COUNTRY DOSSIER

Saudi Arabia

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

Green Solutions · contact@green-solutions-group.com · green-solutions-group.com



The Al-'Ula oasis, in the Madinah region.

Foreword

This dossier describes Saudi Arabia from the angle of water, climate, fertilisers and crops. It is written for the ministries in charge of agriculture, water and trade, the regional directorates of agriculture, cooperatives and producer organisations. It answers three questions: Where is water short, for which crops, and in which regions? It then examines what our products can change, in rainfed as well as irrigated farming, 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, Saudi public bodies (GASTAT, Ministry of Environment, Water and Agriculture, Zakat, Tax and Customs Authority)).

• **B**: Research institute, laboratory, United Nations agency or recognised climate model.

• **C**: Manufacturer statement, website, press or estimate.

• "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 in Saudi Arabia.

Contents

Summary
1. Green Solutions and our products
2. Saudi Arabia in figures
3. Sunshine, rainfall and climate change
4. Water: Resources, irrigated areas, withdrawals
5. Fertilisers: Quantities, purchases, spending
6. The regions at a glance
7. The twenty main crops: Three rankings
8. Extrapolation by crop: Irrigation and rainfed crops
9. Potential benefits of our products
10. External trade: Exports, imports, importing
11. A study of each region
Annex A. Sources and confidence levels
Annex B. Calculation method
Annex C. Photo credits

Summary

The points below summarise the dossier. The figures come from public sources: The World Bank, FAO (FAOSTAT, AQUASTAT), Saudi public bodies (GASTAT, Ministry of Environment, Water and Agriculture, Zakat, Tax and Customs Authority), PVGIS and NASA POWER. The production gains and water savings are scenarios, described in Annex B.

36.97 M
Inhabitants in 2025 (World Bank)

257,613 ha
Of dates harvested in 2024, the main crop

3.28 M ha
Equipped for irrigation (2024)

2,425 Mm³
Of irrigation water saved a year, central scenario

5,719 M$
Of agricultural exports in 2024 (FAOSTAT)

Key points

• **Irrigation, a pillar of production.** 3.28 million hectares equipped for irrigation in 2024, or 71% of the 4.59 million hectares of cropland.

• **Dates: The main crop.** 257,613 ha harvested in 2024, for 1.93 million tonnes, or 7.48 t/ha.

• **Water is scarce.** National water stress reaches 974.2%; at Madinah, the air demands 2,752 mm more than it rains.

• **In irrigation, the water saved enlarges the schemes.** 2,425.0 Mm³ a year in the central scenario, enough to irrigate about 416,973 more ha, or 12.7% of the equipped area.

• **An organic chain.** 20,064 ha of certified organic cropland in 2024: ECOFERT® is EU Bio certified.

• **Fertilisers made locally.** 258,330 t of nitrogen used in 2024; the country produces 3,539,966 t and imports 42,837 t.

• **Farm trade.** $5,719 million of exports and $29,523 million of imports in 2024. First sale: Refined sugar ($598 million). Rice weighs $1,981 million of purchases.

Key figures

Key indicators for Saudi Arabia

Indicator	Value	Year	Source (level)
Population	36.97 M	2025	World Bank (A1)
GDP per capita	34,537 $	2025	World Bank (A1)
Agriculture share of GDP	2.6%	2025	World Bank (A1)
Agricultural employment	2.5%	2025	World Bank (A1)
Cropland	4,590,000 ha	2024	FAOSTAT (A6)
Area equipped for irrigation	3,278,920 ha	2024	FAOSTAT (A6)
Harvested area: Dates	257,613 ha	2024	FAOSTAT (A2)
Certified organic cropland	20,064 ha	2024	FAOSTAT (A6)
Agricultural exports	5,719 M$	2024	FAOSTAT (A4)
Agricultural imports	29,523 M$	2024	FAOSTAT (A4)

Indicator	Value	Year	Source (level)
Mineral nitrogen, agricultural use	258,330 t	2024	FAOSTAT (A5)

Source: Table based on the sources indicated.

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, 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, usable in organic farming.	Published certificate; potato trial combined with EVERGREEN®. Level A (certificate), C (results).
Paulownia ALTIFOLIA®	Fast-growing tree for agroforestry.	Website figures; no trial in Saudi Arabia. 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.



A bee on a flower, on a farm in the Asir region.

2. Saudi Arabia in figures

Saudi Arabia had 36.97 million inhabitants in 2025, 15% of them in rural areas. Agriculture accounts for 2.6% of gross domestic product and employs 2% of the labour force. The country covers 2,149.7 thousand km², of which 82% is agricultural land. Undernourishment affects 2.5% of the population.

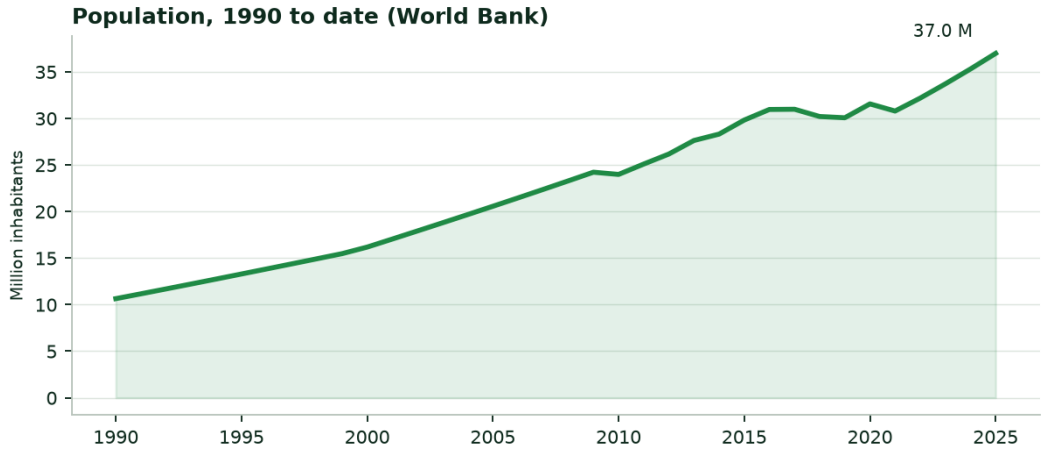


Figure 1. Population of Saudi Arabia, 1990 to date. Source: World Bank (A1)

