, the overall situation of beekeeping in Eastern and possible future cases in light of the available data reveals, the problem of identifying and developing some proposals aimed. This study presents a study of the current status (During the 1991-2005 period) and 15-year trend of beekeeping in the Eastern Anatolian Region of Turkey. Study has indicated the current situation of beekeeping. At this stage, a simple proportional tables, simple index, chain index and an average annual growth rate of such analysis is used. The long-term trend analysis for the prediction of the future, the ARIMA Model Used. The 17.05% of total honey production of Turkey is produced in this region and it contains 18.33% of the total bee hives. There are a total of 4.027 villages and 841.000 beehives in the Eastern Anatolian Region producing 14.116 tons honey. Honey production per bee hive is close to the Turkish average (16.7 kg). In the 1991-2005 period, the annual average increase in the number of hives number was -2.43%; honey production decreased by -1.86% and wax production was reduced by -0.94%. According to ARMA analysis, the honey production in 2005 of 14 thousand tons, 14.6 thousand tons in 2020 would be approximately estimated. In the long term trend analysis, it was found that if honey production continues with the current techniques and information level of the farmers, no development will be achieved in honey and wax production in the long term.

Key words: Beekeeping, honey, ARIMA, Eastern anatolian region, Turkey

INTRODUCTION

Beekeeping is still an important activity in developed and developing countries. While, in Europe, beekeeping is considered as a traditional activity, in countries such as Spain, Poland, Hungary, Greece and Turkey it is carried out to increase the incomes of rural people who are engaged in agricultural activities and in Far East, Central and Southern America it is carried out to generate foreign income and in developed countries such as USA, Canada and Japan, it is carried out to assist in pollination of crops (Firatli *et al*., 2000; Nuray and Aziz, 2003; Parlakay and Esengun, 2005).

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In the world approximately 56 million honey bee colonies is available (Kaygan and Yildiz, 2006). Ninty percent of these colonies in Europe, Africa and Asia are located. Turkey, in terms of honey bee colonies are located within the first 30-35 countries (Topcu and Arslan, 2004). In 2006 the World honey production was 1.478.261 tons. The largest producer is China which alone makes up 21.20% of the total. Other important producers are USA, Argentina and Turkey. Honey from these four countries make up approximately 40.00% of world honey production (FAO, 2008). The most important exporter in the world is China and the most important importers are Germany and USA. Although, the USA is the second largest honey producer, due to its high domestic consumption, it also imports a significant amount (Celikel, 2002).

Today, nature, destruction of the unconscious as a result of the use, of agricultural products due to a lack of pollination causes a drop in productivity. lack of pollination, honey bee colonies can be fixed. The contribution of vegetable production in the honey bee, bee products, is more than the revenue (Kumova and Korkmaz, 2000).

In experiments on the utilization of bees in vegetable gardens as a pollinator, it was found that grain yield of broad beans increased from 20 to 70.00% and fruit weight per plant increased 25.00% in courgettes. It is thought that the contribution that beekeeping makes to an economy through fertilization is at least equal to its contribution provided by bee products (Celikel, 2002). For example, it is estimated that in USA the value of products that need bee pollination is $24 billion and total value of the products in which commercial pollination is utilized is $10 billion (Parlakay and Esengun, 2005). Therefore, the developed and developing country with beekeeping activity in a given activity is important for different purposes. Not connected to the soil, that can be done with little capital and less labor due to an agricultural activity to date is in the foreground (Cengiz and Yucel, 2001; Nuray and Aziz, 2003).

Turkey's geographic richness owned habitat for many kinds of bees and the basin is the case. Terms of diversity of plant species in the temperate zone between the countries has a good position (Nuray and Aziz, 2003). Development of beekeeping as a result of this activity shall be converted to wealth production. In Turkey nearly 120.000 families keep bee hives with 10.00% earning their living from beekeeping and 28.000 earning additional income from this activity (Celikel, 2002). In 2005, there were 4.433.000 new bee hives and 157.000 existing bee hives in Turkey and in total of 22,500 villages, beekeeping is carried out. The honey harvested per bee hive is 17.9 kg (TSI, 2005).

