

# Economic Evaluation of Almond Farming. The Case of Adiyaman (Turkey)

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## Abstract

Almond consumption is constantly increasing due to its nutritious properties. Almond production is unable to meet the growing demand in Turkey and therefore the import is done. The almond growing in Turkey, which is one of the oldest fruit species in Anatolia, is becoming increasingly important. Almonds grown in all regions except the Eastern Black Sea coasts are noteworthy for the increase in production in Southeastern Anatolia Region. Adiyaman province, which is one of the provinces of the region, has come to the point of almond growing in many respects for studying. In this study, it is aimed to reveal the existing almond growing potential of Adiyaman. The potential in almond growing of Kahta, one of the districts of Adiyaman, is in the scope of this study, as well. In the study, benefiting from Turkey's Statistics Institute data, analysis and comments have been made. In addition, almond cultivation data were obtained from producers and evaluated. Using the statistical data of TSI between the years 2009-2018, the area where almond is grown, the number of bearing and non bearing trees, yield and production amounts has been determined and the increase rates during the period have been calculated. Almond production area in Adiyaman increased by 35 times and amount of production increased by 26 times during the ten years examined. These values are higher in Kahta district. If these developments in almond cultivation continue, it is foreseen that it will make significant contributions to the national economy, increase in income and employment, and decrease in imports and gain foreign currency saving.

**Keywords:** Almond growing, almond production, Adiyaman, Kahta

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## 1. Introduction

The demand of foods that are considered to be healthy and suitable for fast consumption is increasing due to the difficulties of working life and the desire for healthy nutrition. Almond is one of the products that meet this demand. Changes in consumer awareness and health concerns are the main reasons for the increase in demand for nut crops such as almonds.

Almond; It is a fruit used in the food industry, confectionery, chocolate and pastry industry and almond oil is widely used in cosmetic and pharmaceutical industry. Almond (*Prunus Dulcis*) is a rosaceae family and its native land is southwest of Asia. It grows as long as the spring frosts don't give damage its flowers. Almond cultivation is carried out in hot climate and dry summer environments rather than cool and humid places in summer. There are bitter and sweet types of almond plant. Sweet almond seeds are consumed as a snack, used in the preparation of various foods, almond oil and almond flour. Bitter almonds are used as additives and fragrances in cosmetic industry.

It is very difficult to grow nut crops due to factors such as special climatic requirements, specific physiology and special growing methods and special rootstock requirements according to soils. Despite the growing difficulty, the demand for almonds and almond products is constantly increasing in the world. World almond production and exports continue to increase due to the increasing demand for almonds. Both old markets and emerging markets are growing strongly in response to availability and acceptable price conditions. Within all markets, new innovative uses and traditional almond use will continue to increase demand as long as supply is available and prices remain attractive [1]

The countries that are prominent in the production of almonds have increased the total amount of product obtained from the unit area by researching new varieties and applying modern growing techniques. Compared to these countries, Turkey has many advantages in many ways such as soil, climate, irrigation water and so on [2]. Almond trees, which are usually planted as border trees at the edges of the field, are now formed in the form of enclosed almond orchards, which are modern breeding.

Almonds, which are in the scope of nut crops, are preferred due to their low labor requirements and cost advantages compared to other fruits. With the various supports provided by the ministries, almonds have been able to spread significantly throughout the country. For example, as a result of government support provided by the Ministry of Agriculture and Forestry, almond production has increased significantly, especially since the early 2000s, as a result of fuel, fertilizer and soil analysis, certified seed / seedling and standard seedling use [3]. In recent years, both walnut and almonds are in great demand for producers and non-agricultural sectors who want to invest in agriculture due to the fact that they can be substituted for each other as well as in the arboriculture sector. This has been influenced by a number of rural development projects aimed at increasing almond

production[4].

The use of almond and almond by-products in the food, confectionery and cosmetics sectors increases the importance of the almond sector and necessitates solutions to its problems. 6.4% of our country's total fruit production is composed of nut corps. Almond constitutes 1.2% of the number of trees and 4.3% of the production amount among the nut corps [5].