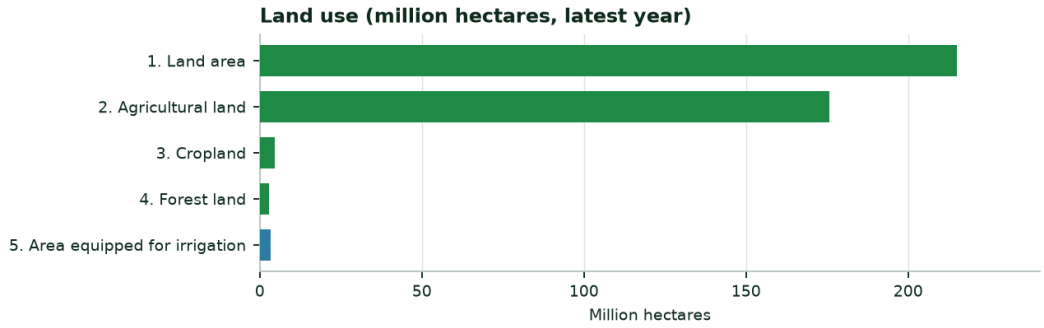


Figure 2. Land use, latest year published. Source: FAOSTAT (A6)

Agricultural and water indicators, latest year published

Indicator	Value	Year	Source
Cropland certified organic	20,064 ha	2024	FAOSTAT (A6)
Average cereal yield	5,105 kg/ha	2024	World Bank (A1)
Fertiliser use per hectare of arable land	125.5 kg/ha	2024	World Bank (A1)
Water withdrawals, agricultural share	81.6%	2022	World Bank (A1)
Internal freshwater resources	2.4 km³	2022	World Bank (A1)
Internal resources per inhabitant	75 m³	2022	World Bank (A1)



Date palms in Saudi Arabia.

3. Sunshine, rainfall and climate change

3.1 Sunshine

Global solar radiation reaches 2,116 to 2,391 kWh/m² a year depending on the region. Energy is not the limit: Water available at the right time makes the harvest.

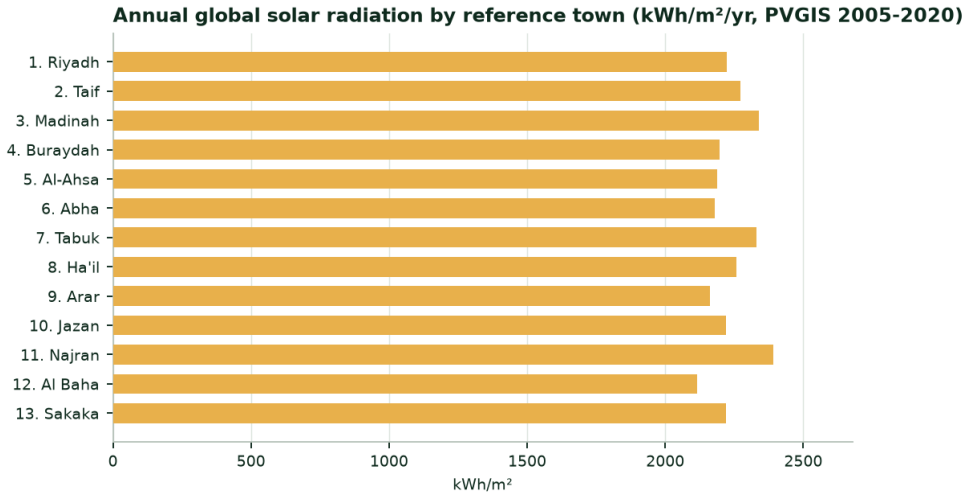


Figure 3. Annual global solar radiation in each reference town. Source: PVGIS (A8)

3.2 Rainfall and evapotranspiration

It rains 171 mm a year at Jazan, but only 19 mm at Tabuk, where reference evapotranspiration reaches 2,181 mm. Rain is scarce and irregular over most of the country: It falls mostly from winter to spring in the north and centre, and in spring and summer in the south-west. Almost all farming therefore depends on irrigation.

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

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Riyadh	6	5	4	5	1	0	0	0	0	1	6	5
Taif	3	0	3	7	7	3	1	1	1	3	7	2

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Madinah	3	1	1	2	1	0	0	2	0	1	6	2
Buraydah	4	2	4	6	1	0	0	2	0	1	6	8
Al-Ahsa	8	6	6	4	0	0	0	0	0	1	7	7
Abha	8	6	11	12	8	1	7	8	1	1	3	3
Tabuk	6	2	2	1	2	0	0	0	0	1	3	1
Ha'il	5	2	6	6	1	0	0	0	0	1	6	3
Arar	4	4	4	2	0	0	0	1	0	3	4	4
Jazan	7	4	7	9	8	11	33	45	15	10	11	11
Najran	1	1	3	5	4	0	3	5	0	1	1	1
Al Baha	10	2	4	11	6	3	2	3	1	5	7	5
Sakaka	9	4	4	1	0	0	0	0	0	1	5	5

Source: NASA POWER (A9); author's calculation.

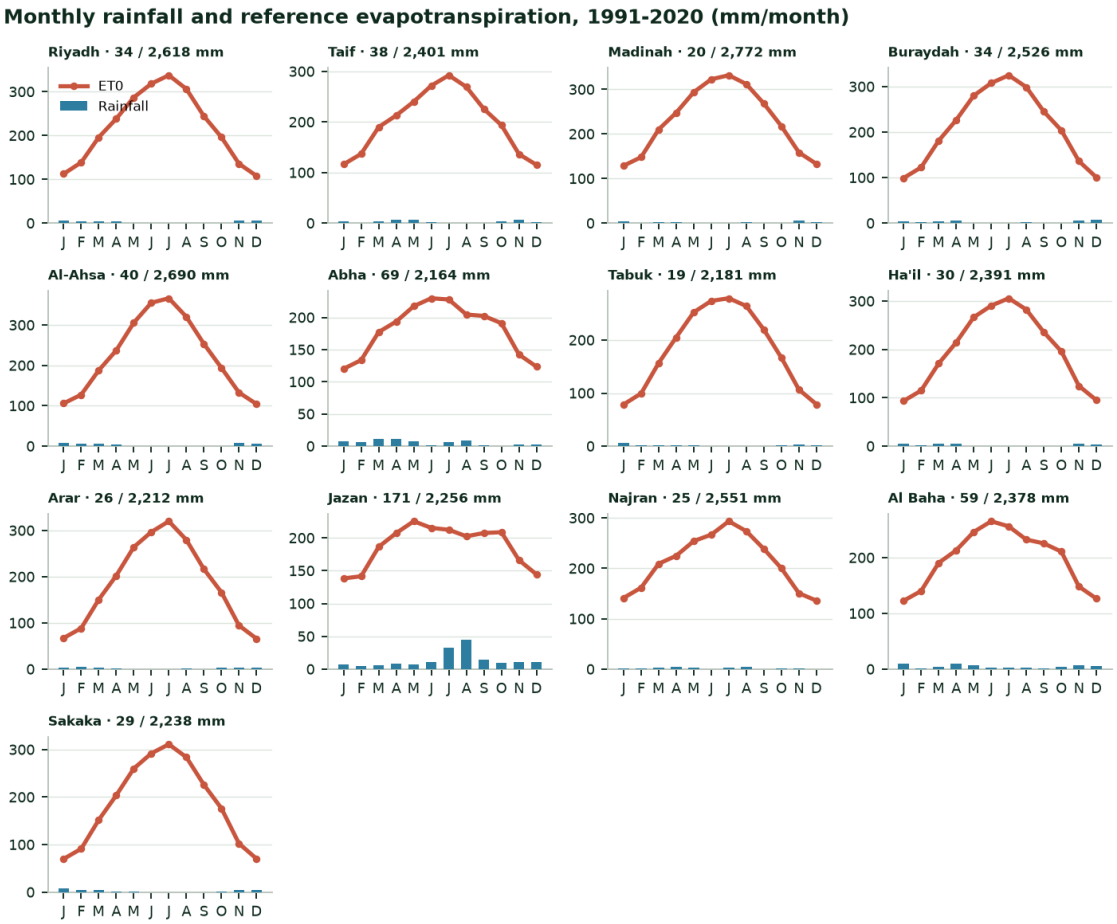


Figure 4. Monthly rainfall and reference evapotranspiration by city, 1991-2020. Source: NASA POWER (A9)

