

COUNTRY DOSSIER

Türkiye

Irrigation water, climate, fertilisers and crops: National study and a study of each region, potential benefits of our products, external trade

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Olive grove and cultivated fields near Karaisalı, Adana province.

Foreword

This dossier describes Türkiye from the angle of irrigation water, climate, fertilisers and crops. It is written for the ministries in charge of agriculture, water and trade, the provincial directorates of agriculture, cooperatives and large farms. It answers three questions: Where is water used, for which crops, and in which regions? It then examines what our products can change, and what that can mean for the country's external trade.

Reading the sources. Every figure refers to a source, named in the text and detailed in Annex A. Each source carries a confidence level:

> **How to read this document**
>
> • **A**: Official statistics or international database (World Bank, FAO, Turkish administration).
>
> • **B**: Research institute, laboratory, United Nations agency or recognised climate model.
>
> • **C**: Manufacturer statement, website, press or estimate.
>
> • "bn" means billion; "M" means million; "Mm³" means million cubic metres; "t" means tonnes; "I$" means constant 2014-2016 international dollars.
>
> • A "scenario" is a calculation based on the trials cited. It is not a measurement made across Türkiye.

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Summary

The points below summarise the dossier. The figures come from public sources: The World Bank, FAO (FAOSTAT), the General Directorate of State Hydraulic Works (DSİ), PVGIS and ERA5. The water savings are scenarios, described in Annex B.

85.9 M Inhabitants in 2025 (World Bank)	**4.91 M ha** Actually irrigated in 2024 (FAOSTAT)	**56.0 km³** Of water withdrawn by agriculture (2022)
8.63 Md m³ Bn m³ of water saved per year, central scenario	**756 000 ha** Extra irrigable hectares with the same water	**30.7 Md$** Bn$ of agricultural exports in 2024 (FAOSTAT)

Eight key points

• **Wheat dominates the land.** 6.93 million hectares harvested in 2024, for 20.8 million tonnes, almost always without irrigation.

• **Agriculture withdraws most of the water.** 56.0 km³ a year out of 64.5 km³ total withdrawals (87%, 2022).

• **Irrigation is expanding.** 4.91 million hectares actually irrigated in 2024, out of 7.20 million equipped; DSİ puts the economically irrigable area at 8.5 million hectares.

• **A very contrasted climate.** From 299 mm of rain a year at Konya to 861 mm at Bursa; at Şanlıurfa, the air demands 1,181 mm more than it rains.

• **The central scenario saves 8.63 billion m³ a year**, or 15.4% of agricultural withdrawals, as if about 756 000 extra hectares could be irrigated.

• **Maize has its trial in Türkiye itself.** At the TIGEM state farm in Konya, EVERGREEN® cut irrigation by 38.9% and raised yield by 17.1% (2025). Maize accounts for 20% of the central saving.

• **The climate is warming.** At Konya, mean annual temperature has risen by 0.50 °C per decade since 1981.

• **A major exporting country.** $30.7 billion of agricultural exports in 2024, against $23.1 billion of imports; shelled hazelnuts come first ($1,503 million).

Key figures

Key indicators for Türkiye

Indicator	Value	Year	Source (level)
Population	85.9 M	2025	World Bank (A1)
GDP per capita	18,599 $	2025	World Bank (A1)
Agriculture share of GDP	5.2%	2025	World Bank (A1)
Area actually irrigated	4,914,000 ha	2024	FAOSTAT (A6)
Area equipped for irrigation	7,204,000 ha	2024	FAOSTAT (A6)
Water withdrawals, agriculture	56.0 km³	2022	World Bank (A1)
Water saved, central scenario	8,626 Mm³	—	Calculation (Annex B)
Wheat harvested	6.93 M ha	2024	FAOSTAT (A2)
Agricultural exports	30,666 M$	2024	FAOSTAT (A4)
Agricultural imports	23,059 M$	2024	FAOSTAT (A4)

Indicator	Value	Year	Source (level)
Mineral nitrogen, agricultural use	1,916,971 t	2024	FAOSTAT (A5)

Source: Table based on the sources indicated; author's calculation for the scenarios.

1. Green Solutions and our products

Green Solutions develops products for water, fertilisation and crop protection. Four families are of interest to this dossier. The yields cited are those published by the manufacturer or by the trials, with their confidence level.

Products covered by this dossier

Product	Claimed use	Published evidence (level)
EVERGREEN® (water-retention polymer)	Holds rain or irrigation water as a gel, near the roots.	Trials on maize (Türkiye), potato, watermelon, date palm and soybean. Level B to C.
ECOSORB® (water-retention polymer based on corn starch)	Same use; action lasting 2 to 3 years according to the website.	Soybean trial (China); laboratory acrylamide analysis. Level B to C.
ECOFERT® (fertiliser)	Fertiliser certified by SOHISCERT and EU Bio.	Published certificate; potato trial combined with EVERGREEN®. Level A (certificate), C (results).
Paulownia ALTIFOLIA®	Fast-growing tree for agroforestry.	Website figures; no trial in Türkiye. Level C.
Water Vital®, NAPEMA®	Outside the scope of this dossier.	No independent source in the documents consulted.

Source: Green Solutions website (product sheets and published trials), Annex A.

The indicative dose published on the website is 30 to 75 kg/ha.



Irrigated groundnut fields in the Harran plain (Şanlıurfa).

2. Türkiye in figures

Türkiye had 85.9 million inhabitants in 2025. Agriculture accounts for 5.2% of gross domestic product and employs 14% of the labour force. The country covers 770 000 km², of which 50% is agricultural land.

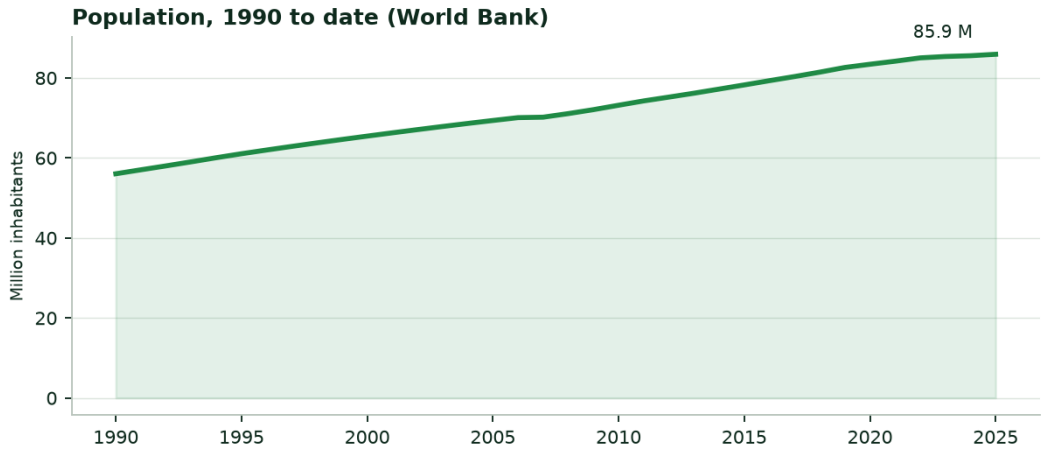


Figure 1. Population of Türkiye, 1990 to date. Source: World Bank (A1)