In 2005 the honey production of Turkey was 82.336 tons and a large part is used in domestic consumption. Turkey is also a honey exporter, although not in large amounts. Turkey exports a large proportion to of honey to Germany which mostly imports pine honey. In addition, Turkey also exports honey to Saudi Arabia and France (Celikel, 2002).

Although, beekeeping has a great potential in Turkey it has not yet completed the institutionalization process and the process of being a sector. Although state organs determine many beekeeping and product standards, there are significant factors limiting the development of beekeeping in the country. These factors include the fact that bee farmers are not organized and carry out their activity according to the traditional methods of old bee farmers and appropriate or inadequate methods are used to combat diseases in the bees diseases (Dogaroglu, 1992; Cakmak *et al*., 2003; Sirali and Dogaroglu, 2005; Parlakay and Esengun, 2005). The main problems of beekeeping in Turkey and some solutions are listed as follows (Celikel, 2002).

The most important problem in beekeeping is breeding. This problem can be solved by making farmers use breeded queen bee and by increasing the number of institutions that will grow these queen bees which they need.

While the share of technical information and training in animal husbandry and other agricultural production costs vary between 8.00 and 10.00%; this share varies between 70.00-80.00% in beekeeping. For this reason, the organizations that aim to provide continuous extention and education services for beekeepers should be supported.

In studies such as erosion control, meadow improvement and forest maintenance, beekeeping should also be taken into account; the plants that are important for beekeeping should be included in these studies.

In appropriate applications by bee farmers of chemical substances leave residues in the honey. Adding naphthalene to wax, making drugs from diesel oil, use of drugs at the wrong time and the wrong amounts both jeopardize human health and result in quality issues for the exportation of honey.

In the study, the importance of Eastern Anatolian Region of Turkey was underlined. In addition, present situation feature of the sector was analyzed and some suggestions were provided. Finally, due to the sectoral characteristics, we can suggest that the beekeeping sector should be supported.

MATERIALS AND METHODS

The main material of this study consists of data collected from the Provincial Directorates of Agriculture in the region and statistical information provided on the web site of the Turkish Statistical Institute. In addition various related articles and publications were reviewed. The data used in this study covers the period 1991-2005.

The scope of the study is Eastern Anatolia Region of Turkey. There total 13 provinces in the region. These are Ağri, Ardahan, Bingöl, Bitlis, Erzurum, Erzincan, Elazığ, Hakkâri, Iğdır, Kars, Malatya, Van and Tunceli (Fig. 1). General economic structure of the region is premised on agriculture and husbandry.

The raw statistical data was processed and interpreted in the tables. The subject can be understood better by calculation according to the formula below:

The simple index of production of factors such as hive number, honey production and wax which is a by-product:

$$İ = (Pi/Po)\times 100 \quad (1)$$

The chain index is:

$$İ = (Pi/(Pi\text{-}1))\times 100 \quad (2)$$

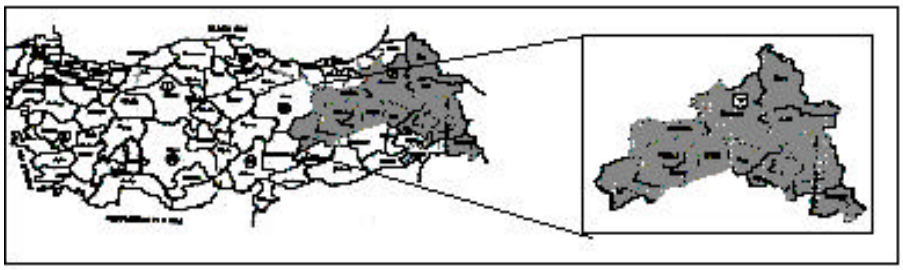

Fig. 1: View of eastern anatolian region on turkey map

and the annual average increase ratios are (Koc and Aykut, 2001; Koc and Ceylan, 2008):