Almond orchards, which have been concentrated commercially in the Aegean, Marmara and Mediterranean regions in recent years, have become the favorite product of producers in Southeast Anatolia Region in parallel with the increasing importance of the product. Adıyaman is also one of the important provinces where almonds are cultivated in the GAP region. Almond growing is preferred by Adıyaman producers because it is less selective in terms of soil and water demand compared to many other fruit species [6]. Another important factor in the region is the softening of the climate in the region by the Atatürk Dam Lake. In this respect, considering the climatic characteristics of Adıyaman, it has a suitable climate for almond growing and it is expected that almond growing will become more widespread in Adıyaman[7].

In this study, the general situation of Adıyaman in almond cultivation, which has made a great leap in almond production in recent years, was analyzed, its contributions to local and national economy were analyzed and recommendations were made. It is thought that the study will be important in terms of insufficient studies, conducted beforehand, and guiding the future researches.

## 2. Material And Methods

In this study, it is aimed to reveal the general structure of almond cultivation in Adıyaman. To this end, statistics released by Turkey Statistical Institute (TSI) were used widely. In the study, first of all evaluations about growing areas of almond in Turkey, number of trees, amount of production and amount of production by cities have been made. In order to reveal the economic characteristics of almond production in Adıyaman, the data have been examined. Adıyaman's almond production area, production amount, fruit-bearing and non-fruit-bearing trees for the years 2009-2018 were also analyzed by districts, as well. Considering the importance of Kahta in the production of almonds, this district was examined in more detail. While the situation of the region in almond farming was revealed, face-to face talks were made with the producers and the evaluations of the producers were added to the study. In addition, various publications on the subject have been benefited.

## 3. Results And Discussion

### 3.1. Almond Growing in Turkey

Turkey, due to its geographical and climatic characteristics of the structure is the homeland of many fruit species [8,9]. Almonds, walnuts, pomegranates, pistachios, apples, hazelnuts, cherries, apricots and figs have emerged in Anatolia and have gained importance in recent years. Being a member of nut corps, almond has about 40 species and, 12 of these are grown in Turkey [10,11]. Almond, which has an important place in human nutrition in terms of health due to its content of fat, rich minerals and vitamins, has been increasing continuously in consumption and production in recent years [11, 12, 13].

Almond is one of the oldest fruit species cultivated in Anatolia. Almond has a wide range of gene potential. However, almond hasn't received importance in Turkey for a long time and has usually been grown as border tree on the edge of the fields. Commercial almond cultivation is underdeveloped due to the fact that almond trees cannot be harvested regularly due to various climatic factors. As a result, the number of almond orchards remained inadequate until recent years. Almond growing, which has a very important place in world-wide nut corps production, is becoming increasingly common in Turkey, as well. It can be grown easily in all regions except Black Sea coastal areas. Almond cultivation, which was limited to Aegean, Mediterranean and South Eastern Anatolia Regions in the past, has become attractive due to the ability of almonds to adapt to difficult conditions and high demand in the market and it has started to expand with the establishment of plant nurseries in other regions in recent years. In this context, almond has become a shining star fruit in Southeastern Anatolia. When the region is evaluated in terms of climate, it is under the extension and influence of the Mediterranean climate. With this advantage, almond is preferred by producers because it is less selective in terms of soil and water demand compared to other fruit types such as pistachio and olives [6]. Therefore, in the coming years, increases in producer revenues may be seen especially for the producers, especially with the expansion of modern enclosure gardens established with suitable varieties [14, 15].

Almond production has continuously increased in recent years. Since the year 2010 almond production in Turkey has increased almost two times. It can be predicted that the increase in almond production will be realized at higher levels with the yield of the trees which do not produce fruit yet. According to TSI data for 2018, a total of 421 914 hectares in 64 provinces in Turkey in almond growing is carried out, the amount of production of 100,000 tons and an average yield of almond 12kg / tree. The total number of trees is 13.891 thousand, of which 8.490 thousand give fruit, but 5.401 thousand do not produce fruit yet. (Table 1). In terms of regions, the Mediterranean region is the first in almond production, the Aegean region is the second and the Southeastern

Anatolian Region is the third. On the basis of provinces, the first five provinces are listed as follows. Mersin (14.141 tons), Adiyaman (11.747 tons), Antalya (6.358 tons), Çanakkale (5.098 tons) and Muğla (5.028 tons). Adiyaman's almond production is close to 12% in Turkey's almond production.