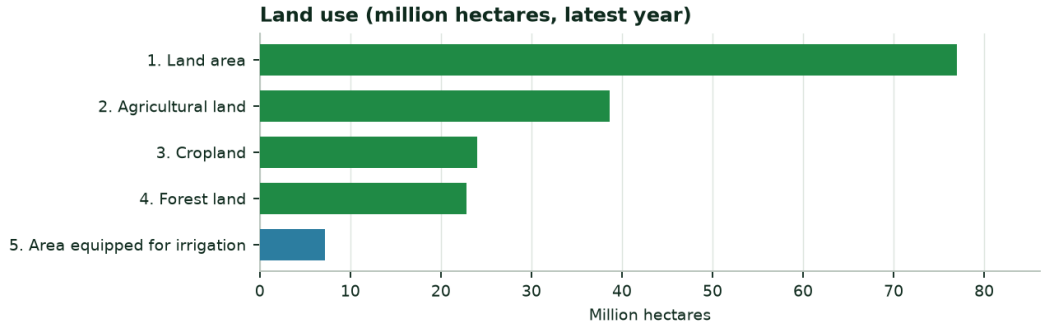


Figure 2. Land use, latest year published. Source: FAOSTAT (A6)

Agricultural and water indicators, latest year published

Indicator	Value	Year	Source
Cropland certified organic	173 000 ha	2024	FAOSTAT (A6)
Cropland under protective cover	78 000 ha	2024	FAOSTAT (A6)
Average cereal yield	3,429 kg/ha	2024	World Bank (A1)
Fertiliser use per hectare of arable land	139 kg/ha	2024	World Bank (A1)
Water withdrawals, agricultural share	86.9%	2022	World Bank (A1)
Internal freshwater resources	227 km³	2022	World Bank (A1)
Internal resources per inhabitant	2,671 m³	2022	World Bank (A1)



Wheat field at Ceyhan, in the Çukurova plain (Adana).

3. Sunshine, rainfall and climate change

3.1 Sunshine

Global solar radiation reaches 1,353 to 1,859 kWh/m² a year depending on the region. It is highest in the Southeast and on the Mediterranean coast: Where the sun is most generous, water is most short.

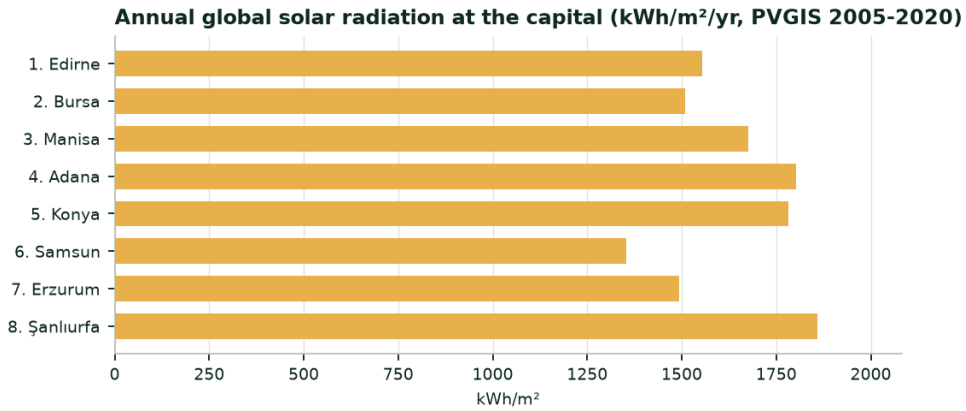


Figure 3. Annual global solar radiation at each region's reference city. Source: PVGIS (A8)

3.2 Rainfall and evapotranspiration

Rainfall varies strongly from one region to another. At Bursa, average annual rainfall is 861 mm; at Konya, on the central plateau, it is only 299 mm, while reference evapotranspiration there reaches 1,328 mm a year. The largest deficit is at Şanlıurfa: 1,181 mm a year.

Mean monthly rainfall, 1991-2020 (mm per month)

Month	Edirne	Bursa	Manisa	Adana	Konya	Samsun	Erzurum	Şanlıurfa
January	54	95	106	110	39	81	37	84
February	48	89	101	83	30	72	42	73

Month	Edirne	Bursa	Manisa	Adana	Konya	Samsun	Erzurum	Şanlıurfa
March	56	95	82	76	34	89	65	64
April	44	81	62	64	35	78	85	51
May	48	70	42	56	36	77	106	35
June	39	55	17	19	23	60	66	6
July	31	26	4	7	4	37	44	1
August	15	26	4	6	4	35	32	1
September	28	57	22	20	7	67	24	5
October	60	83	60	49	18	91	45	38
November	56	79	91	83	29	81	40	56
December	62	104	105	144	40	90	38	77

Source: ERA5 via Open-Meteo (A9); author's calculation.

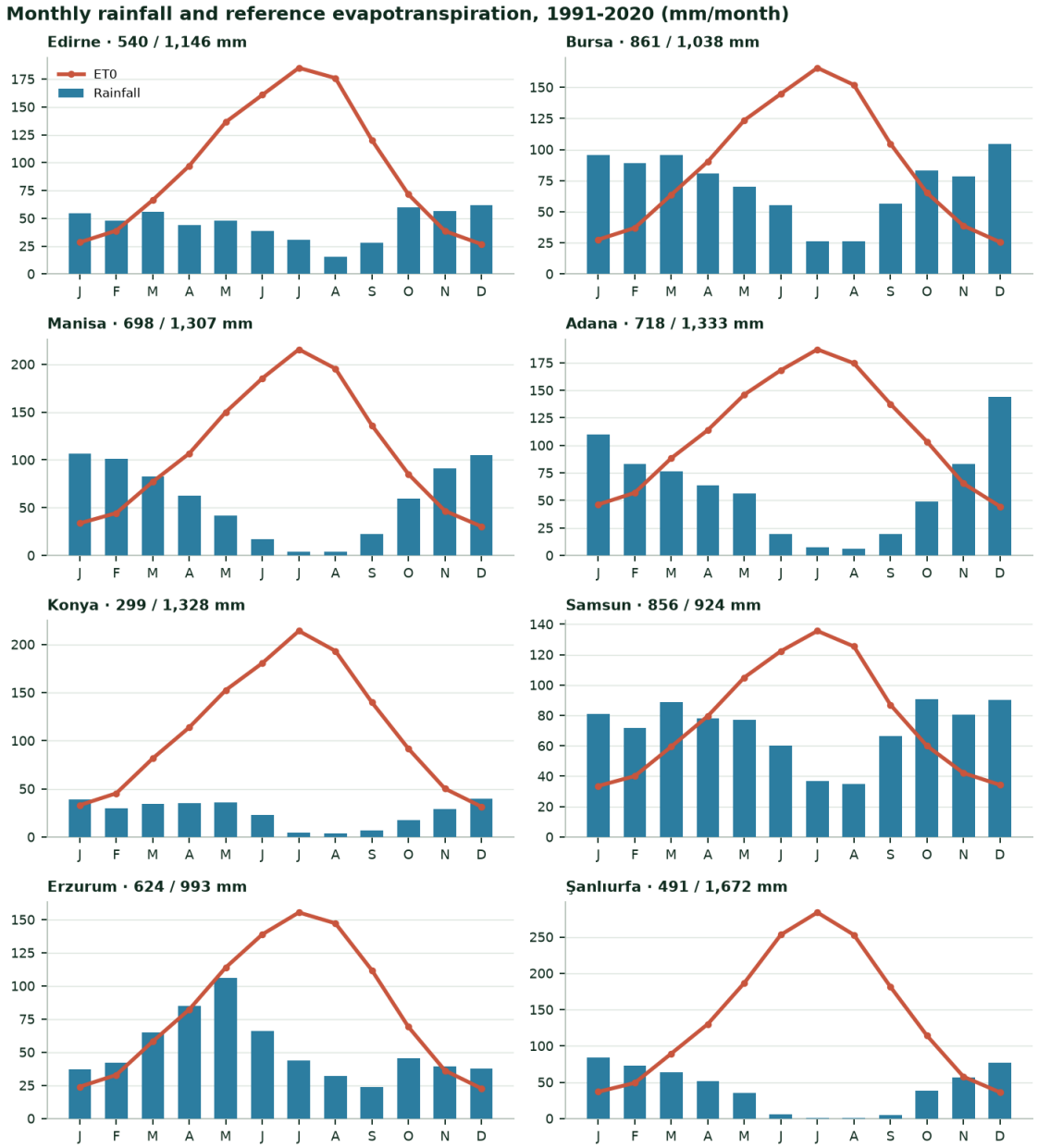


Figure 4. Monthly rainfall and reference evapotranspiration by region, 1991-2020. Source: ERA5 via Open-Meteo (A9)