$$= (((\text{lastyear}/\text{firstyear})^{\wedge}(1/n))-1)\times 100 \quad (3)$$

Long-term trend analysis study ARIMA (1.0.1) model was used. Model for non-seasonal series are called Autoregressive integrated moving average model, denoted by ARIMA (p,d,q). Here p indicates the order of the autoregressive part, d indicates the amount of differencing and q indicates the order of the moving average part. If the original series is stationary, d = 0 and the ARIMA models reduce to the ARMA models (Kemal *et al*., 2001; Contreras *et al*., 2003; Nochai and Nochai, 2006; Oguz and Serkan, 2009). The difference linear operator (Δ), defined by:

$$\Delta Y_t = Y_t - Y_{t-1} = Y_t - BY_t = (1-B)Y_t \quad (4)$$

The stationary series W_t obtained as the dth differences (Δ^d) of Y_t:

$$Wt = \Delta^d Y_t = (1-B)^d Y_t$$

ARIMA (p,d, q) has the general form Nochai and TNochai (2006):

$$\Phi_p (B)(1-B)^d Y_t = \mu + \theta_q(B)\varepsilon_t \quad (5)$$

Or

$$\Phi_p(B)W_t = \mu + \theta_q(B)\varepsilon_t$$

Autoregressive moving average model: ARMA (p, q) which has the general form (Nochai and Nochai, 2006).

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2+\ldots+} \Phi_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \ldots - \theta_q \varepsilon_{t-q} \quad (6)$$

Where:

Y_t	=	Response (dependent) variable at time t
$Y_{t-1}, Y_{t-2,\ldots}, Y_{t-p}$	=	Response variable at time lags t-1, t-2,….t-p, respectively
$\Phi_0, \Phi_1, \Phi_{2,\ldots\ldots}, \Phi_p$	=	Coefficients to be estimated
ε_t	=	Error term at time t
$\varepsilon_{t-1}, \varepsilon_{t-2,\ldots\ldots}, \varepsilon_{t-q}$	=	Errors in previous time periods that are incorporated in the response Y_t
μ	=	Constant mean of the process
$-\theta_1, \theta_{2,\ldots\ldots} \theta_q$	=	Coefficients to be estimated

RESULTS

Current Situation of Beekeeping in Eastern Anatolian Region

Both migratory and stationary beekeeping enterprises mostly prefer the Eastern Anatolian Region. With its land structure, climate, rich flora and uncultivated large plains, this region consistutes one of the largest and richest basins of Turkey in flower honey production. Moreover it is also suitable for bee ecology. The Total honey production in 2005 was 14.040 tons in the Eastern Anatolian Region. Bee hives numbered 841.270 which was

Table 1: General situation of beekeeping in provinces in eastern anatolian region (2005)

Provinces	No. of beekeeping villages	No. of hive	Honey production	
			Normal (ton)	Organic* (ton)
Agrı	56	5.220	141	0
Ardahan	211	22.569	476	1.8
Bingol	185	52.675	1.005	0
Bitlis	134	44.456	738	0
Elazıg	419	77.740	1.004	0
Erzincan	443	75.300	1.336	0
Erzurum	1.168	190.395	3.068	0
Hakkari	103	54.505	803	0
Igdır	62	6.847	125	0
Kars	144	44.298	1069	0
Malatya	338	71.955	739	0
Mus	95	18.450	467	0
Tunceli	243	37.080	791	0
Van	426	126.751	2.354	30

Source: TUIK, Animal Statistics, 2005 (www.tuik.gov.tr) and Records of *Provincial Directorate of Agriculture

Table 2: Relative situation of beekeeping in provinces in eastern anatolian Region (2005)

