

RECENT DEVELOPMENTS IN VEGETABLE PRODUCTION IN THE WORLD AND TÜRKİYE

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Abstract

In this study, the developments in global and Turkish vegetable production were examined during the period of 1980-2021, and the position and importance of Türkiye in vegetable production was emphasized. The study covers 22 vegetable species which were important in terms of production potential. Significant increases in vegetable production area and quantity have been observed globally and in Türkiye throughout the period. Increases in vegetable production have also been observed in Türkiye with the increase in productivity. In Türkiye, except for some species, the vegetable yield was above the global average. Türkiye is an important producer country in terms of vegetable production, particularly for vegetables such as tomatoes, peppers, eggplants, cucumbers, beans, lettuce, cabbage, zucchini, leeks, spinach, onions, and garlic. Therefore, it is recommended to implement proposals to increase producer income and productivity in vegetable production in Türkiye.

Key words: *vegetables, vegetable production, production area, vegetable yield, Türkiye, world*

INTRODUCTION

The vegetable sector, which is one of the most important sub-components of the agricultural sector, directly affects the continuity of human life by producing plant-based carbohydrates, proteins, and vitamins that are essential for people's basic needs [4]. Moreover, the vegetable sector is an essential industry that contributes to the country's economy by serving as a source of raw material for the food industry that processes vegetables and by supporting foreign trade [3].

Due to certain characteristics that Türkiye possesses, there are advantages and disadvantages in vegetable production. The most significant advantages include the ecological suitability of many regions for vegetable production, the experience of producers in vegetable production, and higher income obtained compared to other product groups. The disadvantages, on the other hand, are the small scale of enterprises and the lack of specialization in this field, inadequate use of advanced technology in enterprises, and low levels of education and input usage among producers [5]. In addition to this,

excessive use of artificial chemical inputs in world vegetable production in recent years has caused chemical residues and Türkiye has gained an advantageous position for vegetable production thanks to its soils that have not yet been contaminated with chemicals [14].

More than 50 vegetable species that can be grown in the temperate and subtropical climate zones are producible in Türkiye's ecology [15]. Production is focused more intensively on some of the species that are both heavily consumed domestically and exported. Vegetable types such as tomatoes, peppers, onions, cucumbers, eggplant, cabbage, pumpkins and carrots are widely produced in Türkiye.

In Türkiye, the total area cultivated in 2020 (excluding grassland and pasture) was 23,145,000 hectares. This value represents an 18.73% decrease from 1980. The share of vegetable production areas in the total agricultural land has ranged between 1.74% and 3.06% from 1980 to 2020. In 2020, the share of vegetable production areas in the total agricultural land was 2.93%. Vegetable production areas have increased by 36.97%, from 495,000 hectares in 1980 to 679,000 hectares in 2020. The trend has followed a

fluctuating but rising course over the years. While the total agricultural land in Türkiye has decreased, it has been found that the vegetable production areas have increased. This can be attributed to producers who opt for vegetable production as it generates more income compared to other crops.

In contrast, the share of vegetable production areas in the total agricultural land has been continuously increasing worldwide.

In 1980, the share of vegetable production areas in the total agricultural land was 1.80%, which has risen to 3.68% in recent years (Fig 1).

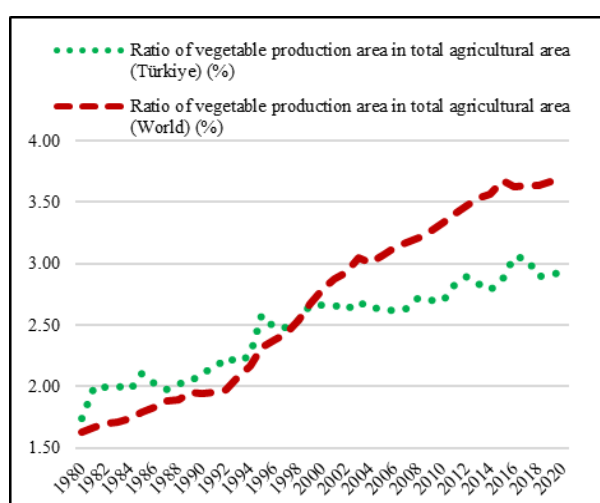


Fig. 1. Ratio of vegetable production areas in total agricultural areas
Source: [6].

In this study, it was aimed to examine the developments in the world and Türkiye's vegetable production from the past to the present and to reveal the production potential of Türkiye in terms of world vegetable production.

MATERIALS AND METHODS

The study refers to the main vegetable products in the world: onions and shallots (dry), tomatoes, peas (green), cabbages, okra, cucumbers and gherkins, chillies and peppers (green), eggplants, green garlic, asparagus, other beans (green), pumpkins (squash and gourds), cauliflowers and broccoli, lettuce and chicory, carrots and turnips, green corn

(maize), spinach, broad beans and horse beans (green), onions and shallots (green), string beans, leeks and other alliaceous vegetables, artichokes, other vegetables (fresh n.e.c.) covers its products.

Statistical data on 23 different vegetable crops were obtained from FAO and various national and international publications on the subject. Within the scope of the study, the development of vegetable production in the world and Türkiye was analyzed for the period 1980-2021. Indices were calculated for these data and the values obtained were interpreted.