Table 1. Number of almond trees and production quantities in Turkey

Years	Number of trees (thousand)		Production (Ton)	Production Index (2000=100)*
	Bearing trees	Non bearing trees		
2000	3.600	565	47.000	100
2005	3.400	543	45.000	96
2009	3.408	1.875	54.844	117
2010	3.683	2.589	55.398	118
2011	4.221	3.101	69.838	149
2012	4.679	3.242	80.261	171
2013	5.256	3.602	82.850	176
2014	5.637	3.815	73.230	156
2015	5.864	4.295	80.000	170
2016	6.664	4.964	85.000	181
2017	6.810	5.099	90.000	191
2018	8.490	5.401	100.000	213

Source: TSI, 2019. Crop Production Statistics. <http://www.tuik.gov.tr/PreTabloArama.do>

\*Calculated by the author.

Demand for almonds is increasing every day in Turkey and because this demand cannot be met by domestic production almond is imported. Almond production area has been increasing rapidly around the world recently. The top almond producer countries in the world are the USA, Spain, Iran and Morocco.

### 3.2. Almond Growing in Adiyaman

The city center of Adiyaman is located at 37 ° 45 'north latitude and 38 ° 16' east longitude and its altitude is 672m. The climate of the mountainous region to the north of the Anti-Taurus which divides Adiyaman from east to west is different from the climate of the region to the south. The south is dry and hot in summers, warm and rainy in winters; the north is dry and cool in summers, rainy and cold in winters. The prevailing winds in the province are in the north, northeast and northwest directions. In Adiyaman, temperatures rarely fall below zero in winter. The lowest temperatures of the year are between -10 ° C and -2 ° C. However, it was observed that the temperature did not fall below zero for some years. In summer, the average temperatures are 28 ° C to 38 ° C and maximum temperatures range from 35 ° C to 47 ° C. The average annual rainfall is 674 mm. With these characteristics, the climate of the province, which is a bridge between Eastern Anatolia and the Mediterranean Regions, is different from other provinces in the region. Furthermore, after the formation of the Atatürk Dam Lake area, there has been a softening and an increase in the humidity rate in the climate of the province [17].

Climate diversity is an effective factor in the growing of many crops in Adiyaman. Almond is one of these products. Adiyaman province is more advantageous than other almond growing provinces in terms of its location and climate. Considering the climatic characteristics of the province, the effect of late spring frosts, which are an important factor in almond cultivation, the desired high temperatures during the fruit filling period, the availability of underground water resources for irrigation, which affect yield and quality, have an effective and economic shape, existence of large-scale land suitable for efficient and economic use of agricultural mechanization, being close to the institutions and organizations conducting research in almonds in order to monitor the research on almonds and exchange information are some of these advantages [18]. In addition, after many years of field cultivation in Adiyaman producers have turned to horticultural agriculture. Almond, olive and walnut orchards are established as an alternative product [19]. In terms of input costs, almond growing was found to be the most advantageous among the nut corps [20]. Therefore, especially after the restriction of tobacco in the region, producers turned to alternative products and started to make an important contribution to both the local people and the national economy.

Almond growing is carried out in all the provinces of Southeastern Anatolia Region, which is at the third place in almond growing in Turkey (Table 2). According to 2018 statistics, 24,742 tons of almonds are produced in 130,045 decares of land in the Southeastern Anatolia Region; yield per tree 10 kg / tree; the number of fruit-bearing trees is 2,579,510; the number of non bearing trees is 1.661.971 and the total number of trees is 4.241.481 (TSI, 2019).

Table 2. Number of almond trees, yield and production amount in Southeastern Anatolian Region (2018)

Cities	Number of bearing trees	Number of non bearing trees	Area (Decar)	Yield (Kg/tree)	Production (Ton)	Share in total production (%)*
Adıyaman	1.204.200	819.488	58.430	10	11.747	47.48
Batman	33.530	25.910	2.855	15	489	1.98
Diyarbakır	339.352	97.255	7.910	9	2.899	11.72
Gaziantep	188.346	38.482	10.388	14	2.673	10.80
Kilis	51.650	9.558	2.482	10	498	2.01
Mardin	158.803	100.290	7.347	11	1.702	6.88
Siirt	29.115	6.881	614	6	181	0.73
Şanlıurfa	568.759	561.279	39.639	8	4.515	18.25
Şırnak	5.755	2.828	380	7	38	0.15
Total	2.579.510	1.661.971	130.045	10	24.742	100.00