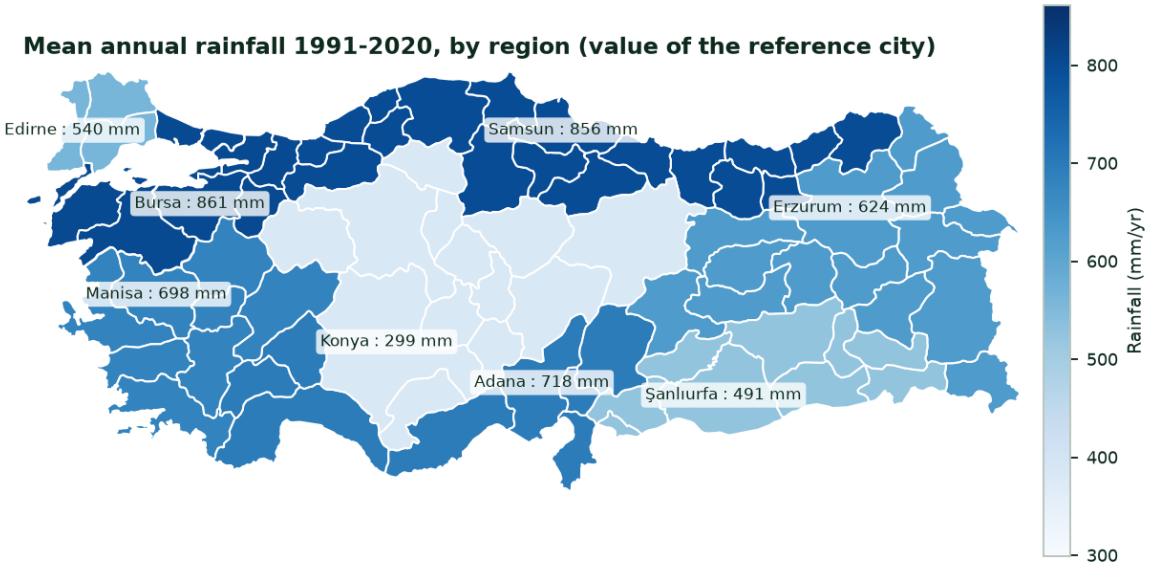


Figure 5. Mean annual rainfall 1991-2020: Each region takes the value of its reference city. Source: ERA5 (A9); Natural Earth (A10)

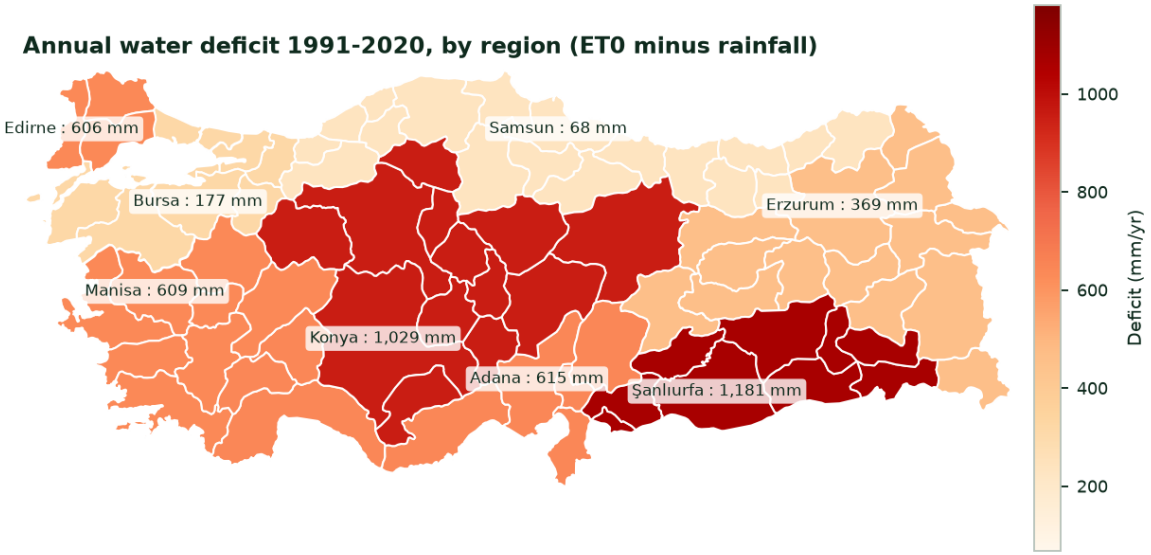


Figure 6. Annual water deficit (reference evapotranspiration minus rainfall), by region. Source: ERA5 (A9); Natural Earth (A10)

3.3 Climate change

Mean annual temperature is rising. At Konya it went from 12.0 °C in 1981 to 14.1 °C in 2024, a trend of 0.50 °C per decade. At Şanlıurfa the trend is 0.51 °C per decade, from 17.7 °C to 19.2 °C. Warmer air demands more water from crops.

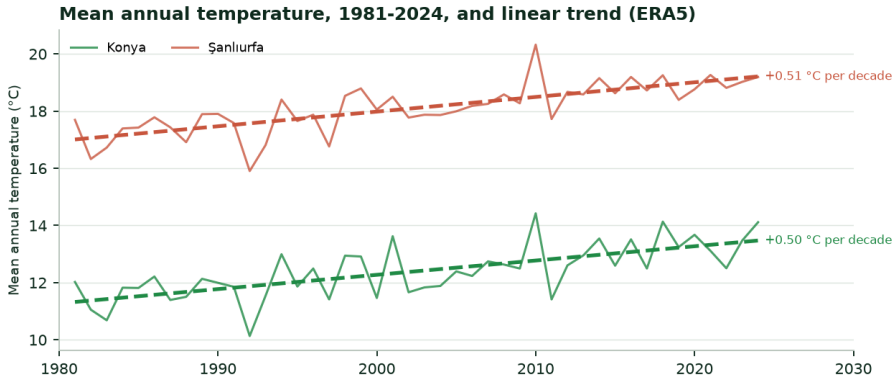


Figure 7. Mean annual temperature, 1981-2024, and linear trend. Source: ERA5 (A9)



Wheat fields in the Saimbeyli mountains (Adana).

4. Irrigation water: Resources, areas, withdrawals

4.1 Resources and withdrawals

Total freshwater withdrawals reach 64.5 km³ a year (2022). Agriculture withdraws 86.9% of it, that is 56.0 km³. Internal water resources amount to 227 km³ a year, or 2,671 m³ per inhabitant. Water stress, the ratio of withdrawals to available resources, reaches 47.9%. According to DSİ, irrigation uses 44 billion m³ a year, or 77% of the water consumed (A11).