RESULTS AND DISCUSSIONS

Development of vegetable production in the world

Production areas

When the developments in world vegetable production were evaluated between 1980 and 2021, the vegetable production area, which was 24 million 565 thousand hectares on average between 1980-1985, increased by 132.58% during the analyzed period and rose to 57 million 133 thousand hectares on average between 2016-2021.

According to the average for 2016-2021, onions and shallots (dry) rank first with a rate of 9.30% in the vegetable production areas, followed by tomatoes with a rate of 8.73%, and green peas with a rate of 4.41% in third place.

Cabbages (%4.25), okra (%4.23), and cucumbers and gherkins (%3.77) follow them respectively. The rate of other vegetables (fresh n.e.c.) was 35.78%.

During the examined periods, the increase in production areas occurred respectively in okra by 313.50%, asparagus by 291.88%, spinach by 289.66%, onions and shallots (dry) by 215.54%, and green peas by 208.58%.

The production area of string beans decreased by 12.00%. It was determined that the production areas of vegetables (primary) increased by 132.58% (Table 1).

Table 1. Development of vegetable production areas in world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Hectare	Percent (%)	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare	Percent (%)	
<i>Vegetables Primary</i>	24,564,900	100.00	28,323,298	33,056,273	41,932,727	47,403,550	53,892,480	57,132,922	100.00	232.58
Onions and shallots (dry)	1,683,739	6.85	1,866,262	2,327,306	2,958,892	3,850,163	4,565,555	5,312,941	9.30	315.54
Tomatoes	2,561,079	10.43	2,846,134	3,167,457	3,864,483	4,228,071	4,744,086	4,987,597	8.73	194.75
Peas (green)	816,240	3.32	902,666	1,139,271	1,575,526	1,918,688	2,281,598	2,518,738	4.41	308.58
Cabbages	1,593,553	6.49	1,709,509	1,945,035	2,466,959	2,249,096	2,396,401	2,429,417	4.25	152.45
Okra	584,353	2.38	720,436	837,326	875,192	1,004,591	1,844,421	2,416,294	4.23	413.50
Cucumbers and gherkins	1,103,637	4.49	1,185,635	1,439,956	1,959,904	1,926,198	2,106,273	2,153,651	3.77	195.14
Chillies and peppers (green)	992,348	4.04	1,109,912	1,273,884	1,612,140	1,748,099	1,915,161	1,990,262	3.48	200.56
Eggplants	772,404	3.14	848,545	1,034,381	1,536,839	1,748,594	1,844,216	1,905,942	3.34	246.75
Green garlic	673,369	2.74	769,055	856,468	1,060,497	1,256,142	1,419,648	1,587,731	2.78	235.79
Asparagus	400,627	1.63	535,407	740,764	1,068,321	1,366,102	1,471,074	1,569,968	2.75	391.88
Other beans (green)	688,506	2.80	873,495	1,145,510	1,378,074	1,438,153	1,514,203	1,561,582	2.73	226.81
Pumpkins (squash and gourds)	876,666	3.57	931,356	1,103,628	1,412,946	1,623,129	1,847,372	1,624,938	2.84	185.35
Cauliflowers and broccoli	459,815	1.87	572,256	718,907	863,901	1,039,213	1,233,303	1,355,834	2.37	294.87
Lettuce and chicory	466,112	1.90	527,700	666,952	869,874	1,086,999	1,165,448	1,218,767	2.13	261.48
Carrots and turnips	551,125	2.24	629,330	775,939	1,004,972	1,147,466	1,164,138	1,110,444	1.94	201.49
Green corn (maize)	768,282	3.13	903,214	1,016,212	1,081,807	1,116,856	1,138,459	1,131,875	1.98	147.33
Spinach	235,435	0.96	311,444	451,462	684,289	807,430	891,172	917,394	1.61	389.66
Broad and horse beans (green)	169,824	0.69	196,329	186,989	199,437	248,070	265,487	263,523	0.46	155.17
Onions and shallots (green)	139,560	0.57	159,760	179,091	204,291	231,281	226,492	219,468	0.38	157.26
String beans	183,819	0.75	182,416	217,978	224,223	235,455	208,750	161,759	0.28	88.00
Leeks and other alliaceous vegetables	57,996	0.24	72,900	92,505	98,892	118,953	129,423	133,409	0.23	230.03
Artichokes	114,840	0.47	113,870	113,343	120,707	127,392	124,112	119,816	0.21	104.33
Other vegetables (fresh n.e.c.)*	8,671,573	35.30	10,355,668	11,625,912	14,810,564	16,887,411	19,395,687	20,441,576	35.78	235.73

*n.e.c. not elsewhere classified

Source: [6].

Production quantity

World vegetable production increased by 244.26% from 325 million 272 thousand tons

to 1 billion 119 million 789 thousand tons. In terms of world vegetable production, tomatoes ranked first with a share of 16.28% (Table 2).