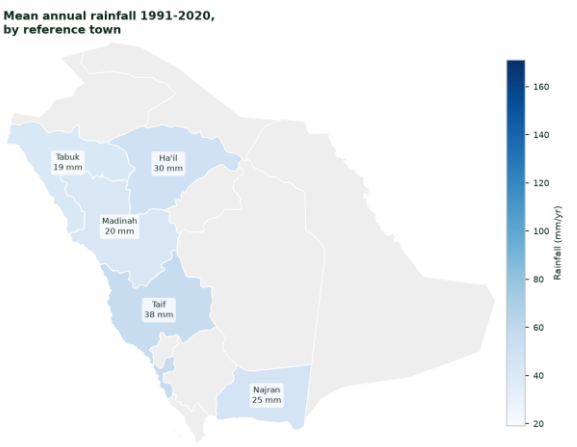
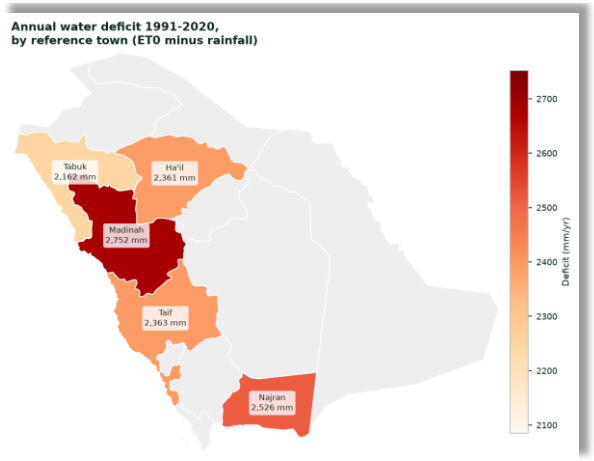


Figure 5. Mean annual rainfall 1991-2020, by region. Source: NASA POWER (A9), Natural Earth (A10).



Annual water deficit, by region. Source: NASA POWER (A9), Natural Earth (A10).

3.3 Climate change

Mean annual temperature is rising. At Riyadh it went from 25.5 °C in 1981 to 26.7 °C in 2024, a trend of 0.43 °C per decade. At Abha the trend is 0.26 °C per decade, from 24.6 °C to 25.2 °C. Warmer air dries the soil faster between two rains.

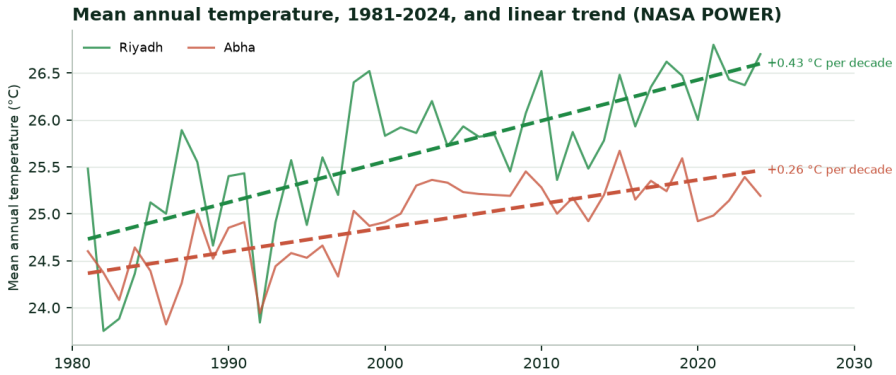


Figure 6. Mean annual temperature, 1981-2024, and linear trend. Source: NASA POWER (A9)



Al Sawda peak, in the Asir region.

4. Water: Resources, irrigated areas, withdrawals

4.1 Resources and withdrawals

Total freshwater withdrawals are 23,380 million m³ a year (2022). Agriculture withdraws 81.6% of it, that is 19,070 Mm³. Internal resources are 2.4 km³ a year and water stress is 974.2%: The resource is already heavily used: Every cubic metre kept in the soil counts.

Freshwater: Withdrawals and resources

Indicator	Value	Year	Source
Total withdrawals	23,380 Mm³	2022	World Bank (A1)
Agricultural share	81.6%	2022	World Bank (A1)
Agricultural withdrawals	19,069.6 Mm³	2022	Calculated from A1
Area equipped for irrigation	3,278,920 ha	2024	FAOSTAT (A6)
Agricultural withdrawals per equipped hectare	5,816 m³/ha	—	Calculation (Annex B)
Water stress	974.2%	2022	World Bank (A1)

4.2 Irrigated areas

FAOSTAT counts 3,278,920 hectares equipped for irrigation in 2024. Irrigation relies mostly on non-renewable groundwater: According to a 2024 study, it supplies 62.4% of the country's water supply (A11). Every cubic metre kept in the soil therefore counts, and centre pivots and drip irrigation dominate the large farms.



A reservoir between hills.

4.3 What the water saving represents

In the central scenario, the saving is 2,425.0 million m³ a year, or 12.7% of agricultural withdrawals. At 5,816 m³ per equipped hectare, this water would irrigate about 416,973 more hectares, or 12.7% of today's equipped area.

5. Fertilisers: Quantities, purchases, spending

5.1 Quantities used

In 2024, agricultural use reaches 258,330 tonnes of nitrogen, 200,959 tonnes of phosphate (P2O5) and 80,535 tonnes of potash (K2O). The country produces 3,539,966 tonnes of nitrogen and 2,345,914 tonnes of phosphate (P2O5); it imported 42,837 tonnes of nitrogen in the same year. Per hectare of arable land, use is 125.5 kg per hectare.