Freshwater: Withdrawals and resources

Indicator	Value	Year	Source
Total withdrawals	64.47 km³	2022	World Bank (A1)
Agricultural share	86.9%	2022	World Bank (A1)
Agricultural withdrawals	56.04 km³	2022	Calculated from A1
Area actually irrigated	4,914,000 ha	2024	FAOSTAT (A6)
Agricultural withdrawals per irrigated hectare	11,404 m³/ha	—	Calculation (Annex B)
Water stress	47.9%	2022	World Bank (A1)

4.2 Irrigated areas

FAOSTAT counts 7,204,000 hectares equipped for irrigation in 2024, of which 4,914,000 are actually irrigated. DSİ gives 8.5 million hectares technically and economically irrigable, 7.1 million hectares opened to irrigation at the end of 2023 and a target of 7.52 million by the end of 2026 (A11). The main irrigated crops are maize, cotton, sugar beet, vegetables and melons, potato, orchards and vineyards, and rice.



Irrigation canal in the Harran plain, between Şanlıurfa and Altınbaşak.

4.3 What the water saving represents

In the central scenario, the saving is 8,626 million m³ a year, or 15.4% of agricultural withdrawals. At 11,404 m³ per irrigated hectare, this water would irrigate about 756 000 more hectares, without withdrawing one extra cubic metre.

5. Fertilisers: Quantities, purchases, spending

5.1 Quantities used

In 2024, agricultural use reaches 1,916,971 tonnes of nitrogen, 732,812 tonnes of phosphate (P2O5) and 156,669 tonnes of potash (K2O). In the same year, the country produced 1,065,677 tonnes of nitrogen and imported 1,551,108 tonnes.

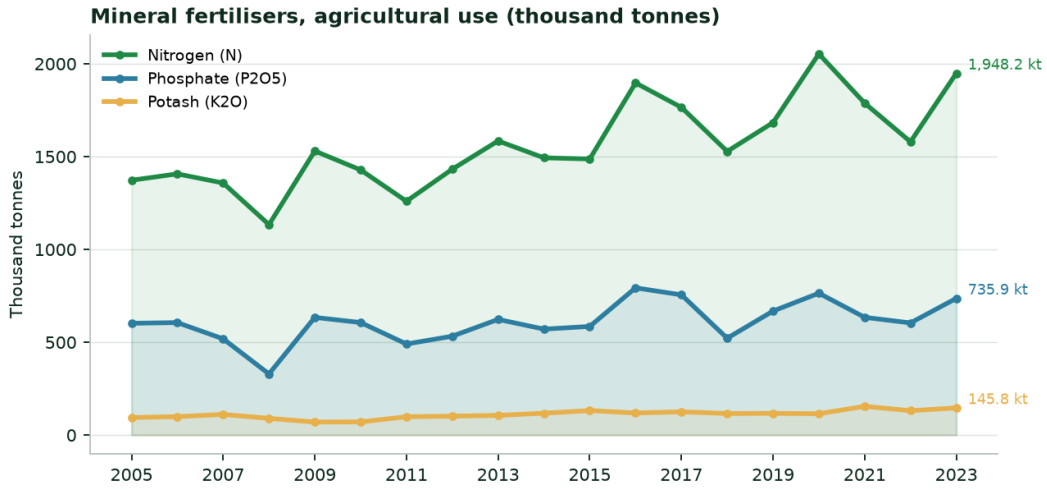


Figure 8. Mineral fertilisers, agricultural use, 2005-2023. Source: FAOSTAT (A5)

5.2 Regulatory framework

Mineral and organic fertilisers and soil conditioners ("toprak düzenleyici") fall under the Ministry of Agriculture and Forestry. The General Directorate of Plant Production (BÜGEM) issues import permits and registration certificates; for an imported product it requires, among other things, an analysis by the Turkish Standards Institution (TSE) and a label sample (A13).



Wheat ears at Karataş (Adana).

5.3 Indicative spending

In 2024, the indicative minimum spending on mineral fertilisers reaches $2,243 million, at international fertiliser prices (calculation in Annex B, lower bound). It peaked at $3,531 million in 2022, when world prices soared.

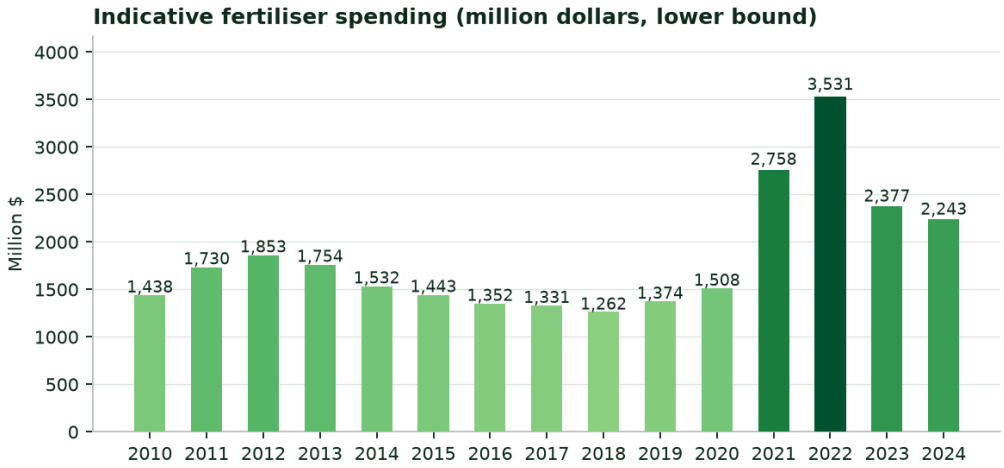


Figure 9. Indicative fertiliser spending, lower bound. Source: Author's calculation from A5 and A7

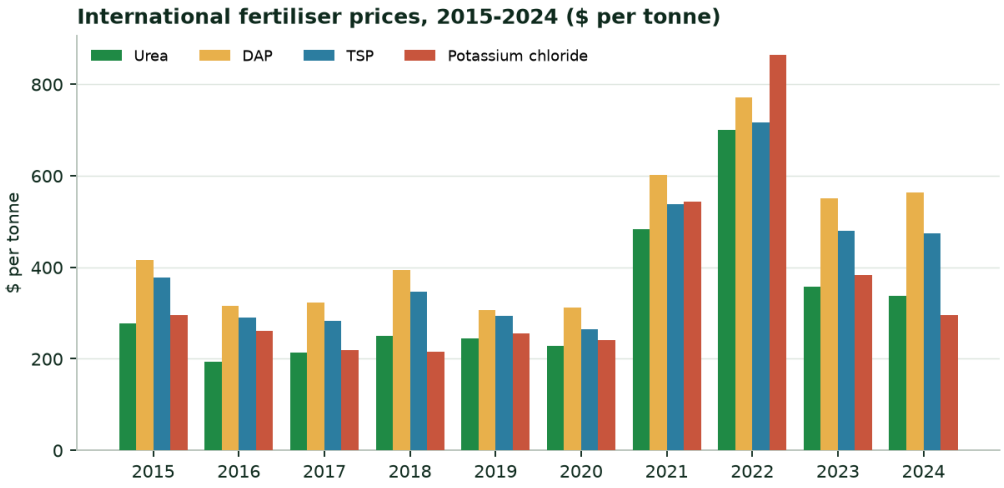


Figure 10. International prices of urea, DAP, TSP and potassium chloride. Source: World Bank, Pink Sheet (A7)

6. The regions at a glance

The table compares the country's seven geographical regions, plus Thrace, using a reference city for each. Climate figures are 1991-2020 averages, except radiation (2005-2020).