Provinces	No. of villages (%)	No. of hives (%)	Normal honey production (%)	Organic honey production (%)
Agrı	1.39	0.63	1.00	0.00
Ardahan	5.24	2.72	3.37	5.66
Bingol	4.59	6.36	7.12	0.00
Bitlis	3.33	5.37	5.23	0.00
Elazıg	10.40	9.39	7.11	0.00
Erzincan	11.00	9.09	9.46	0.00
Erzurum	29.00	22.99	21.73	0.00
Hakkari	2.56	6.58	5.69	0.00
Igdır	1.54	0.83	0.89	0.00
Kars	3.58	5.35	7.57	0.00
Malatya	8.39	8.69	5.24	0.00
Mus	2.36	2.23	3.31	0.00
Tunceli	6.03	4.48	5.60	0.00
Van	10.58	15.30	16.68	94.34
Total	100.00	100.00	100.00	100.00

18.33% of the total number of hives in Turkey. Of the total honey produced in Turkey 17.05% came from this region. Honey is produced in 4.027 villages, with an average of 208.9 hives per village. and production per hive is 16.7 kg, which is close to the national average. In the region organic honey production is carried out especially in Van and Ardahan provinces (Table 1) and there appears to be a potential for widespread organic honey production in the region.

In the region, the largest honey producer is Erzurum province, the second largest is Van province. Organic honey production is particularly made in Van and Ardahan provinces (Table 2).

Annual Average Increase Rate of the Factors and Simple and Chain Index Analysis

In the 1991-2005 period, the annual average increase in the number of hives number was -2.43%; honey production decreased by -1.86%; and wax production was reduced by -0.94%. In the 1996-2000 period, despite the annual decrease of -12.01% in hive numbers, an increase of 3.39% was obtained in honey production. Therefore, it can be seen that annual average increase in honey production is not necessarily correlated with an annual increase in the number of hives thus it not a linear relationship. It can be stated that, even when the annual average bee hive number rate is negative, a positive annual average increase rate can be observed in honey production (Table 3).

Table 3: Annual average increase rates of factors related to beekeeping in eastern anatolian region

Period	No. of bee hives	Honey production (ton)	Wax (ton)
1991-1995	-5.24	-6.75	-1.13
1996-2000	-12.01	3.44	0.09
2001-2005	-0.74	-3.39	-1.56
1991-2005	-2.43	-1.86	-0.94

Table 4: Simple index of factors related to beekeeping in the eastern anatolian region (1991-93 = 100)

Year	No. of hives	Honey production (ton)	Wax (ton)
1991-93	100.00	100.00	100.00
1994	119.79	104.81	96.75
1995	124.60	135.48	101.11
1996	125.01	107.08	95.71
1997	116.74	81.46	80.55
1998	120.98	97.38	87.40
1999	127.47	111.81	106.09
2000	236.97	90.43	95.29
2001	132.68	106.55	101.73
2002	132.09	130.52	108.79
2003	125.90	115.92	98.82
2004	130.42	102.93	109.83
2005	137.68	126.58	110.03

Table 5: Chain index (P_t/P_{t-1}) of factors related to beekeeping in eastern anatolian region

Year	No. of Hives	Honey production (ton)	Wax (ton)
1991-93	-	-	-
1994	119.79	104.81	96.75
1995	104.01	129.25	104.51
1996	100.33	79.04	94.66
1997	93.39	76.08	84.16
1998	103.64	119.53	108.51
1999	105.36	114.82	121.38
2000	185.90	80.87	89.82
2001	55.99	117.84	106.75
2002	99.55	122.49	106.94
2003	95.32	88.82	90.84
2004	103.59	88.79	111.13
2005	105.57	122.97	100.19

On the basis of the 1991-93 period averages, a 2.37 fold increase was obtained in the year 2000. However, this increase level could not be achieved in the following years. In 2000, a 9.57% decrease was experienced in honey production when compared to the same basis period. This indicates that although there was an increase in the number of hives the honey production obtained per unit did not be increase. In wax production, only a 10.03% increase was achieved when compared to the basis year in 2005 (Table 4).

In 1994, 19.79% increase was obtained in the number of hives, a 4.81% increase was obtained in honey production and a 3.25% decrease was observed in wax production when compared to the previous year. In the year 2000, a 1.86 fold increase was obtained in hive numbers when compared to the previous year and in the same period, a 19.13% decrease was obtained in honey production. The decrease rate in wax production in the same period was 10.18%. In 2005, increases were calculated in all factors according to the previous year (Table 5).