Table 2. Development of vegetable production in world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Tons	Percent (%)	Tons	Tons	Tons	Tons	Tons	Tons	Percent (%)	
<i>Vegetables Primary</i>	325,272,326	100.00	400,454,493	498,546,576	677,797,372	840,600,405	1,013,969,590	1,119,789,214	100.00	344.26
Tomatoes	58,919,615	18.11	70,918,405	83,606,998	109,036,996	136,820,217	165,805,304	182,336,163	16.28	309.47
Onions and shallots (dry)	24,813,683	7.63	29,691,262	37,796,403	50,957,759	69,929,906	85,362,303	100,100,142	8.94	403.41
Cucumbers and gherkins	14,400,289	4.43	16,570,655	22,785,766	37,178,007	51,988,886	71,507,863	86,766,059	7.75	602.53
Cabbages	38,350,845	11.79	39,319,720	44,318,090	64,273,062	64,815,905	68,926,497	71,179,818	6.36	185.60
Eggplants	9,139,054	2.81	10,888,325	17,085,178	27,430,607	36,296,466	48,029,348	55,456,640	4.95	606.81
Carrots and turnips	11,325,849	3.48	13,485,813	17,412,488	22,235,647	30,329,882	37,629,516	40,285,208	3.60	355.69
Chillies and peppers (green)	8,499,893	2.61	10,450,780	14,045,373	21,191,581	26,844,007	31,338,283	35,403,479	3.16	416.52
Spinach	3,334,769	1.03	3,883,108	6,034,291	9,785,849	16,215,854	22,796,271	29,509,848	2.64	884.91
Green garlic	4,799,190	1.48	6,094,073	8,154,737	11,267,698	18,306,550	24,221,905	27,061,359	2.42	563.87
Lettuce and chicory	8,965,317	2.76	10,875,358	14,380,313	18,720,843	23,413,417	25,280,531	26,846,818	2.40	299.45
Cauliflowers and broccoli	6,652,137	2.05	8,763,455	12,501,893	15,911,729	19,066,342	23,016,008	25,366,564	2.27	381.33
Pumpkins (squash and gourds)	8,781,262	2.70	10,302,145	13,621,231	17,638,932	21,117,267	24,332,596	23,917,060	2.14	272.36
Other beans (green)	4,382,077	1.35	5,557,299	7,774,627	10,655,485	17,087,620	21,298,959	23,104,989	2.06	527.26
Peas (green)	5,827,090	1.79	6,650,018	8,821,758	11,786,300	14,158,856	17,321,901	19,738,947	1.76	338.74
Green corn (maize)	5,505,756	1.69	6,810,111	8,158,321	9,733,015	10,728,757	10,967,193	10,649,866	0.95	193.43
Okra	2,688,532	0.83	3,419,266	4,988,882	5,446,058	6,448,804	8,996,784	9,864,399	0.88	366.91
Asparagus	1,385,716	0.43	1,845,730	2,946,507	4,874,528	6,989,232	8,085,225	8,432,120	0.75	608.50
Onions and shallots (green)	2,073,231	0.64	2,474,744	3,076,994	3,590,772	4,301,327	4,486,273	4,539,422	0.41	218.95
Leeks and other alliaceous vegetables	801,819	0.25	1,267,350	1,635,048	1,624,008	2,020,817	2,151,552	2,143,695	0.19	267.35
Broad and horse beans (green)	901,003	0.28	1,023,504	988,619	1,155,035	1,565,526	1,735,444	1,706,404	0.15	189.39
Artichokes	1,147,073	0.35	1,266,471	1,196,780	1,263,589	1,401,980	1,486,307	1,483,332	0.13	129.31
String beans	1,223,532	0.38	1,265,414	1,600,500	1,842,334	2,093,119	1,913,837	1,546,574	0.14	126.40
Other vegetables (fresh n.e.c.)	101,354,595	31.16	137,631,484	165,615,778	220,197,537	258,659,670	307,279,690	332,350,308	29.68	327.91

Source: [6].

This was followed by onions and shallots (dry) with 8.94%, cucumbers and gherkins with 7.75%, cabbages with 6.36%, eggplants with 4.95% and carrots and turnips with 3.60%.

The increase in production quantity compared to the average of 1980-1985 was 784.91% for spinach, 508.50% for asparagus, 506.81% for eggplant, 502.53% for cucumbers and gherkins and 463.87% for green garlic. It was determined that the production quantity of vegetables (primary) increased by 244.26% (Table 2).

Yield

In order to meet the nutritional demands of the world's expanding population, which was projected to exceed nine billion by 2050, the current rates of agricultural productivity were unlikely to be sufficient to achieve this

objective [12]. In this regard, effective methods should be developed to improve crop breeding in order to increase yield [13].

The world average vegetable yield increased by 48.18% from 13,226 kg to 19,598 kg per hectare. Compared to the 1980-1985 average, the yields of cucumbers and gherkins increased by 209%, eggplant by 145.98%, green garlic by 139.40%, other beans (green) by 132.77%, spinach by 112.67% and chillies and peppers (green) by 107.65% in 2016-2021. The average yields for 2016-2021 were 40,290 kg/ha for cucumber and cucumber, 36,305 kg/ha for carrot and turnip, 36,558 kg/ha for tomato, 32,162 kg/ha for spinach, 29,299 kg/ha for cabbage and 29,088 kg/ha for eggplant. It was determined that the yield of vegetables (primary) increased by 48.18% (Table 3).