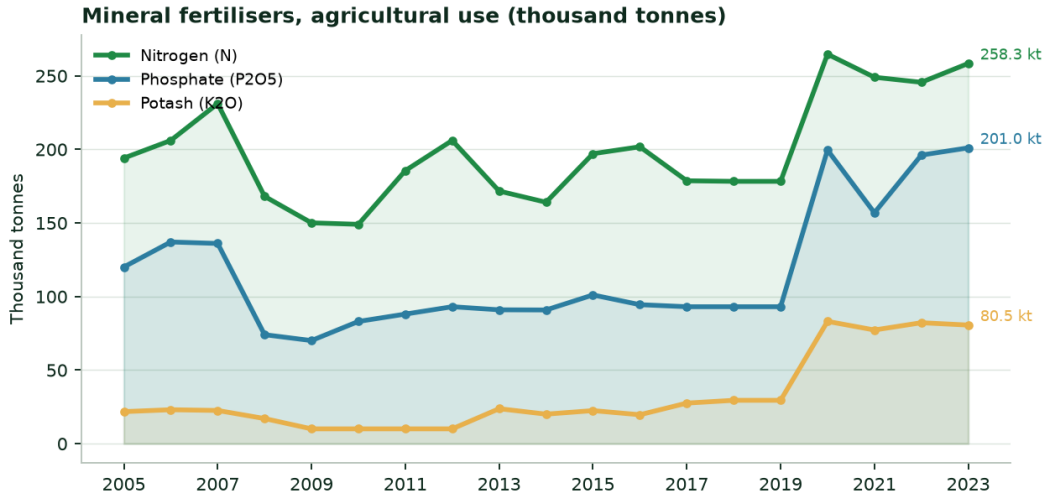


Figure 7. Mineral fertilisers, agricultural use, 2005-2023. Source: FAOSTAT (A5)

5.2 Regulatory framework

Fertilisers are registered with the Ministry of Environment, Water and Agriculture (A13, level C). A water-retaining polymer would come under it according to its classification, to be confirmed with the ministry.



A young tomato plant in a peat pot.

5.3 Indicative spending

In 2024, the indicative minimum spending on mineral fertilisers reaches $437 million, at international fertiliser prices (calculation in Annex B, lower bound).

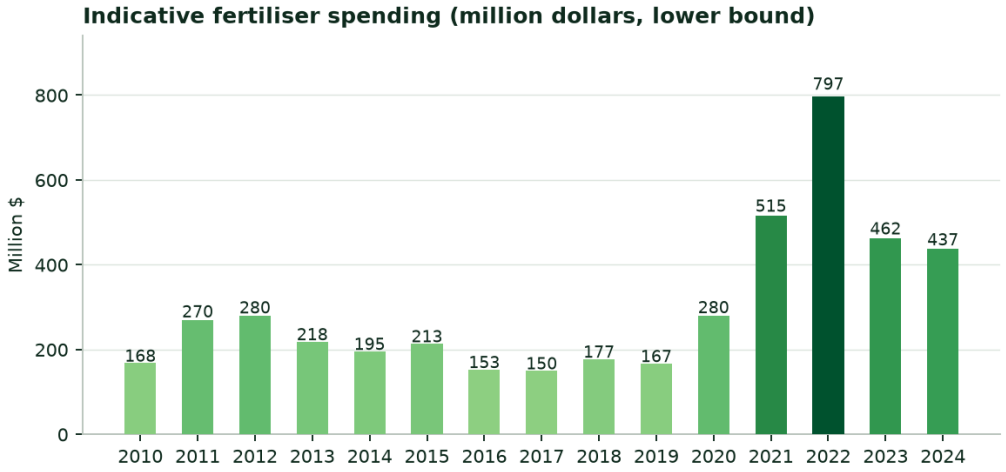


Figure 8. Indicative fertiliser spending, lower bound. Source: Author's calculation from A5 and A7

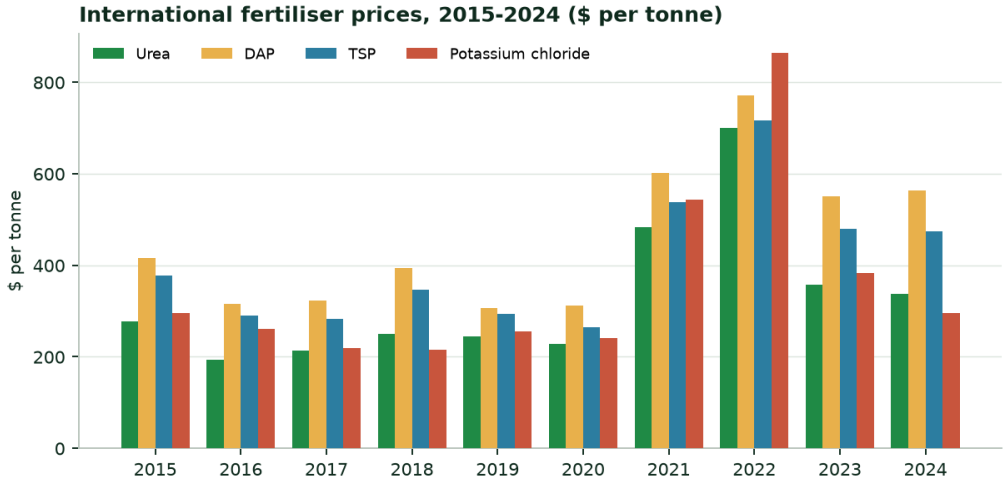


Figure 9. International prices of urea, DAP, TSP and potassium chloride. Source: World Bank, Pink Sheet (A7)

6. The regions at a glance

The table compares the thirteen administrative regions, each represented by a reference town. Climate figures are 1991-2020 averages, except radiation (2005-2020).

Climate of the capitals, 1991-2020 means

Region (city)	Rainfall (mm/yr)	ET0 (mm/yr)	Deficit (mm/yr)	Radiation (kWh/m²/yr)	Temperature (°C)
Riyadh (Riyadh)	34	2,618	2,584	2,222	25.8
Makkah (Taif)	38	2,401	2,363	2,272	23.7
Madinah (Madinah)	20	2,772	2,752	2,338	26.2
Qassim (Buraydah)	34	2,526	2,492	2,196	24.6
Eastern Province (Al-Ahsa)	40	2,690	2,650	2,187	26.8
Asir (Abha)	69	2,164	2,095	2,180	25.0
Tabuk (Tabuk)	19	2,181	2,162	2,331	20.4
Ha'il (Ha'il)	30	2,391	2,361	2,257	22.3
Northern Borders (Arar)	26	2,212	2,186	2,163	21.5
Jazan (Jazan)	171	2,256	2,085	2,219	30.6
Najran (Najran)	25	2,551	2,526	2,391	24.5

Region (city)	Rainfall (mm/yr)	ET0 (mm/yr)	Deficit (mm/yr)	Radiation (kWh/m²/yr)	Temperature (°C)
Al Baha (Al Baha)	59	2,378	2,319	2,116	26.6
Al Jawf (Sakaka)	29	2,238	2,209	2,220	21.0