ARMA Model with the Help of Long Term Forecast

Obtained the number of hives model in the form (Table 6):

$$Y_t=630.94295-0.9762Y_{t-1}-0.95723\epsilon_{t-1}$$

Table 6:Estimated model parameters number of hives model

Type	Coef.	SE coef.	T-ratio	p-value
AR1	-0.97626	3.50764	-0.2783238	0.78592608
MA1	-0.95723	4.20383	-0.2277034	0.82405389
Constant	630.94295	107.44718	5.8721222	0.00010738

Table 7: Long term ARIMA Analysis results of hive numbers

Crrent situation		Estimated period			
Year	No. of hives	Year	No. of hives	Lower value	Upper value
1991	581.673	2006	957.0	456.9	1.457,0
1992	607.031	2007	949.5	439.5	1.459,4
1993	644.393	2008	995.4	471.4	1.519,3
1994	731.949	2009	989.1	453.3	1.525,0
1995	761.328	2010	1.033,8	482.1	1.585,6
1996	763.831	2011	1.028,8	463.4	1.594,2
1997	713.312	2012	1.072,3	489.4	1.655,1
1998	739.246	2013	1.068,4	470.4	1.666,4
1999	778.889	2014	1.110,8	494.0	1.727,6
2000	144.963	2015	1.108,0	474.8	1.741,2
2001	810.731	2016	1.149,3	496.2	1.802,4
2002	807.085	2017	1.147,6	477.0	1.818,2
2003	769.286	2018	1.187,8	496.5	1.879,2
2004	796.894	2019	1.187,1	477.3	1.897,0
2005	841.270	2020	1.226,4	495,1	1.957,8

Table 8: Estimated model parameters of honey production model

Type	Coef.	SE coef.	T-ratio	p-value
AR1	-0.99483	0.32026	-3.106313	0.00999098
MA1	-0.96190	1.19670	-0.803794	0.43854135
Constant	11323.41589	806.17186	14.045908	0.00000002

According to long-term ARMA analysis; the number of hives-which was recorded as 841 thousand in 2005 is estimated to reach 1.226 thousand in 2020, with the average annual increase of 2.54%. It has been found out that the number of hives shows a continuous upward trend by years (Table 7).

Obtained the of honey production model in the form (Table 8):

$$Y_t=11323.41589-0.99483Y_{t-1}-0.96190\epsilon_{t-1}$$

According to long-term honey production ARMA analysis; honey production-which was recorded as 14.040 tons in 2005 is estimated to decrease to 13.0 tons in 2010, with an average annual decrease of -1.42%. Honey production foreseen for 2015 is approximately 14.3 thousand tons, with an average annual increase of 0.22%. Honey production to exceed 13.7 thousand tons as of 2016 will reach 14.1 thousand tons in 2020. Average annual increase expected to be recorded in honey production in 2005–2020 period is calculated as 0.05%. It is thought that beekeeping, in turn, honey production in the region will not be subject to any considerable increase in the next 15 years (2005-2020) under current conditions and technical facilities (Table 9).

Obtained the of wax production model in the form (Table 10):

$$Y_t=453.27775-0.52819Y_{t-}1-0.93510\epsilon_{t-1}$$

Long-term trend equation developed on the basis of the actual data of 1991-2005 period is used to estimate the potential wax production in the next 15 years. According to the data

Table 9: Long term trend analysis results of honey production

Crrent situation		Estimated period			
Year	Honey production (ton)	Year	Honey production (ton)	Lower value	Upper value
1991	10.596	2006	12.639	8.840	16.438
1992	10.820	2007	13.515	9.656	17.378
1993	11.860	2008	12.856	8.878	16.834
1994	11.626	2009	13.726	9.671	17.781
1995	15.027	2010	13.073	8.886	17.259
1996	11.877	2011	13.935	9.659	18.211
1997	13.360	2012	13.289	8.870	17.708
1998	10.801	2013	14.144	9.624	18.664
1999	12.402	2014	13.506	8.833	18.179
2000	10.030	2015	14.353	9.569	19.137
2001	11.819	2016	13.723	8.778	18.667
2002	14.477	2017	14.562	9.499	19.629
2003	12.858	2018	13.939	8.708	19.170
2004	11.417	2019	14.771	9.414	20.128
2005	14.040	2020	14.156	8.626	19.686