Table 3. Development of vegetable yield in world

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index (1980-1985 = 100)
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	
<i>Vegetables Primary</i>	13,226	14,134	15,072	16,130	17,716	18,808	19,598	148.18
Cucumbers and gherkins	13,039	13,976	15,793	18,930	26,964	33,914	40,290	309.00
Carrots and turnips	20,532	21,449	22,429	22,105	26,421	32,363	36,305	176.82
Tomatoes	22,971	24,903	26,369	28,187	32,328	34,942	36,558	159.15
Spinach	15,123	12,466	13,349	14,180	20,052	25,558	32,162	212.67
Cabbages	24,056	23,018	22,781	25,959	28,826	28,762	29,299	121.80
Eggplants	11,825	12,832	16,537	17,845	20,871	26,031	29,088	245.98
Lettuce and chicory	19,229	20,583	21,567	21,485	21,540	21,692	22,029	114.56
Onions and shallots (green)	14,855	15,482	17,180	17,566	18,593	19,826	20,689	139.27
Cauliflowers and broccoli	14,458	15,304	17,365	18,414	18,347	18,655	18,709	129.40
Onions and shallots (dry)	14,724	15,907	16,233	17,209	18,152	18,706	18,847	128.00
Chillies and peppers (green)	8,567	9,434	10,976	13,121	15,351	16,364	17,791	207.65
Green garlic	7,120	7,912	9,510	10,578	14,455	17,053	17,046	239.40
Leeks and other alliaceous vegetables	13,817	17,310	17,683	16,454	16,992	16,625	16,070	116.30
Pumpkins (squash and gourds)	10,007	11,063	12,326	12,461	13,009	13,171	14,862	148.51
Other beans (green)	6,356	6,360	6,780	7,710	11,867	14,057	14,796	232.77
Artichokes	9,985	11,116	10,559	10,468	11,002	11,980	12,381	124.01
String beans	6,706	6,937	7,341	8,214	8,890	9,177	9,535	142.19
Green corn (maize)	7,176	7,528	8,021	8,989	9,607	9,635	9,393	130.90
Peas, green	7,134	7,352	7,764	7,490	7,377	7,588	7,836	109.84
Broad and horse beans (green)	5,330	5,218	5,291	5,777	6,306	6,540	6,483	121.64
Asparagus	3,461	3,448	3,965	4,528	5,116	5,494	5,371	155.21
Okra	4,599	4,742	5,942	6,225	6,413	5,125	4,103	89.22
Other vegetables (fresh n.e.c.)	11,662	13,289	14,247	14,840	15,312	15,836	16,258	139.42

Source: [6].

Development of vegetable production in the Türkiye

Production areas

When the developments in vegetable production in Türkiye were evaluated between 1980 and 2021, the vegetable production area, which was 543,224 hectares in the average of 1980-1985, increased by 26.90% in the period

analyzed and increased to 689,357 hectares in the average of 2016-2021.

According to the average of 2016-2021, tomatoes ranked first with 25.53%, pumpkins (squash and gourds) ranked second with 13.80%, chillies and peppers (green) ranked third with 11.99%. These were followed by onions and shallots (dry) (9.45%), other beans (green) (6.51%) and cucumbers and gherkins

(4.77%). The share of other vegetables (fresh n.e.c.) was 4.40%.

The increase in production areas during the periods under review was 493.15% for asparagus, 461.90% for other vegetables (fresh n.e.c.), 275.91% for cauliflowers and broccoli, 260.08% for pumpkins (squash and

gourds) and 231.41% for lettuce and chicory. Production areas of some vegetable crops decreased. This decrease was 71.12% in green garlic, 56.96% in leeks and other alliaceous vegetables, 51.74% in onions and shallots (green), 49.21% in eggplants (Table 4).

Table 4. Development of vegetable production areas in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Hectare	Percent (%)	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare	Percent (%)	
<i>Vegetables Primary</i>	543,224	100.00	569,296	646,965	699,636	676,115	673,831	689,357	100.00	126.90
Tomatoes	112,350	20.68	149,839	176,668	207,324	194,267	185,845	175,988	25.53	156.64
Pumpkins (squash and gourds)	26,417	4.86	20,958	19,134	16,318	37,100	64,479	95,122	13.80	360.08
Chillies and peppers (green)	47,667	8.77	48,333	60,415	73,440	77,342	79,163	82,626	11.99	173.34
Onions and shallots (dry)	74,215	13.66	78,735	102,493	98,102	68,757	63,545	65,150	9.45	87.79
Other beans (green)	49,395	9.09	49,417	54,031	56,796	54,104	51,643	44,855	6.51	90.81
Cucumbers and gherkins	38,050	7.00	41,167	44,803	45,011	42,797	38,601	32,881	4.77	86.42
Cabbages	34,064	6.27	29,116	30,364	29,908	27,074	25,553	26,822	3.89	78.74
Lettuce and chicory	6,599	1.21	11,100	14,752	19,985	22,318	21,214	21,870	3.17	331.41
Eggplants	41,000	7.55	36,433	33,330	32,837	28,655	24,896	20,824	3.02	50.79
Spinach	17,896	3.29	16,852	17,868	20,656	20,490	18,053	16,456	2.39	91.96
Cauliflowers and broccoli	3,411	0.63	3,783	4,225	4,928	7,060	9,109	12,822	1.86	375.91
Peas (green)	6,167	1.14	6,421	7,448	8,262	9,206	10,846	11,000	1.60	178.38
Carrots and turnips	6,767	1.25	6,611	7,893	7,706	11,661	11,536	11,059	1.60	163.43
String beans	8,667	1.60	4,723	5,401	5,889	8,013	8,931	8,529	1.24	98.41
Onions and shallots (green)	16,833	3.10	17,750	15,608	15,528	12,564	9,739	8,123	1.18	48.26
Leeks and other alliaceous vegetables	17,417	3.21	13,281	12,609	12,571	10,759	8,502	7,496	1.09	43.04
Okra	6,783	1.25	6,146	6,703	7,422	7,877	7,024	5,230	0.76	77.10
Broad and horse beans (green)	7,944	1.46	8,578	6,654	5,961	6,432	5,643	4,878	0.71	61.41
Green garlic	15,064	2.77	12,700	12,580	13,183	11,812	12,488	4,350	0.63	28.88
Artichokes	1,107	0.20	1,116	1,251	1,972	2,776	2,557	2,863	0.42	258.73
Asparagus	12	0.00	4	3	3	3	24	72	0.01	593.15
Other vegetables (fresh n.e.c.)	5,400	0.99	6,233	12,733	15,837	15,050	14,443	30,343	4.40	561.90

Source: [6].