Source: TSI, 2019. Crop Production Statistics

<http://www.tuik.gov.tr/PreTabloArama.do>

\*Calculated by the author

Adıyaman is the province where almond cultivation is most intense in the GAP Region. The province ranks first in terms of number of trees, area and production. The share of Adıyaman almond production in the total production of the region is 47.48% (Table 2). Therefore, Adıyaman performs almost half of the almond production in the region. In addition, with the return of non-bearing trees to yield in the coming years, the weight of the province in the region may increase. Adıyaman is followed by Şanlıurfa, Diyarbakır and Gaziantep with their shares in production respectively. Almond yield per tree in Adıyaman is the same as the region average (10 kg / tree). The gardens established in the region are usually Ferragnes and Ferraduel almond varieties grafted to bitter almond rootstock. In addition to these, there are also gardens which are established with scented seedlings grafted on rootstocks which are almond hybrid. Since the starting age of yield of saplings that are grafted to bitter almond rootstock is later than clonal rootstocks and garden's not being irrigated, affects negatively almond yield in the region [18].

Since 2018, 11,747 tons of almonds have been produced from 1,204,200 bearing trees of almond in Adıyaman (Table 3). The production will increase with the trees that have not produced fruit yet. 54.13% of the almonds produced in Adıyaman belongs to Kahta. In this respect, Kahta district stands out in the production of almonds. Kahta is followed by Gölbaşı (22.24%) and Besni (15.98%).

Table 3. Almond tree numbers and production amount in Adıyaman province (2018)

Districts	Number of bearing trees	Number of non bearing trees	Area (Decar)	Yield (Kg/tree)	Production (Ton)	Share in total production (%)*
Besni	192.000	167.720	12.710	10	1.877	15.98
Gerger	14.080	25.155	1.020	9	126	1.07
Gölbaşı	246.700	18.000	7.500	11	2.613	22.24
Kahta	650.358	331.405	28.000	10	6.359	54.13
Merkez	55.880	222.320	6.500	8	455	3.87
Samsat	10.300	16.450	800	10	101	0.9
Sincik	2.358	2.662	140	8	19	0.2
Tut	26.524	33.276	1.560	7	173	1.47
Çelikhan	6.000	2.500	200	4	24	0.2
Total	1.204.200	819.488	58.430	10	11.747	100

Source: TSI, 2019. Crop Production Statistics

<https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr>

\*Calculated by the author.

Table 4 shows the developments in the almond production area of Adıyaman districts over the years. The production area increased from 1662 decares in 2009 to 58,430 decares in 2018. In the last decade, there has been an increase of approximately 35 times in the field of almond production. In the aspect of production area, Kahta district is first with 28.000 decares, and it is followed by Besni and Gölbaşı districts.

Table 4. Almond production area (decare) in Adıyaman by year

Years	Besni	Gerger	Gölbaşı	Kahta	Central	Samsat	Sincik	Tut	Çelikhan	Total
2009	731	29	644	200	0	50	8	0	0	1.662
2010	752	32	820	500	322	25	8	32	0	2.491
2011	752	12	820	1150	475	45	8	300	0	3.562
2012	763	12	832	1167	690	46	8	365	0	3.883
2013	2772	277	2512	3468	2.016	40	15	368	0	11.468
2014	2772	277	2620	8468	2.500	35	35	542	0	17.249
2015	3772	527	2620	12968	4.500	120	35	800	0	25.342
2016	7250	541	4695	20219	5.655	450	65	900	200	39.975
2017	11447	922	5922	22468	5.534	634	132	1.466	189	48.714
2018	12710	1020	7500	28000	6.500	800	140	1.560	200	58.430

Source: TSI, 2019. Crop Production Statistics

<https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr>

Almond is produced in all districts of Adıyaman. Almond production increased from 448 tons in 2009 to 11,747 tons in 2018 (Table 5). Almond production increased by 26 times in the decade examined. In 2018, Kahta had the highest production with 6359 tons and Sincik had the lowest production with 19 tons. Gölbaşı and Besni are the districts where almond production is concentrated.