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

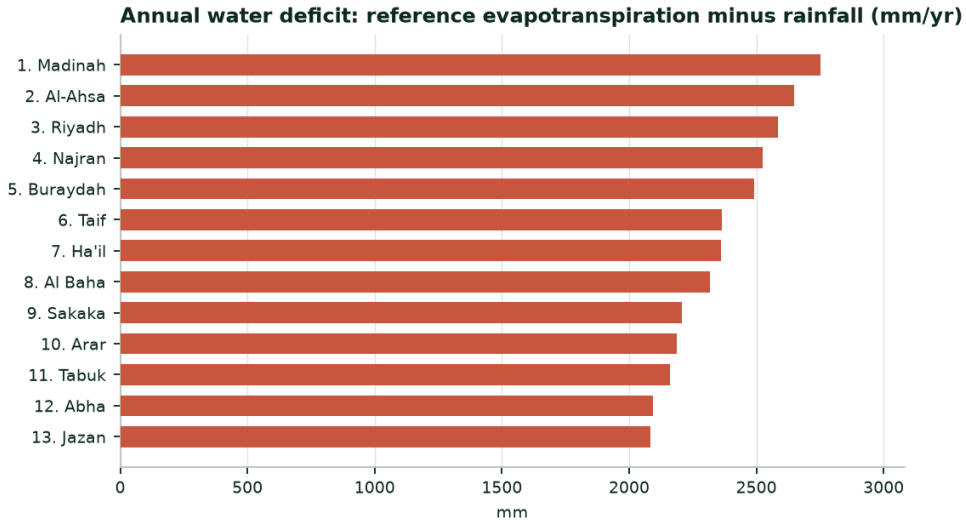


Figure 10. Annual water deficit: Reference evapotranspiration minus rainfall. Source: NASA POWER (A9)



Irrigation pivots in the Al Jawf region, seen from a satellite.

7. The twenty main crops: Three rankings

7.1 By harvested area

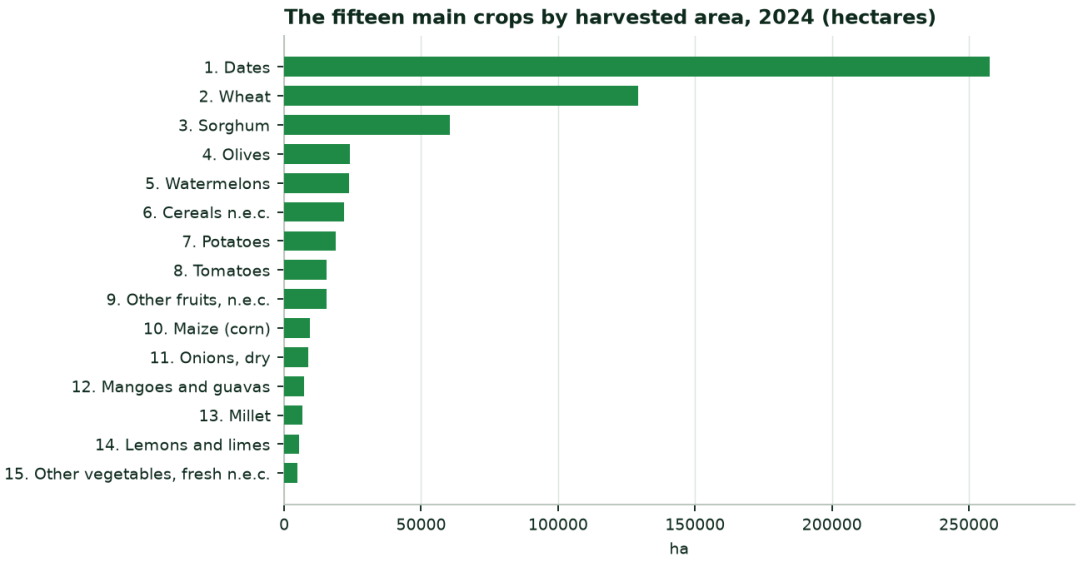


Figure 11. The fifteen main crops by harvested area, 2024 (hectares). Source: FAOSTAT (A2)

The ten main crops by area, 2024

Crop	Harvested area (ha)	Production (t)	Yield (t/ha)
Dates	257,613	1,927,556	7.48
Wheat	129,202	820,393	6.35
Sorghum	60,475	168,328	2.78
Olives	24,004	351,278	14.63
Watermelons	23,648	608,478	25.73
Cereals n.e.c.	21,746	92,664	4.26
Potatoes	18,843	625,071	33.17
Tomatoes	15,518	682,569	43.99
Other fruits, n.e.c.	15,345	266,855	17.39
Maize (corn)	9,453	67,441	7.13

Source: FAOSTAT (A2).

7.2 By production

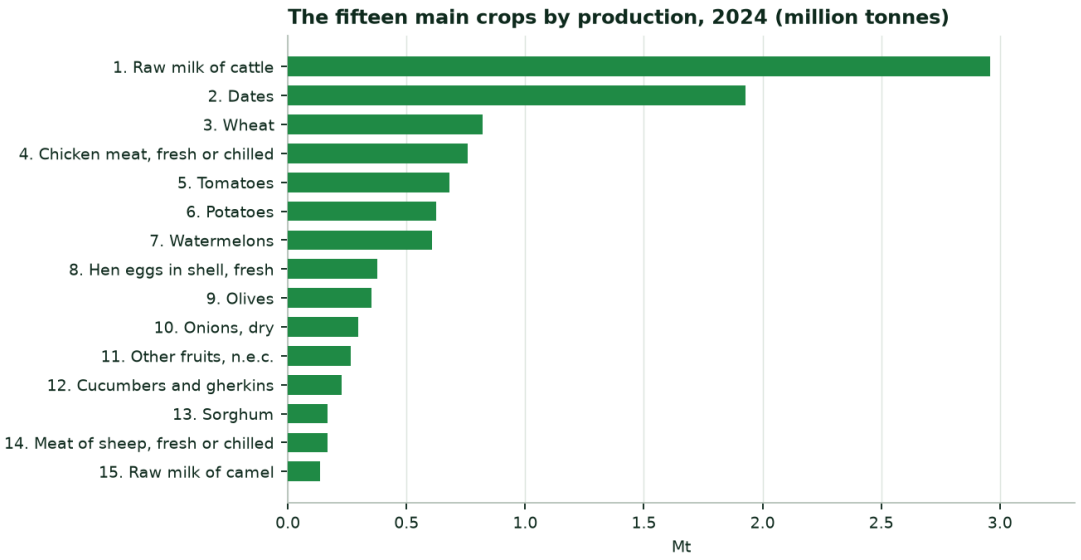


Figure 12. The fifteen main crops by production, 2024 (million tonnes). Source: FAOSTAT (A2)

7.3 By production value

By production value, the three main crops are: Dates, olives and tomatoes (FAOSTAT, 2023, constant international dollars).