Climate of the reference cities, 1991-2020 means

Region (city)	Rainfall (mm/yr)	ET0 (mm/yr)	Deficit (mm/yr)	Radiation (kWh/m²/yr)	Temperature (°C)
Thrace (Edirne)	540	1,146	606	1,555	14.1
Marmara (Bursa)	861	1,038	177	1,509	15.0
Aegean (Manisa)	698	1,307	609	1,676	16.9
Mediterranean (Adana)	718	1,333	615	1,802	18.4
Central Anatolia (Konya)	299	1,328	1,029	1,782	12.5
Black Sea (Samsun)	856	924	68	1,353	13.8
Eastern Anatolia (Erzurum)	624	993	369	1,493	5.8
Southeastern Anatolia (Şanlıurfa)	491	1,672	1,181	1,859	18.2

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

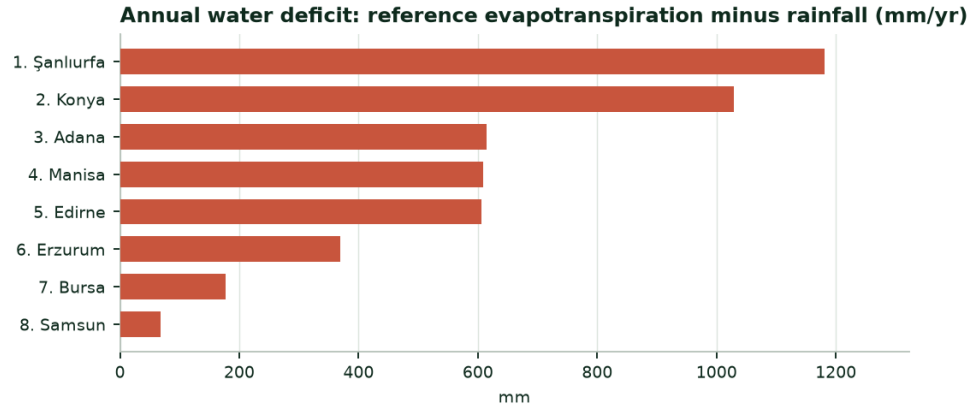


Figure 11. Annual water deficit: Reference evapotranspiration minus rainfall. Source: ERA5 (A9)



Cappadocia from the air, near Göreme: Orchards and vines at the foot of the fairy chimneys.

7. The twenty main crops: Three rankings

7.1 By harvested area

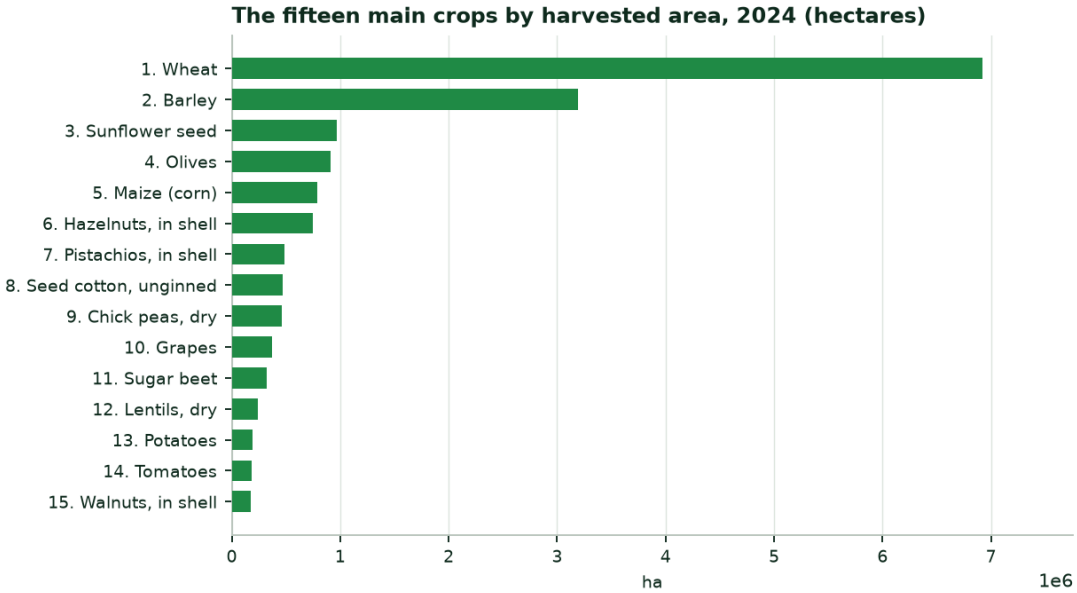


Figure 12. The fifteen main crops by harvested area, 2024 (hectares). Source: FAOSTAT (A2)

The ten main crops by area, 2024

Crop	Harvested area (ha)	Production (t)	Yield (t/ha)
Wheat	6,925,108	20,800,000	3.00
Barley	3,193,649	8,100,000	2.54
Sunflower seed	971,032	2,195,000	2.26
Olives	913,319	3,750,000	4.11
Maize (corn)	789,379	8,100,000	10.26

Crop	Harvested area (ha)	Production (t)	Yield (t/ha)
Hazelnuts, in shell	749,769	717,000	0.96
Pistachios, in shell	484,529	383,000	0.79
Seed cotton, unginned	466,927	2,243,000	4.80
Chick peas, dry	459,430	575,000	1.25
Grapes	372,285	3,468,000	9.32

Source: FAOSTAT (A2).

7.2 By production

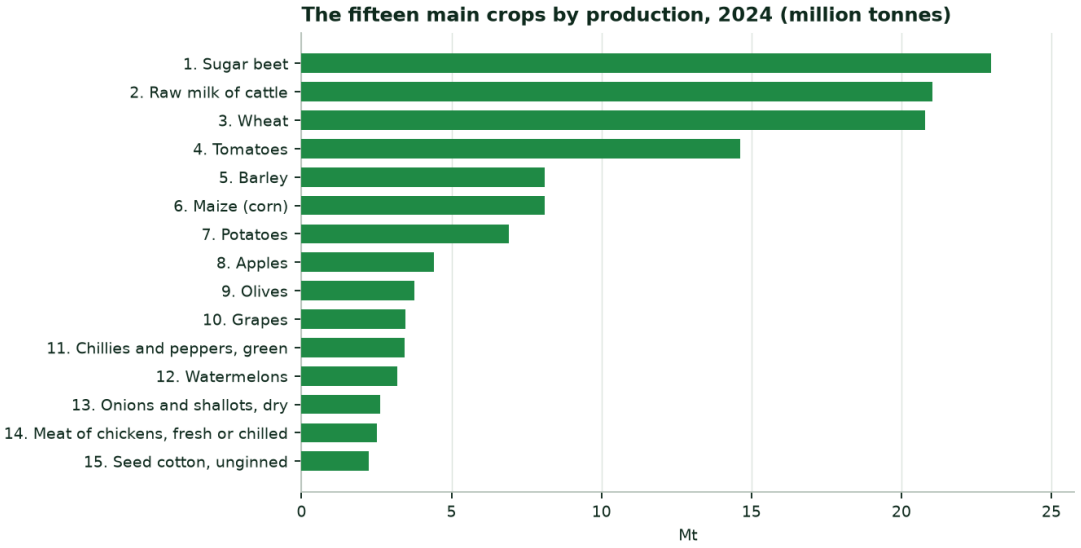


Figure 13. The fifteen main crops by production, 2024 (million tonnes). Source: FAOSTAT (A2)

7.3 By production value

Tomato is the first crop by value, ahead of wheat: An irrigated, high-yield crop weighs more than the cereal that covers twenty times the area.