Table 5. Almond production in the province of Adıyaman by year (ton)

Years	Besni	Gerger	Gölbaşı	Kahta	Central	Samsat	Sincik	Tut	Çelikhan	Total
2009	53	50	165	72	47	0	2	29	30	448
2010	55	51	165	77	72	6	2	29	30	487
2011	55	51	182	134	64	11	4	82	15	598
2012	64	49	207	164	71	12	5	82	15	669
2013	81	59	519	235	125	13	6	89	14	1.141
2014	185	33	477	348	140	11	8	32	3	1.237
2015	250	43	512	588	267	13	10	93	24	1.800
2016	614	121	717	1441	480	53	13	103	34	3.576
2017	1220	111	652	2170	196	55	14	149	26	4.593
2018	1877	126	2613	6359	455	101	19	173	24	11.747

Source: TSI, 2019. Crop Production Statistics

<https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr>

### 3.3. Almond Growing in Kahta

Kahta, one of the districts of Adıyaman, is at the forefront in almond growing as it is in many aspects in the agricultural field. In recent years, modern gardens and standard varieties such as Ferragnes, Ferraduel and Texas have been established in the region for the development of almond cultivation [7]. For this reason, it is important to consider the almond growing of Kahta district separately. Kahta district has made a big leap in almond growing. While only 200 decare of almonds were grown in 2009, the production area increased to 28,000 decare in 2018 (Table 6). While the number of bearing trees was 6500 in 2009, it raised to 650,358 in 2018. There has been a 100 times increase in the number of bearing trees. A similar trend was observed in the amount of almond production. Production, which was only 72 tons in 2009, reached 6,359 tons in 2018. This means about a 90 times increase. In the coming years, the amount of production will increase with the start of yielding trees that are non bearing.



Table 6. Almond tree number and production amount in Kahta district by years

Years	Number of bearing trees	Number of non bearing trees	Area (Decares)	Yield (Kg/tree)	Production (Ton)	Production index* (2009=100)
2009	6.500	4.000	200	11	72	100
2010	7.000	14.500	500	11	77	107
2011	10.300	28.750	1.150	13	134	186
2012	12.600	26.400	1.167	13	164	228
2013	18.900	66.900	3.468	12	235	326
2014	29.000	176.500	8.468	12	348	483
2015	49.000	296.000	12.968	12	588	817
2016	139.544	535.383	20.219	10	1.441	2.001
2017	236.644	509.885	22.468	9	2.170	3.014
2018	650.358	331.405	28.000	10	6.359	9.082

Source: TSI, 2019. Crop Production Statistics <https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr>

\*Calculated by the author

The Central Institute of Agricultural Credit Cooperatives established the Research Institute for Not Corps in Kahta Organized Industrial Zone. The Institute conducts studies for marketing and exporting almonds. With this aspect, the marketing problem for the almonds produced by the producers is eliminated. Not only Adıyaman but also Şanlıurfa, Diyarbakır, Malatya and Kahramanmaraş can benefit from the Almond and Pistachio Operating Facility established under the Agricultural Credit Cooperative. Almonds and Pistachios as well as walnuts can be processed in the facility. The facility also produces and markets products such as almond oil, almond flour, confectionery and mash for the processing of almonds. As an example, some sweet shops in Kahta have started to produce almond baklava as an alternative.

Almond consumption is increasing all over the world. Demand for almonds in Turkey is increasing and since the domestic production doesn't meet the consumption, import for almond is needed. Therefore, almond cultivation is an area of economic benefit for producers. By meeting the domestic demand and focusing on exports, significant contributions can be made to the national economy. For this reason, Adıyaman may have an important advantage in meeting almond demand.

Going to branding in almonds is an important stage in terms of creating added value to the product. In this process, Adıyaman Chamber of Commerce and Industry's application for registration of geographical signs for almonds is an important step. The positive result of this process will increase Adıyaman's importance in terms of almond growing. If Malatya is known as apricot and Gaziantep is the brand city in pistachio, Adıyaman can be referred to as brand city for almond. In this way, almond-related industrial investments can increase in the nut corps sector, and this situation can also contribute to employment. Local people who go to other regions as seasonal workers will now be able to work and maintain their lives in their own city with the development of almond cultivation.