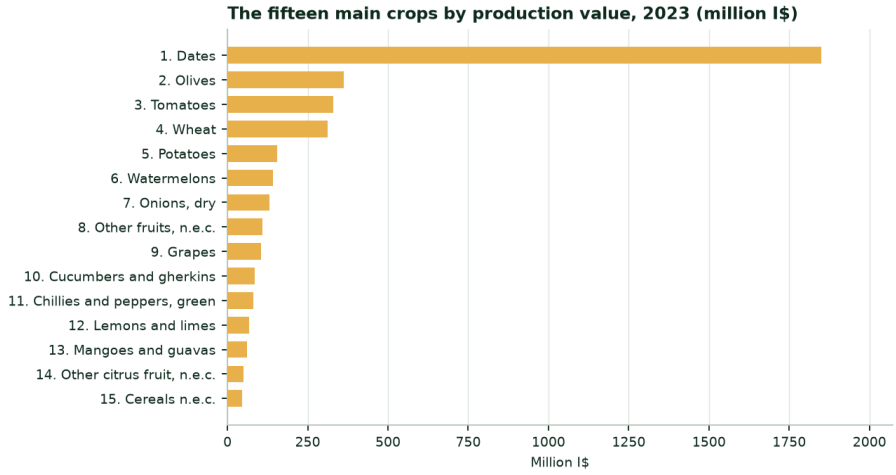


Figure 13. The fifteen main crops by production value, 2023 (million I$). Source: FAOSTAT (A3)



The Al-'Ula oasis.

8. Extrapolation by crop: Irrigation and rainfed crops

8.1 Method

Method in brief

• **Irrigation.** National agricultural water is shared between irrigated crops (date palm, wheat and barley, watermelon and melon, potato, vegetables, olive tree, citrus, other fruit, maize and other irrigated land), in proportion to their harvested areas; the equipped area is shared the same way.

• Each calculation applies the effect of the trial cited: A quarter (cautious), half (central), all of it (high). Without a trial: 5, 10 and 20% of water, with no yield gain.

8.2 Trials used as analogues

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%	Maize: Water and yield
Soybean, China	Soybean	Assumption	+11.3%	Not used; cited for reference
Watermelon, Mexico (2023)	Watermelon	-60.5%	+30.0%	Watermelon and melon: Water and yield
Potato, South Africa (2025)	Potato	-52.0%	+31.4%	Potato: Water and yield
Date palm, UAE (ICBA, 2021)	Palm	-82.0%	+20.0%	Date palm: Water and yield

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

No trial has yet been conducted in Saudi Arabia: The figures below apply the trials cited to the country's average yields.

8.3 Irrigation: Date palm, Wheat and barley, Watermelon and melon and Potato

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

Crop group	Equipped area (ha)	Share	Trial or assumption	Water saved (Mm³/yr)
Date palm	257,613	7.9%	Date palm, UAE (ICBA, 2021)	614.3
Wheat and barley	131,255	4.0%	Generic assumption, no trial	76.3
Watermelon and melon	26,215	0.8%	Watermelon, Mexico (2023)	46.1
Potato	18,843	0.6%	Potato, South Africa (2025)	28.5
Vegetables (tomato, onion, aubergine, pepper, cucumber, others)	51,925	1.6%	Generic assumption, no trial	30.2
Olive tree	24,004	0.7%	Generic assumption, no trial	14.0
Citrus (lemon, orange, mandarin)	9,676	0.3%	Generic assumption, no trial	5.6
Other fruit (mango, grape, peach, fig, banana, pomegranate)	31,947	1.0%	Generic assumption, no trial	18.6
Maize	9,453	0.3%	Maize, Türkiye (TIGEM, 2025)	10.7
Other irrigated land (lucerne, fodder)	2,717,989	82.9%	Generic assumption, no trial	1,580.7

Source: Author's calculation (Annex B).

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

Scenario	Water (Mm³/yr)	Extra hectares	Production (t/yr)
Cautious	1,212.5	208,487	199,150
Central	2,425.0	416,973	398,299
High	4,850.1	833,947	796,599

Source: Author's calculation (Annex B).

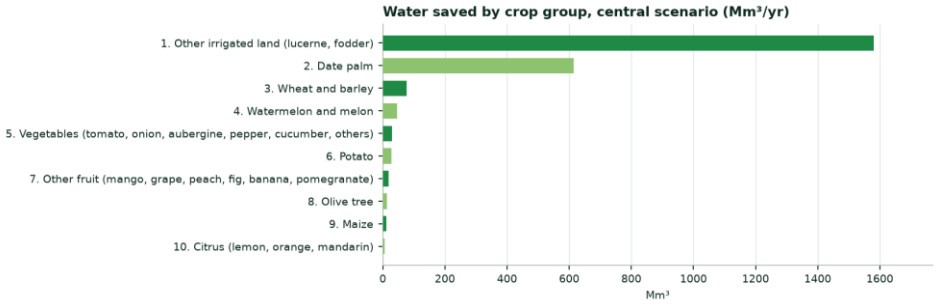


Figure 14. Water saved by crop group, central scenario. Source: Author's calculation

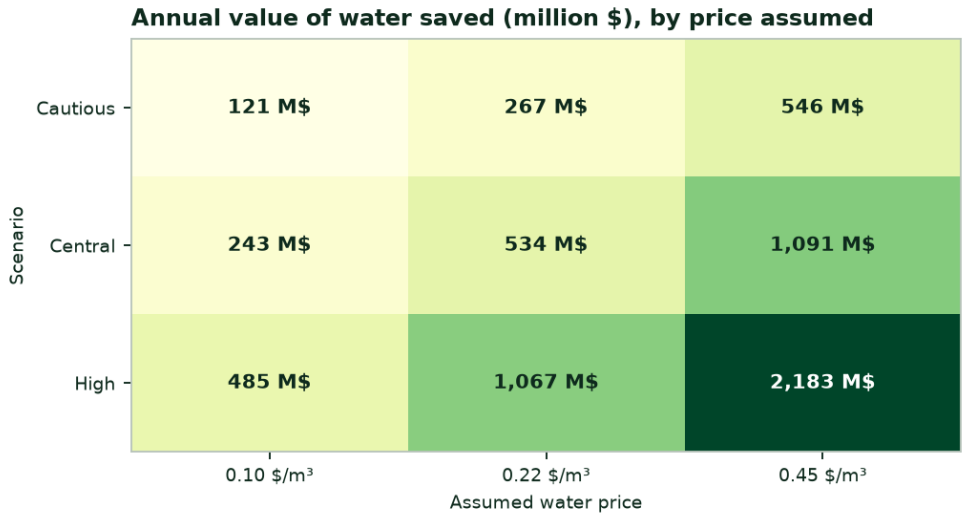


Figure 15. Annual value of the water saved, by price assumed per cubic metre. Source: Author's calculation; prices assumed, no national tariff

8.4 Reading the results

Key points

• The "other irrigated land" group gives 65% of the irrigation water saving (generic assumption, no trial).