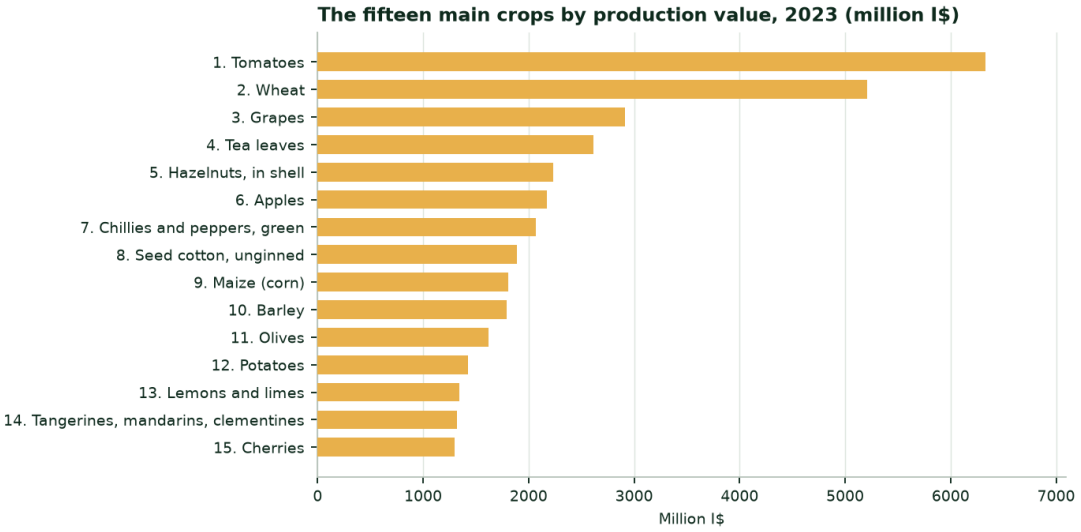


Figure 14. The fifteen main crops by production value, 2023 (million I$). Source: FAOSTAT (A3)



Cotton field near Belek (Antalya).

8. Extrapolation by crop and water savings

8.1 Method

Method in brief

• National agricultural water is shared per irrigated hectare: 11,404 m³ per hectare. Each irrigable crop receives the water of its harvested area.

• The part of the irrigated area not covered by these crops (irrigated wheat, sunflower, fodder, olives…) forms an "other irrigated crops" group.

• Each group receives the effect of the trial cited for its crop: A quarter (cautious), half (central), all of it (high).

• Without a trial, the generic assumption is 5, 10 and 20% of water saved, with no yield gain.

8.2 Trials used as analogues

The maize trial was conducted in Türkiye, at the TIGEM state farm in Konya, in 2025: 528 mm of irrigation instead of 864 mm, and 12,060 kg/ha against 10,300 kg/ha on the control plot (A18).

Trials cited and their use in the calculation

Trial	Crop	Water	Yield	Use in the calculation
Maize, Türkiye (TIGEM, Konya, 2025)	Maize	−38.9%	+17.1%	Grain maize
Watermelon, Mexico (2023)	Watermelon	−60.5%	+30%	Vegetables and melons
Potato, South Africa (2025)	Potato	−52%	+31.4%	Potato and onion
Soybean, China	Soybean	Assumption	+11.3%	Soybean (irrigated second crop)
Date palm, UAE (ICBA, 2021)	Palm	−82%	+20%	Not used (no date palm); cited for reference

Source: A14 to A18 (published trials and manufacturer's website, levels B and C).

8.3 Parameters by crop group

Irrigated area assigned, trial used and water saved (central scenario)

Crop group	Irrigated area (ha)	Share	Trial or assumption	Water saved (Mm³/yr)
Grain maize	789,379	16.1%	Maize, Türkiye (TIGEM, Konya, 2025)	1,755
Cotton	466,927	9.5%	Generic assumption, no trial	533
Sugar beet	324,286	6.6%	Generic assumption, no trial	370
Rice (paddy)	128,904	2.6%	Generic assumption, no trial	147
Potato and onion	261,437	5.3%	Potato, South Africa (2025)	775
Vegetables and melons	731,538	14.9%	Watermelon, Mexico (2023)	2,524
Soybean	43,712	0.9%	Water: Generic assumption; yield: Soybean, China	50
Orchards and vineyards (apple, apricot, citrus, cherry, grape…)	1,140,917	23.2%	Generic assumption, no trial	1,301
Other irrigated crops (wheat, sunflower, fodder, olives…)	1,026,900	20.9%	Generic assumption, no trial	1,171

Source: Author's calculation (Annex B).

8.4 National results

8,626 Mm³
Of water saved per year (central, 15.4% of agricultural withdrawals)

756 000 ha
Extra irrigable hectares with this water

6.82 Mt
Of extra production, for the crops with a trial

2.58 Md I$
Bn I$ of extra production value (2014-2016)

Water saved, extra irrigable hectares and production gain, by scenario

Scenario	Water (Mm³/yr)	Extra hectares	Production (t/yr)	Value (M I$/yr)
Cautious	4,313	378,179	3,409,281	1,291
Central	8,626	756,357	6,818,562	2,583
High	17,252	1,512,715	13,637,124	5,165

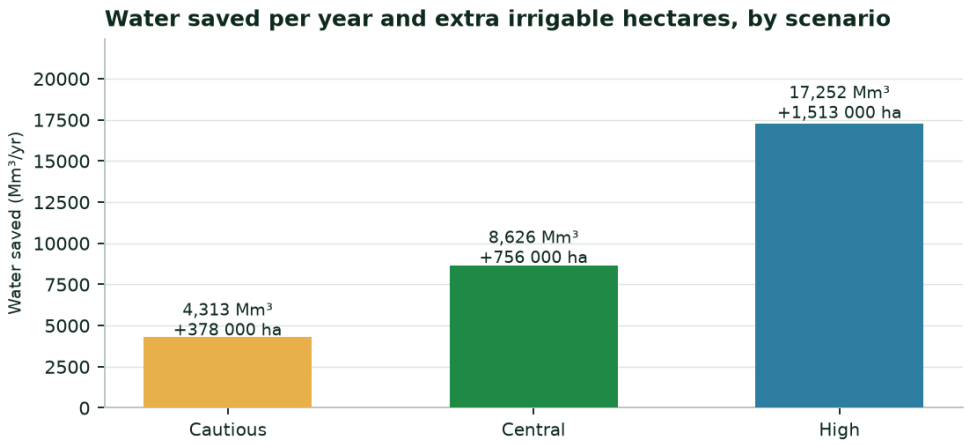


Figure 15. Water saved per year and extra irrigable hectares, by scenario. Source: Author's calculation

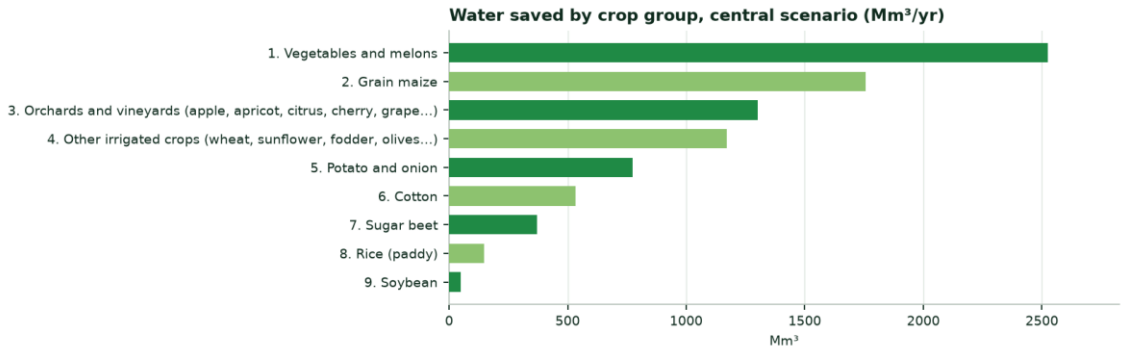


Figure 16. Water saved by crop group, central scenario. Source: Author's calculation