Production quantity

From the early 2000s to the present, there has been a significant increase in the total vegetable production in Türkiye. The increase can be attributed to factors such as the use of new technologies, conscious farming practices, the inclusion of disease-resistant vegetable species in the production program, changes in greenhouse production technologies, the introduction of high-yield greenhouse vegetable species in the production program, developments in seedling production, and the impact of grafted seedling production technology [14]. In Türkiye, there were studies showed that the yields of vegetables produced using greenhouse production technologies and therefore the total vegetable production per enterprise were high [2] [7] [9] [10] [11]. Türkiye's vegetable production increased by 168.83% from 9

million 396 thousand tons to 25 million 261 thousand tons (Table 5).

In terms of vegetable production in Türkiye, tomato ranks first with a share of 50.57%. Tomato was half of the total vegetable production. It was followed by chillies and peppers (green) with 10.54%, onions and shallots (dry) with 8.71%, cucumbers and gherkins with 7.40%, eggplants with 3.34%, cabbages with 3.21% and pumpkins (squash and gourds) with 2.47% (Table 5).

According to the average of 1980-1985, asparagus was the most important crop among vegetables with an increase in production. Asparagus increased 21.33 times in the relevant period. Other vegetables (fresh n.e.c.) increased 8.43 times, lettuce and chicory 6.57 times, carrots and turnips 5.62 times, cauliflowers and broccoli 5.01 times, artichokes 5.01 times, chillies and peppers (green) 4.19 times and tomatoes 3.27 times.

Production of green garlic decreased by 51.92%, leeks and other alliaceous vegetables by 25.01%, broad and horse beans (green) by 15.39% and onions and shallots (green) by 5.37% (Table 5). The significant increase in cauliflower and broccoli production in recent

years can be attributed to the growing demand from consumers for functional food and product quality, as well as the higher prices these vegetables can command on the market compared to other types of cabbage [1].

Table 5. Development of vegetable production in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Tons	Percent (%)	Tons	Tons	Tons	Tons	Tons	Tons	Percent (%)	
<i>Vegetables Primary</i>	9,396,638	100.00	12,132,714	15,018,085	18,872,714	20,565,219	22,308,720	25,261,064	100.00	268.83
Tomatoes	3,908,333	41.59	5,533,333	6,766,667	8,971,833	10,168,726	11,448,406	12,773,544	50.57	326.83
Chillies and peppers (green)	635,000	6.76	815,167	1,047,833	1,573,667	1,793,597	2,080,585	2,662,473	10.54	419.29
Onions and shallots (dry)	1,074,167	11.43	1,409,167	2,000,000	2,153,333	1,931,923	1,891,878	2,201,198	8.71	204.92
Cucumbers and gherkins	602,500	6.41	860,000	1,198,333	1,690,520	1,726,310	1,764,661	1,870,569	7.40	310.47
Eggplants	677,500	7.21	732,500	792,833	941,667	874,620	821,272	844,212	3.34	124.61
Cabbages	625,333	6.65	673,833	688,333	717,500	682,185	720,756	810,262	3.21	129.57
Pumpkins (squash and gourds)	369,167	3.93	357,167	355,583	347,667	382,674	421,320	624,586	2.47	169.19
Carrots and turnips	107,500	1.14	164,000	231,740	264,067	510,689	586,748	603,757	2.39	561.63
Other beans (green)	345,000	3.67	409,833	448,667	498,333	564,573	622,593	583,936	2.31	169.26
Lettuce and chicory	76,583	0.82	147,167	228,667	329,167	424,663	433,063	502,816	1.99	656.56
Cauliflowers and broccoli	59,167	0.63	65,333	78,667	89,167	149,184	199,767	296,148	1.17	500.53
Leeks and other alliaceous vegetables	302,500	3.22	312,667	313,000	303,167	283,482	235,948	226,849	0.90	74.99
Spinach	129,333	1.38	143,333	170,167	207,667	230,009	216,417	223,002	0.88	172.42
Onions and shallots (green)	143,333	1.53	168,833	222,833	218,500	188,418	152,276	135,632	0.54	94.63
Peas (green)	36,167	0.38	36,500	43,500	56,333	90,208	103,567	107,571	0.43	297.43
String beans	61,667	0.66	33,167	37,583	42,667	58,498	77,728	87,167	0.35	141.35
Green garlic	98,917	1.05	90,667	99,917	106,767	103,773	109,050	47,559	0.19	48.08
Broad and horse beans (green)	48,667	0.52	61,333	51,333	45,000	46,691	39,964	41,177	0.16	84.61
Artichokes	7,750	0.08	11,040	15,933	26,383	34,332	32,666	38,790	0.15	500.52
Okra	23,083	0.25	21,500	23,583	28,833	38,135	34,439	31,947	0.13	138.40
Asparagus	23	0.00	18	16	14	12	99	484	0.00	2,133.09
Other vegetables (fresh n.e.c.)	64,949	0.69	86,157	202,896	260,463	282,514	315,521	547,388	2.17	842.80

Source: [6].