Table 10: Estimated model parameters of wax production model

Type	Coef.	SE coef.	T-ratio	p-value
AR1	-0.52819	0.413947	-1.275988	0.22824406
MA1	-0.93510	0.489313	-1.911045	0.08239463
Constant	453.27775	24.927232	18.184039	0.00000000

Table 11: Long term trend analysis results of wax production

Crrent situation		Estimated period			
Year	Wax production (ton)	Year	Wax production (ton)	Lower value	Upper value
1991	460	2006	507.1	413.8	600.4
1992	473	2007	509.3	399.5	619.1
1993	512	2008	513.2	403.7	622.8
1994	466	2009	516.2	400.4	632.0
1995	487	2010	519.7	401.7	637.8
1996	461	2011	523.0	400.4	645.6
1997	388	2012	526.3	400.2	652.4
1998	421	2013	529.6	399.2	660.1
1999	511	2014	533.0	398.4	667.5
2000	459	2015	536.3	397.3	675.2
2001	490	2016	539.6	396.2	683.0
2002	524	2017	542.9	394.9	690.9
2003	476	2018	546.3	393.6	699.0
2004	529	2019	549.6	392.1	707.1
2005	530	2020	552.9	390.6	715.2

obtained from Turkish Statistics Institute; wax production recorded in Eastern Anatolia Region as 530 tons in 2005 is foreseen to be recorded as 519.7 tons in 2010, with an average annual decrease of -0.39%. But, an improvement in terms of wax production can be recorded as of 2020 and the concerned production can approximate to 2005 production. It is estimated that wax production will reach 536.3 tons in 2015 and then will show an average annual increase of 0.61% and be realized as 552.9 tons in 2020. Estimated average annual decrease rate for wax production in 2005-2020 period is 0.28% (Table 11).

DISCUSSION

In this study, the Eastern Anatolian Region is one of the richest basins for flower honey production. Honey production per bee hive is close to the Turkish average (16.7 kg).

The highest honey production was made in Erzurum province and the second highest honey production was made Van province.

In Van province, it was seen that during this period annual average rate of increase of 5.28% in number of hives led to an increase of yield of 1.44 per hive and annual average rate of increase of 3.79% in totally honey production (Koc and Ceylan, 2008).

Turkey's other results are obtained in different regions is as follows: In Van province, the amount of honey hives 10.72 per kg were obtained (Yıldırım and Agar, 2008). 15.89 kg in Bingoll (Kutlu and Sezen, 1999); 17.4 kg in Cukurova Region (Kumuva and Ozkutuk, 1988); 18.7 kg in Tokat (Cicek, 1993) and 8.5 kg in South Eastern Region of Turkey (Dagdemir and Topcu, 2003).

Turkey ranks fourth in world honey production and a large part of the production is used in domestic consumption. For example, 70.77% of beekeepers in the Aegean region (Mugla and İzmir) have sold in honey farm gate, while 10.77%, directly to retailers have been selling honey (Saner *et al*., 2004).

In Turkey breeding, technical information and education costs are high and extinction still not clear and education services are inadequate. In order to prevent inappropriate applications of chemicals and to facilitate quality production, the Provincial Directorate of Agriculture should provide related education and extinction not clear services free of charge and adequate sources should be spared for these applications.

It was found that annual increase rate in honey production is not correlated with annual increase rate in bee hive number. For example, in the year 2000, despite the increase in bee hive numbers, a decrease was observed in honey and wax production. In the long term trend analysis, it was found that if honey production continues with the current techniques and information level of the farmers, no development will be achieved in honey and wax production in the long term.

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