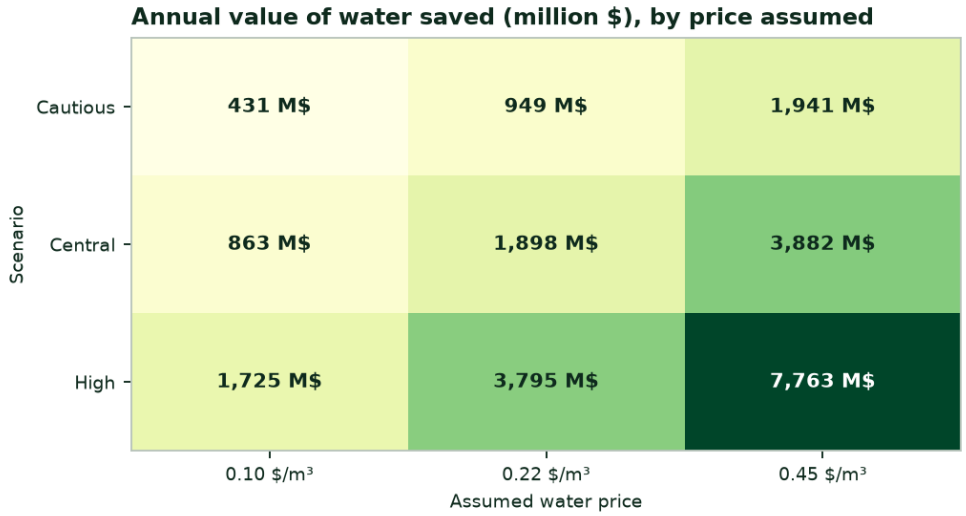


Figure 17. Annual value of the water saved, by price assumed per cubic metre. Source: Author's calculation; prices assumed, no national tariff

8.5 Reading the results

Key points

• Maize, roots and vegetables give 59% of the central saving, based on published trials, one of them conducted in Türkiye.

• Cotton, sugar beet, rice, orchards and other irrigated crops rest on the generic assumption (10% in the central scenario).

• The production gain, 6.82 million tonnes in the central scenario, concerns only crops where a trial is cited; vegetables make up most of it, because their yields per hectare are high.

9. Potential benefits of our products

The table lists what the products may bring according to the documents available, with their confidence level and their limit.

Potential benefits, by situation

Benefit	Published figures	Source (level)	Limit
Irrigation water saving	Maize −38.9% (Konya); date palm −82%; watermelon −60.5%; potato −52%	A14 to A18 (B, C)	One trial per crop; only one in Türkiye

Benefit	Published figures	Source (level)	Limit
Yield	Maize +17.1%; potato +31.4%; watermelon +30%; date palm +20%; soybean +11.2 to +11.4%	A14 to A18 (B, C)	One or two trials per crop; controls sometimes different
Safety: Acrylamide (ECOSORB®)	Below 3.0 µg/g	A19 (B)	One laboratory, one date
REACH compliance (EVERGREEN®)	≤ 0.1% of substances of very high concern in 233 substances tested	A20 (B)	Screening, not an approval
Certification (ECOFERT®)	Certified by SOHISCERT and EU Bio	A21 (A)	Valid for the certified product
Agroforestry (Paulownia ALTIFOLIA®)	13 to 15 m in 6 to 8 years (website)	A22 (C)	No trial in Türkiye

Source: Annex A.



The Euphrates in Türkiye: Its dams feed irrigation in the Southeast.

10. External trade: Exports, imports, importing

10.1 Overview, 2023 and 2024

Agricultural products and total merchandise trade (million $)

Indicator	2023	2024
Agricultural exports (crops and livestock)	29,502	30,666
Agricultural imports (crops and livestock)	25,413	23,059
Exports, all merchandise	255,777	261,855
Imports, all merchandise	361,774	344,020

Source: FAOSTAT (A4).

10.2 Exports

Shelled hazelnuts are the first farm product exported ($1,503 million in 2024), ahead of crude sunflower oil ($1,275 million) and wheat flour ($1,208 million). The country mostly exports processed goods: Oils, flour, pasta, confectionery, raisins.

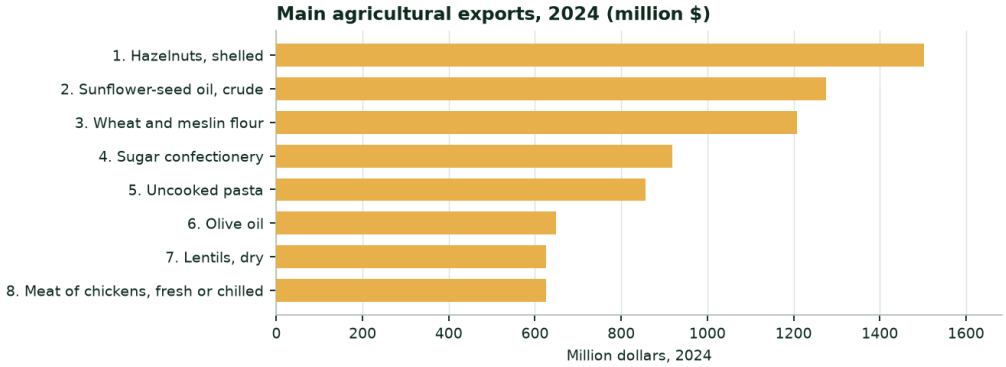


Figure 18. Main agricultural exports, 2024. Source: FAOSTAT (A4)

10.3 Imports

The country imports raw materials for its industry: Soybeans ($1,766 million), cotton lint ($1,525 million), wheat, crude sunflower oil and maize. Part of it is processed and re-exported.

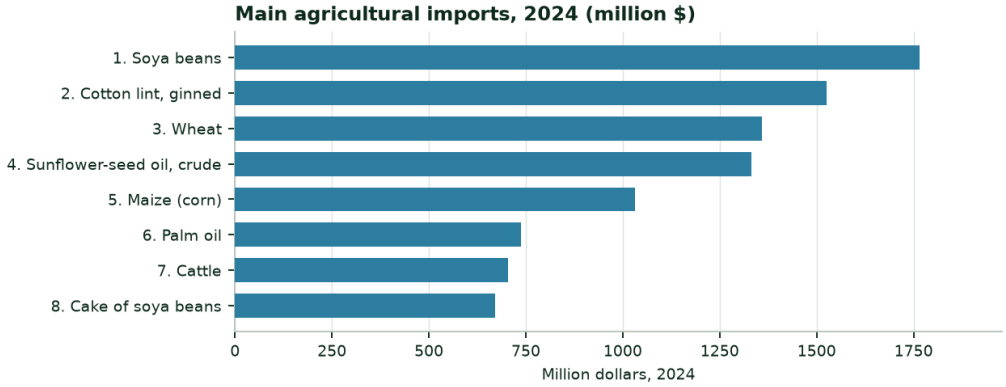


Figure 19. Main agricultural imports, 2024. Source: FAOSTAT (A4)



Figure 20. "Tombul" hazelnuts at Espiye (Giresun).



Freshly harvested artichokes at Urla (İzmir).

10.4 Importing water-retention polymers into Türkiye

What to know

• **Customs duty (code 3906.90.90, acrylic polymers in primary forms):** 0% for goods originating in the European Union and EFTA, Switzerland included; 6.5% under the general tariff (A12).

• **Why 0%:** Türkiye forms a customs union with the European Union for industrial goods and has a free trade agreement with EFTA; a proof of origin is required.

• **VAT (KDV):** General rate of 20% since 10 July 2023 (A12).