Table 6. Development of vegetable yield in Türkiye

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index (1980-1985 = 100)
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	
<i>Vegetables Primary</i>	17,292	21,287	23,188	26,973	30,453	33,101	36,694	212.20
Tomatoes	34,715	36,881	38,279	43,250	52,460	61,551	72,756	209.58
Cucumbers and gherkins	15,819	20,837	26,687	37,518	40,432	45,724	58,420	369.31
Carrots and turnips	16,172	24,899	29,337	33,898	43,487	51,014	54,711	338.31
Eggplants	16,619	20,189	23,981	28,681	30,558	33,023	41,184	247.81
Chillies and peppers (green)	13,387	16,851	17,331	21,387	23,201	26,285	32,360	241.73
Onions and shallots (dry)	14,451	17,890	19,460	21,943	28,243	29,896	33,800	233.89
Leeks and other alliaceous vegetables	17,521	23,607	24,831	24,114	26,403	27,761	30,327	173.09
Lettuce and chicory	12,108	13,077	15,486	16,460	19,024	20,411	23,020	190.13
Cauliflowers and broccoli	17,463	17,269	18,601	18,199	21,039	21,938	23,053	132.01
Cabbages	18,356	23,198	22,681	24,007	25,210	28,208	30,807	167.83
Green garlic	6,569	7,158	7,952	8,115	8,817	8,752	12,664	192.78
Onions and shallots (green)	8,548	9,491	14,272	14,084	14,988	15,646	16,738	195.80
Spinach	7,349	8,495	9,517	10,049	11,252	11,994	13,582	184.82
Artichokes	7,141	10,166	12,517	13,401	12,382	12,768	13,557	189.86
Other beans (green)	7,124	8,291	8,305	8,769	10,438	12,071	13,021	182.79
String beans	7,108	7,025	6,953	7,243	7,301	8,700	10,313	145.09
Peas (green)	5,989	5,686	5,830	6,804	9,720	9,549	9,783	163.35
Broad and horse beans (green)	6,378	7,146	7,717	7,550	7,256	7,082	8,474	132.86
Asparagus	1,882	4,271	4,482	4,083	3,806	3,884	5,456	289.81
Pumpkins (squash and gourds)	13,994	17,291	18,722	21,406	10,413	6,636	6,588	47.07
Okra	3,403	3,504	3,522	3,873	4,839	4,913	6,129	180.13
Other vegetables (fresh n.e.c.)	11,972	13,509	15,807	15,941	17,458	19,648	16,931	141.43

Source: [6].

Yield

In Türkiye, the average yield of vegetables has increased by 112.20% between the relevant periods, rising from 17,292 kg/ha to 36,694 kg/ha. Compared to the average from 1980-1985, the yield of cucumbers and gherkins has increased by 269.31%, carrots and turnips by 238.31%, asparagus by 189.91%, and eggplants by 147.81% in the years 2016-2021. However, the yield of pumpkins (squash and gourds) has decreased by 52.93%. Tomatoes rank first in terms of yield, with 72,756 kg per hectare, followed by cucumbers and gherkins with 58,420 kg/ha, carrots and turnips with 54,711 kg/ha, and eggplants with 41,184 kg/ha (Table 6).

Türkiye's contribution to world vegetable production

The leading countries in world vegetable production were China, India, USA and Türkiye. While China and India produce vegetables to feed their own populations, the USA and Türkiye produce vegetables both to feed their own populations and to generate export revenues.

Among the world's vegetable production, Türkiye ranks second in the world in three types of vegetables. These vegetables were cucumbers and gherkins, chillies and peppers (green) and leeks and other alliaceous vegetables. It ranks third in two vegetable types (tomatoes and spinach) and fourth in two vegetable types (eggplant and other beans (green)) (Table 7).