• The gains are counted by scenario and, in rainfed farming, per 10,000 ha treated: A cooperative or a public programme can scale them to its own area.

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	Date palm −82%; watermelon −60.5%; potato −52%; maize −38.9%	A14 to A18 (B, C)	One trial per crop; none in Saudi Arabia
Yield	Maize +17.1%; potato +31.4%; watermelon +30%; date palm +20%; soybean +11.2 to +11.4%	A14 to A18 (B, C)	Trials conducted under irrigation or in other climates
Organic farming (ECOFERT®)	Certified by SOHISCERT and EU Bio	A21 (A)	Valid for the certified product
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
Agroforestry (Paulownia ALTIFOLIA®)	13 to 15 m in 6 to 8 years (website)	A22 (C)	No trial in Saudi Arabia

Source: Annex A.



The lake and trees of Wadi Hanifa.

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)	4,983	5,719
Agricultural imports (crops and livestock)	27,216	29,523
Exports, all merchandise	322,256	305,350
Imports, all merchandise	211,028	232,028

Source: FAOSTAT (A4).

10.2 Exports

The three main farm products exported in 2024 are: Refined sugar ($598 million), dates ($452 million) and pasta ($374 million).

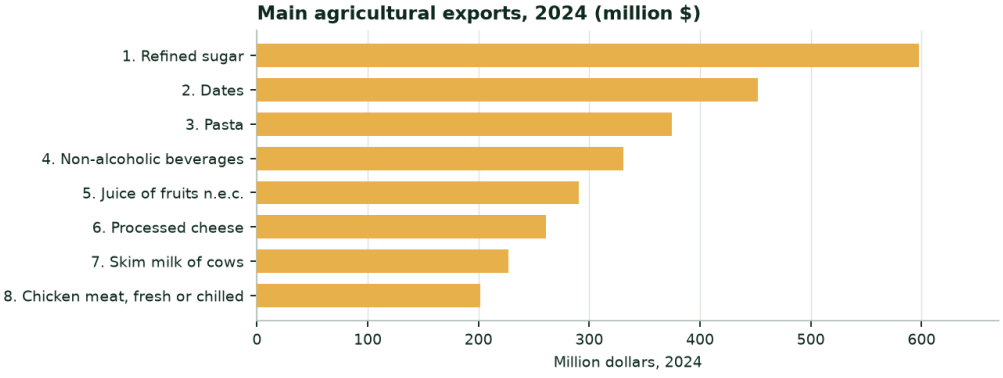


Figure 16. Main agricultural exports, 2024. Source: FAOSTAT (A4)

10.3 Imports

The main farm purchases are: Chicken meat, fresh or chilled ($1,564 million), sheep ($1,260 million) and maize (corn) ($1,214 million). Rice weighs $1,981 million (husked, broken and milled rice): Every tonne grown locally reduces this bill.

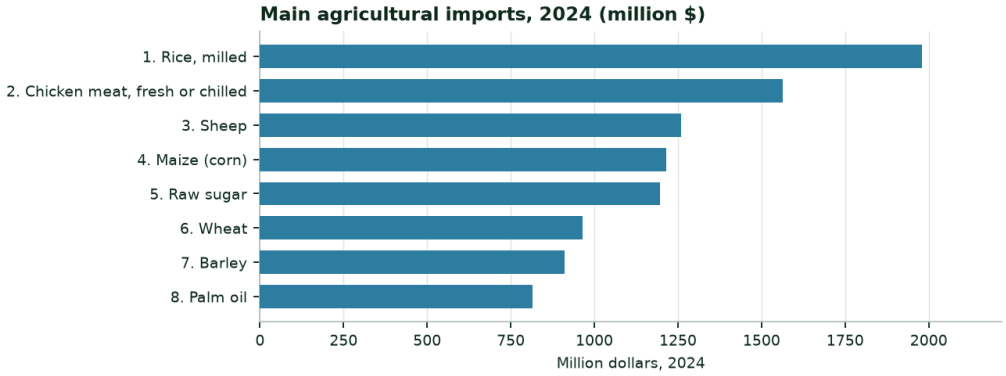


Figure 17. Main agricultural imports, 2024. Source: FAOSTAT (A4)



Figure 18. Mangoes grown in the desert sand of Beesh, Jizan.



A lake formed by the rains at Wadi Hanifah.

10.4 Importing water-retention polymers into Saudi Arabia

What to know

• **Customs duty:** The Gulf Cooperation Council common external tariff is at least 5% on most goods (A12). The exact rate for subheading 3906.90 was not confirmed in the sources consulted.

• **Import VAT:** 15% since July 2020 (A12).

• **Registration:** Fertilisers are registered with the Ministry of Environment, Water and Agriculture (A13, level C). No text specific to water-retaining polymers was found: The classification of a water-retaining polymer is to be confirmed with the ministry.

• **Classification:** Code 3906.90 is an inference for our products; the customs authority settles 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.



The towers of Riyadh at dusk.

Riyadh (Riyadh)

Central plateau, very hot, with almost no rain: Fodder, dairy farming, date palms and vegetables, irrigated by centre pivots and drip from deep groundwater, notably around Al-Kharj and Wadi ad-Dawasir.

Indicator	Value
Annual rainfall, 1991-2020	34 mm
Reference evapotranspiration	2,618 mm
Annual water deficit	2,584 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,222 kWh/m²
Mean temperature	25.8 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Makkah (Taif)

Hejaz highlands, cooler than the coast: Fruit (pomegranate, grape, fig), vegetables and roses, on terraces and irrigated orchards.

Indicator	Value
Annual rainfall, 1991-2020	38 mm
Reference evapotranspiration	2,401 mm
Annual water deficit	2,363 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,272 kWh/m²
Mean temperature	23.7 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Madinah (Madinah)

Oases and palm groves: Dates, including the Madinah varieties, vegetables and the crops of the Al-'Ula oasis, on wells and springs.

Indicator	Value
Annual rainfall, 1991-2020	20 mm
Reference evapotranspiration	2,772 mm
Annual water deficit	2,752 mm
Months with less than 50 mm of rain	12

Indicator	Value
Global solar radiation	2,338 kWh/m²
Mean temperature	26.2 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Qassim (Buraydah)

A region with the densest palm groves of the centre: Dates, wheat, fodder and vegetables, irrigated from groundwater.

Indicator	Value
Annual rainfall, 1991-2020	34 mm
Reference evapotranspiration	2,526 mm
Annual water deficit	2,492 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,196 kWh/m²
Mean temperature	24.6 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Eastern Province (Al-Ahsa)

A large date-palm oasis of the east, fed by springs and wells: Dates, vegetables and fodder, in a very hot climate that is humid in summer.

Indicator	Value
Annual rainfall, 1991-2020	40 mm
Reference evapotranspiration	2,690 mm
Annual water deficit	2,650 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,187 kWh/m²
Mean temperature	26.8 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Asir (Abha)

Asir mountains, with spring and summer rain: Terraced crops, fruit, vegetables, cereals and honey, on slopes where water runs off fast.