• **Registration:** A soil conditioner or fertiliser must obtain an import permit and a registration certificate from BÜGEM before being placed on the market (A13).

• **Classification:** Code 3906.90.90 and the "toprak düzenleyici" category are inferences for our products; customs and the ministry settle it.

11. A study of each region

Each region is described through the city that represents it. The figures describe the climate; the water deficit (evapotranspiration minus rainfall) shows where water is most short. The description of crops is qualitative.



Tea gardens on the slopes of Rize, on the Black Sea coast.

Thrace (Edirne)

Meriç and Ergene plains: Wheat, sunflower and irrigated rice.

Indicator	Value
Annual rainfall, 1991-2020	540 mm
Reference evapotranspiration	1,146 mm
Annual water deficit	606 mm

Indicator	Value
Global solar radiation	1,555 kWh/m²
Mean temperature	14.1 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Marmara (Bursa)

Fertile plains around Bursa and Balıkesir: Processing vegetables, fruit, maize and olives.

Indicator	Value
Annual rainfall, 1991-2020	861 mm
Reference evapotranspiration	1,038 mm
Annual water deficit	177 mm
Global solar radiation	1,509 kWh/m²
Mean temperature	15.0 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Aegean (Manisa)

Gediz and Büyük Menderes valleys: Vines and raisins, cotton, olives, figs and market gardening.

Indicator	Value
Annual rainfall, 1991-2020	698 mm
Reference evapotranspiration	1,307 mm
Annual water deficit	609 mm
Global solar radiation	1,676 kWh/m²
Mean temperature	16.9 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Mediterranean (Adana)

Çukurova plain: Maize, cotton, citrus, vegetables and soybean as a second crop; greenhouses on the Antalya coast.

Indicator	Value
Annual rainfall, 1991-2020	718 mm
Reference evapotranspiration	1,333 mm
Annual water deficit	615 mm
Global solar radiation	1,802 kWh/m²
Mean temperature	18.4 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Central Anatolia (Konya)

Large cereal plateau: Rainfed wheat and barley, irrigated sugar beet and maize on heavily used aquifers. The TIGEM maize trial was conducted there.

Indicator	Value
Annual rainfall, 1991-2020	299 mm
Reference evapotranspiration	1,328 mm
Annual water deficit	1,029 mm
Global solar radiation	1,782 kWh/m²

Indicator	Value
Mean temperature	12.5 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Black Sea (Samsun)

Bafra and Çarşamba deltas: Rice, maize and vegetables; hazelnut and tea on the slopes further east.

Indicator	Value
Annual rainfall, 1991-2020	856 mm
Reference evapotranspiration	924 mm
Annual water deficit	68 mm
Global solar radiation	1,353 kWh/m²
Mean temperature	13.8 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Eastern Anatolia (Erzurum)

Cold high plateaus: Livestock, grassland, fodder and cereals, over a short growing season.

Indicator	Value
Annual rainfall, 1991-2020	624 mm
Reference evapotranspiration	993 mm
Annual water deficit	369 mm
Global solar radiation	1,493 kWh/m²
Mean temperature	5.8 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Southeastern Anatolia (Şanlıurfa)

Harran plain, irrigated by the GAP project from the Euphrates: Cotton, maize, wheat, groundnut and pistachio.

Indicator	Value
Annual rainfall, 1991-2020	491 mm
Reference evapotranspiration	1,672 mm
Annual water deficit	1,181 mm
Global solar radiation	1,859 kWh/m²
Mean temperature	18.2 °C

Source: ERA5 via Open-Meteo (A9); PVGIS (A8); author's calculation.

Annex A. Sources and confidence levels

Ref.	Source	Level
A1	World Bank, World Development Indicators (WDI), Türkiye	A
A2	FAOSTAT, crops and livestock (QCL), areas, production, 2014-2024	A
A3	FAOSTAT, value of production (QV), constant 2014-2016 I$, 2019-2024	A
A4	FAOSTAT, trade in crops and livestock products, 2018-2024	A
A5	FAOSTAT, mineral fertilisers, agricultural use, production and imports, 2005-2023	A

Ref.	Source	Level
A6	FAOSTAT, land use, areas equipped and actually irrigated, 2000-2025	A
A7	World Bank, Pink Sheet (world prices of urea, DAP, TSP and potassium chloride)	A
A8	PVGIS (European Commission Joint Research Centre), radiation, 2005-2020	B
A9	ERA5 (Copernicus), via Open-Meteo: Rainfall, reference evapotranspiration, temperature, 1981-2024	B
A10	Natural Earth, first-level administrative boundaries (provinces); grouping into geographical regions by the author	B
A11	DSİ (General Directorate of State Hydraulic Works), figures reported by Anadolu Agency, March 2024: Irrigable areas, areas opened to irrigation, water consumed	A
A12	Turkish customs tariff (heading 3906.90.90); Presidential Decision No. 7346 of 2023 on the general VAT rate	A
A13	Ministry of Agriculture and Forestry, BÜGEM: Regulation on organic, mineral and microbial fertilisers used in agriculture; documents required for import and registration	A
A14	Soybean trial, China (yield), manufacturer's website	C
A15	Date palm trial, UAE (ICBA, 2021), manufacturer's website	B
A16	Watermelon trial, Mexico (2023), manufacturer's website	C
A17	Potato trial, South Africa (2025), manufacturer's website	C
A18	Maize trial, Türkiye (TIGEM, Konya, 2025), measurements by the TIGEM irrigation department, manufacturer's website	B
A19	ECOSORB® acrylamide analysis (Polymex laboratory, 2024)	B
A20	EVERGREEN® REACH / SVHC screening (SGS, 2023)	B
A21	ECOFERT® certificate (SOHISCERT, EU Bio)	A
A22	Paulownia ALTIFOLIA® sheet figures (website)	C

Annex B. Calculation method

1. Agricultural water. Total withdrawals (64.47 km³, 2022) × agricultural share (86.93%) = 56.04 km³.

2. Water per hectare. Agricultural water ÷ area actually irrigated (4,914,000 ha, 2024) = 11,404 m³/ha. The area actually irrigated is used rather than the equipped area, because it is published for Türkiye and matches the water actually used.

3. Allocation. Irrigable crops (maize, cotton, sugar beet, rice, potato and onion, vegetables and melons, soybean, orchards and vineyards) cover 3,887,100 harvested ha; each receives the water of its area. The rest of the irrigated area (1,026,900 ha) forms the "other irrigated crops" group. Wheat, barley, pulses, olive, hazelnut, pistachio and sunflower are treated as rainfed crops.

4. Scenarios. Water saved = group water × trial effect: A quarter (cautious), half (central), all of it (high). Without a trial: 5, 10 and 20%.

5. Extra hectares. Water saved ÷ water per irrigated hectare (11,404 m³/ha).

6. Production and value. Production gain = group area × average yield × trial effect; value at the implicit 2023 average price (production value ÷ production).

7. Value of water. Three assumed prices (0.10; 0.22 and 0.45 $/m³); no national tariff was adopted.

8. Fertilisers. Minimum spending = nitrogen ÷ 0.46 × urea price + phosphate ÷ 0.46 × TSP price + potash ÷ 0.60 × potassium chloride price (A7).

9. Climate. Rainfall, reference evapotranspiration (FAO-56) and temperature: 1991-2020 means of the ERA5 grid cell containing each city; radiation: PVGIS, 2005-2020. Temperature trends are linear regressions over 1981-2024. On the maps, each province takes the value of its region's reference city.

10. Trade. Totals are those of the FAOSTAT crops and livestock line; products are listed one by one, without aggregates.

Annex C. Photo credits

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The Euphrates at Rumkale, near Halfeti (Şanlıurfa).

Green Solutions

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