Table 7. Türkiye's position in world vegetable production

Vegetables	Türkiye's rank in world vegetable production	Number of countries producing vegetables in the world	Major countries in vegetable production
<i>Vegetables Primary</i>	4	194	<i>China, India, USA, Türkiye, Viet Nam, Nigeria</i>
Tomatoes	3	168	China, India, Türkiye, USA, Italy, Egypt
Onions and shallots (dry)	5	139	India, China, Egypt, USA, Türkiye, Pakistan
Cucumbers and gherkins	2	133	China, Türkiye, Russian, Ukraine, Mexico, Uzbekistan
Cabbages	11	147	China, India, Republic of Korea, Russian, Ukraine, Indonesia
Eggplants	4	93	China, India, Egypt, Türkiye, Indonesia, Iran
Carrots and turnips	14	128	China, Uzbekistan, USA, Russian, Germany, United Kingdom
Chillies and peppers (green)	2	126	China, Türkiye, Indonesia, Mexico, Spain, Egypt
Spinach	3	65	China, USA, Türkiye, Japan, Kenya, Indonesia
Green garlic	27	102	China, India, Bangladesh, Egypt, Spain, Republic of Korea
Lettuce and chicory	8	105	China, USA, India, Spain, Italy, Japan
Cauliflowers and broccoli	7	95	China, India, USA, Spain, Mexico, Italy
Pumpkins (squash and gourds)	6	121	China, Ukraine, Russian, USA, Spain, Türkiye
Other beans (green)	4	104	China, Indonesia, India, Türkiye, France, Thailand
Peas (green)	12	82	China, India, Pakistan, France, USA, Algeria
Okra	16	50	India, Nigeria, Mali, Sudan, Pakistan, Côte d'Ivoire
Asparagus	26	48	China, Peru, Mexico, Germany, Spain, Italy
Onions and shallots (green)	9	46	China, Mali, Japan, Republic of Korea, Tunisia, New Zealand
Leeks and other alliaceous vegetables	2	56	Indonesia, Türkiye, Belgium, France, Republic of Korea, China
Broad and horse beans (green)	13	56	Algeria, Egypt, China, Poland, Tunisia, Mexico
Artichokes	8	29	Italy, Egypt, Spain, Algeria, Peru, China
String beans	5	18	USA, Morocco, Mexico, Philippines, Türkiye, Argentina
Other vegetables (fresh n.e.c.)	33	181	China, India, Viet Nam, Nigeria, Philippines, Nepal

Source: [6].

Türkiye's share in world vegetable production varied between 2.20% and 3.03% in the period. Türkiye's largest share in world vegetable production was leeks and other alliaceous vegetables.

Türkiye accounts for 10.58% of the world production of leeks and other alliaceous vegetables. It was determined that Türkiye's share in the world production of leeks and other alliaceous vegetables followed a

decreasing trend. Other major crops in which Türkiye has a high share in world vegetable production were chillies and peppers (green), tomatoes, string beans, onions and shallots (green), artichokes and pumpkins (squash and gourds).

As a general comment, it was determined that Türkiye's share in the world's primary vegetable production tends to decrease.

Table 8. Ratio of Türkiye's vegetable production to world vegetable production

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021
	Percent (%)						
<i>Vegetables Primary</i>	2.89	3.03	3.01	2.78	2.45	2.20	2.26
Leeks and other alliaceous vegetables	37.73	24.67	19.14	18.67	14.03	10.97	10.58
Chillies and peppers (green)	7.47	7.80	7.46	7.43	6.68	6.64	7.52
Tomatoes	6.63	7.80	8.09	8.23	7.43	6.90	7.01
String beans	5.04	2.62	2.35	2.32	2.79	4.06	5.64
Onions and shallots (green)	6.91	6.82	7.24	6.09	4.38	3.39	2.99
Artichokes	0.68	0.87	1.33	2.09	2.45	2.20	2.62
Pumpkins (squash and gourds)	4.20	3.47	2.61	1.97	1.81	1.73	2.61
Other beans (green)	7.87	7.37	5.77	4.68	3.30	2.92	2.53
Broad and horse beans (green)	5.40	5.99	5.19	3.90	2.98	2.30	2.41
Onions and shallots (dry)	4.33	4.75	5.29	4.23	2.76	2.22	2.20
Cucumbers and gherkins	4.18	5.19	5.26	4.55	3.32	2.47	2.16
Lettuce and chicory	0.85	1.35	1.59	1.76	1.81	1.71	1.87
Eggplants	7.41	6.73	4.64	3.43	2.41	1.71	1.52
Carrots and turnips	0.95	1.22	1.33	1.19	1.68	1.56	1.50
Cauliflowers and broccoli	0.89	0.75	0.63	0.56	0.78	0.87	1.17
Cabbages	1.63	1.71	1.55	1.12	1.05	1.05	1.14
Spinach	3.88	3.69	2.82	2.12	1.42	0.95	0.76
Peas (green)	0.62	0.55	0.49	0.48	0.64	0.60	0.54
Okra	0.86	0.63	0.47	0.53	0.59	0.38	0.32
Green garlic	2.06	1.49	1.23	0.95	0.57	0.45	0.18
Other vegetables (fresh n.e.c.)	0.06	0.06	0.12	0.12	0.11	0.10	0.16
Asparagus	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Source: [6].

Annual rates of increase in vegetable production in Türkiye and the world were analyzed. In Türkiye, the vegetables with the highest annual increase rates were asparagus (135.24%), other vegetables (fresh n.e.c.) (27.34%), lettuce and chicory (16.01%), carrots and turnips (15.26%) and artichokes (11.26%). Broad and horse beans (green), onions and shallots (green), leeks and other

alliaceous vegetables and green garlic had a negative growth in Türkiye's average.

The vegetables with the highest production growth rate in the world were spinach (24.10%), cucumber and gherkins (15.07%) and eggplant (14.92%). In the related period, negative growth was detected only in string beans in the world.

Table 9. Annual rate of increase in vegetable production in the world and Türkiye (%)

Vegetables	Türkiye	World	Vegetables	Türkiye	World
<i>Vegetables Primary</i>	5.01	7.09	Pumpkins (squash and gourds)	2.72	4.73
Asparagus	135.24	13.77	Other beans (green)	1.67	12.08
Other vegetables (fresh n.e.c.)	27.34	6.84	Spinach	1.62	24.10
Lettuce and chicory	16.01	5.23	Okra	1.30	7.88
Carrots and turnips	15.26	7.12	Cabbages	1.22	2.39
Artichokes	11.26	0.41	Eggplants	0.67	14.92
Chillies and peppers (green)	10.31	8.89	String beans	0.41	-0.01
Cauliflowers and broccoli	10.15	7.98	Broad and horse beans (green)	-0.20	2.43
Cucumbers and gherkins	6.62	15.07	Onions and shallots (green)	-0.23	3.26
Tomatoes	6.40	6.17	Leeks and other alliaceous vegetables	-0.69	4.72
Peas (green)	5.67	6.68	Green garlic	-1.25	13.41
Onions and shallots (dry)	3.82	8.95			

Source: Own calculation from FAOSTAT data.