Interesting and rational practices regarding the newly established almond orchards are also on the agenda. For example, sheep farming in almond gardens can be done. For sheep, meeting forage needs by planting forage crops between trees in the garden can reduce livestock production costs. Thus, animal fertilizer needs of almond trees may be met by itself. Therefore, costs can be reduced by using fewer versions, fertilizers and pesticides. As a result, the increase in meat production will contribute to the red meat deficit of the national economy.

The following situations were identified during the interviews with almond growers.

Expectation from almond growing in the region is quite high. Therefore, great importance is given to this field. Increasing of almond production continues. Growers especially prefer Ferragnes and Ferraduel varieties. Producers who are aware of the efficiency increasing feature of irrigation make the necessary investments related to irrigation. Almond growers said that this year because of excessive rainfall in the flowers of almonds shed before ripening and therefore yield will decrease. They also stated that eurytomaamygdali, red spider and aphids were found as the almond pests.

Almond harvest starts in August in the region just like in Southeastern Anatolia. The green shell is cracked in the fruits that reach maturity on the tree and partially dried and undergoes color change. This is a sign of harvest maturity in almonds. It is preferred to pour the fruits with a normal shake. In addition, pole branches are shaken and the ripe almonds are poured from the tree. Harvesting by machine is not preferred much because of the concern that it may damage the roots of the tree. Then, the separation of green shells is provided in machines called patoz. Since the amount of moisture of the harvested fruits is high, it is important that they are dried and kept up to certain humidity. The fruits collected by the producers are spread thinly for 4-5 days under the sun and mixed frequently and the moisture level is controlled. Almonds that are controlled and whose humidity level is at the desired level are stored or immediately sold to the Almond and Pistachio Plant.

#### 4. Conclusion And Suggestions

Significant improvements in almond production have been seen in Turkey in recent years. Particularly, Adiyaman has become the province that makes the most mention of almond production. In this study, it is aimed to reveal the current situation of Adiyaman in almond growing in various aspects. Significant increases in the amount of almond production have emerged due to the support provided by the state and the producers' search for alternative products. While the increase of almond production area is 35 times in Adiyaman, the increase in production is 26 times. The average yield per tree was determined to be 10 kg. In the evaluation made on the basis of districts, it was observed that Kahta district took the first place in almond growing. Almond production in Kahta increased by 90 times during the period examined. It is foreseen from the data that almond production will continue to increase in the coming years. The Almond and Pistachio Plant, established in the Organized Industrial Zone in Kahta, where a large part of almond production takes place, is thought to solve the producer's almond processing and marketing problem to a great extent.

Based on these assessments, it is useful to consider the following issues related to the development of Adiyaman almond cultivation: Almonds with high nutritional value is one of the important food products in human nutrition. However, production is not at a level to meet consumption. Production is increasing day by day with the support and incentives provided by the state to the almond producer.

However, the use of contemporary techniques in almond farming and mechanization should be given importance to research and projects. Promising developments are expected for the future of almond cultivation in the region and the use of almond products in various fields. This will not only provide consumers with more affordable prices and qualified products, but will also contribute to higher income levels and employment. In order to increase the production of almonds, it should be provided the right variety, high quality and healthy seedlings that are flowering late and not to be damaged by late spring frost, breeding problems of seedlings should be solved, farmers should be supported for the establishment of closing gardens, producers should take an active role in the market and other production activities. In order to increase the export potential, efforts towards foreign markets should be given importance.

New almond orchards installed in the region can lead to an increase in the production of insufficient almonds in our country and the marketing of high quality almonds to the world markets. In the provinces where any fruit is grown intensively, the industry of that fruit is also developing. Almond is a fruit consumed fresh and as dried fruit. Initiatives for the almond industry in Adiyaman will both be a solution to the marketing problem and the price losses that producers may experience in product sales will be prevented. Almond processing industry, which is used as raw material (cake, chocolate, etc.) in many products, especially in the confectionery industry, should also be increased in parallel with production. Countries that dominate the almond market should be taken as an example [1].

In short; In order to develop almond farming in the region, producer unions and cooperatives should be established, marketing and storage activities should be given importance and switching to modern farming techniques are of great importance.

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