Agricultural gross value and vegetable gross value

Supply and demand elasticity of agricultural products were low. Vegetable prices decrease during periods of increased production, especially since fresh vegetables have short storage periods and were perishable [8]. This situation causes vegetable prices to fluctuate

over the years. The gross production value obtained from agriculture and vegetables was also affected by these price fluctuations.

In 2020, the total gross value of global agricultural production was approximately 3.98 trillion dollars. In Türkiye, this value was 69.6 billion dollars, which corresponds to a share of 1.75% in the world. This rate

fluctuates between 1.54% and 1.93% over the years examined, indicating a volatile structure.

The gross value of world vegetable production in 2020 was approximately 482 billion dollars. In Türkiye, this value was 1.19 billion dollars, which corresponds to a share of 2.47% in the world. This rate has been decreasing over the years, ranging from 2.38% to 3.71% (Fig. 2).

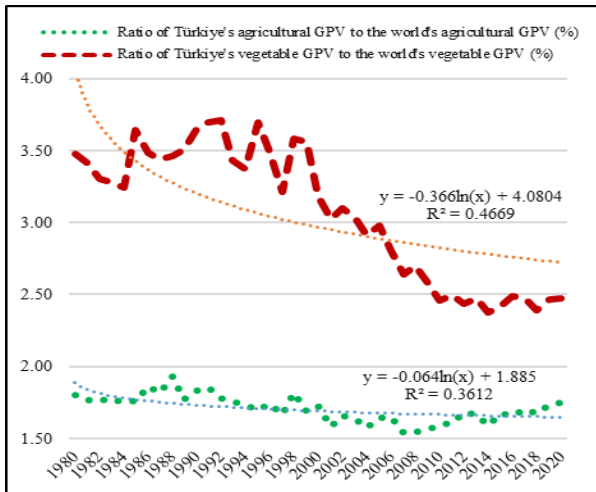


Fig. 2. Ratio of Türkiye's agricultural and vegetable GPV to world's agriculture and vegetable GPV
 Source: Own calculation from FAOSTAT data.

The share of gross value of vegetable production in the total world agricultural production value varies between 6.59% and 12.22%. This rate has been increasing globally and was realized as 12.12% in 2020.

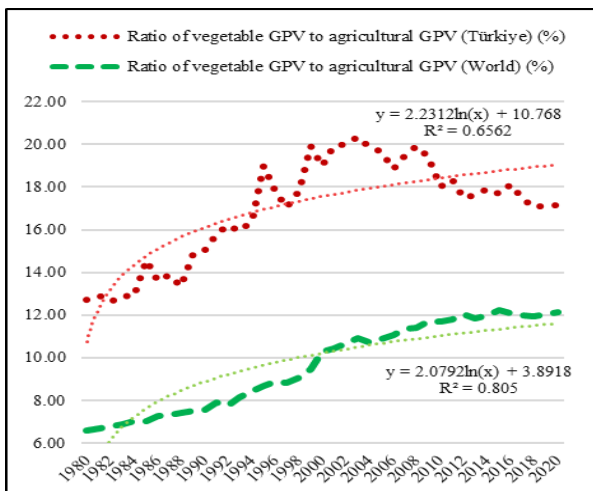


Fig. 3. Ratio of vegetable GPV to agricultural GPV
 Source: Own calculation from FAOSTAT data.

In Türkiye, this rate varies between 12.62% and 20.34%. There was an increasing trend between 1980 and 1995, a fluctuating trend between 1996 and 2008, and a decreasing trend since 2009 (Fig. 3).

CONCLUSIONS

Türkiye holds a prominent position globally in terms of vegetable production. Especially the Mediterranean and Aegean regions are the most suitable areas for vegetable cultivation. Türkiye is among the leading countries in the production of various vegetables such as tomatoes, peppers, eggplants, cucumbers, beans, lettuce, cabbage, zucchini, leeks, spinach, onions and garlic.

Overall, Türkiye's yield was above the world average for the main vegetable types examined. However, for five vegetable types (spinach, green garlic, onions and shallots (green), pumpkins (squash and gourds), and other beans (green)), the average yield was below the world average.

To increase both producer income and productivity, the following recommendations can be made:

Conduct further research on the growing conditions and cultivation techniques for the five vegetables with lower than average yields, to determine ways to improve their productivity.

Introduce new and more efficient production methods, such as the use of high-yield seed varieties, improved irrigation systems, and modern agricultural technologies, to increase overall productivity.

Provide training and education to farmers on new and improved production methods, as well as on the latest market trends and demands, to help them make informed decisions and improve their competitiveness.

Encourage the use of environmentally friendly practices and sustainable farming techniques, such as crop rotation and the use of organic fertilizers, to reduce input costs and improve soil health, which can lead to higher yields and improved quality.

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