Indicator	Value
Annual rainfall, 1991-2020	69 mm
Reference evapotranspiration	2,164 mm
Annual water deficit	2,095 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,180 kWh/m²
Mean temperature	25.0 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Tabuk (Tabuk)

The north-west, cool winters: Wheat, fodder, fruit trees (apple, pomegranate), dates and greenhouses, irrigated from groundwater.

Indicator	Value
Annual rainfall, 1991-2020	19 mm
Reference evapotranspiration	2,181 mm
Annual water deficit	2,162 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,331 kWh/m²
Mean temperature	20.4 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Ha'il (Ha'il)

Northern plateau, cold in winter: Wheat, dates, fodder and vegetables, on large centre-pivot schemes.

Indicator	Value
Annual rainfall, 1991-2020	30 mm
Reference evapotranspiration	2,391 mm
Annual water deficit	2,361 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,257 kWh/m²
Mean temperature	22.3 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Northern Borders (Arar)

Northern border, rare winter rain: Barley, wheat, sheep and camel herding, crops irrigated from boreholes.

Indicator	Value
Annual rainfall, 1991-2020	26 mm
Reference evapotranspiration	2,212 mm
Annual water deficit	2,186 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,163 kWh/m²
Mean temperature	21.5 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Jazan (Jazan)

Red Sea coastal plain, hot and humid: Mango, banana, papaya, sorghum and vegetables; it is the country's tropical fruit region.

Indicator	Value
Annual rainfall, 1991-2020	171 mm
Reference evapotranspiration	2,256 mm
Annual water deficit	2,085 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,219 kWh/m²
Mean temperature	30.6 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Najran (Najran)

Southern valley, at the foot of the mountains: Dates, pomegranate, grape, wheat and vegetables, irrigated from wells.

Indicator	Value
Annual rainfall, 1991-2020	25 mm
Reference evapotranspiration	2,551 mm
Annual water deficit	2,526 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,391 kWh/m²
Mean temperature	24.5 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Al Baha (Al Baha)

South-western mountains: Terraced crops, fig, pomegranate, honey and vegetables, on small farms.

Indicator	Value
Annual rainfall, 1991-2020	59 mm
Reference evapotranspiration	2,378 mm
Annual water deficit	2,319 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,116 kWh/m²
Mean temperature	26.6 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Al Jawf (Sakaka)

The north, desert and irrigated crops: Olive trees, wheat, dates and fodder, on large centre-pivot schemes, with a large groundwater resource.

Indicator	Value
Annual rainfall, 1991-2020	29 mm
Reference evapotranspiration	2,238 mm
Annual water deficit	2,209 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,220 kWh/m²
Mean temperature	21.0 °C

Source: NASA POWER (A9); PVGIS (A8); author's calculation.

Annex A. Sources and confidence levels

Ref.	Source	Level
A1	World Bank, World Development Indicators (WDI), Saudi Arabia	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 for irrigation, organic farming	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	NASA POWER (NASA Langley Research Center), daily data: Rainfall, temperature, humidity, wind and radiation, 1981-2024; reference evapotranspiration calculated by the author with FAO-56 (Penman-Monteith)	B
A10	Natural Earth, first-level administrative boundaries and country outline	B
A11	Suhail M. et al., "Issues of Water Resources in Saudi Arabia: Past, Present, and Future", Sustainability, 2024, 16(10), 4189: Share of non-renewable resources in the water supply	B
A12	US Department of Commerce (International Trade Administration), country commercial guide, Saudi Arabia, import tariffs: Gulf Cooperation Council common external tariff of at least 5% on most goods, VAT at 15% since July 2020	B
A13	Guide to chemical customs codes in Saudi Arabia (Palm Horizon KSA): Registration of fertilisers with the Ministry of Environment, Water and Agriculture	C
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), 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 (23,380 Mm³, 2022) × agricultural share (81.56%) = 19,069.6 Mm³.

2. Irrigation. The equipped area (3,278,920 ha) and agricultural water are shared between irrigated groups (date palm, wheat and barley, watermelon and melon, potato, vegetables, olive tree, citrus, other fruit, maize and other irrigated land) in proportion to their harvested areas (3,278,920 ha), without exceeding each group's harvested area. Our sources have no irrigation statistic by crop. Other crops are treated as rainfed and receive no irrigation water in the calculation. The equipped area exceeds the harvested area of the irrigable crops retained: The difference forms an "other irrigated land" group (lucerne and other fodder), with the generic assumption. Sorghum, millet and other cereals are treated as rainfed.

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

4. Extra hectares. Water saved ÷ water per equipped hectare (5,816 m³/ha).

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

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

8. Climate. Rainfall, reference evapotranspiration (FAO-56) and temperature: 1991-2020 means of the NASA POWER grid cell containing each city; radiation: PVGIS, 2005-2020. Temperature trends are linear regressions over 1981-2024. NASA POWER combines reanalyses and satellite data on a grid of about 50 km: Two nearby cities can share the same cell, and its rainfall can differ from local station records. On the maps, each region is coloured according to the value of its reference town.

9. Trade. Totals are those of the FAOSTAT crops and livestock line; products are listed one by one, without aggregates. Rice amounts add husked rice, broken rice and milled rice.

Annex C. Photo credits

File (Wikimedia Commons)	Author	Licence
Al-'Ula oasis (8).jpg	Radosław Botev	CC BY 3.0 pl
Palm Trees in Saudi Arabia.JPG	Haitham alfalah	CC BY 3.0
Bees Thrive on Berry Farm in Saudi Arabia's Aseer Region (2025).jpg	Saudi Press Agency (SPA)	CC BY-SA 4.0
Al Sawda peak.jpg	Marviikad	CC BY-SA 2.0
Dam reservoir 3 - panoramio.jpg	Juhotski	CC BY-SA 3.0
زراعة الطماطم.jpg	الاءحكمي	CC BY 4.0
Circular irrigations in Al Jawf Region, Saudi Arabia.jpg	Axelspace Corporation	CC BY-SA 4.0
Al-'Ula oasis (1).jpg	Radosław Botev	CC BY 3.0 pl
Wadi Hanifa.jpg	Ahmedpictures12	CC BY-SA 4.0
Tomy Aitkins Mango (Low Sugar Mangoes)..JPG	Abagchi77	CC BY-SA 3.0
Lake at Wadi Hanifah (5218227168).jpg	Peter Dowley from Dubai, United Arab Emirates	CC BY 2.0
Riyadh Skyline.jpg	B.alotaby	CC BY-SA 4.0
Al-'Ula oasis (10).jpg	Radosław Botev	CC BY 3.0 pl

Source: Photos published on Wikimedia Commons, colour-adjusted and sharpened, used under their licence.



The palm grove of the Al-'Ula oasis.

Green Solutions

contact@green-solutions-group.com

green-solutions-group.com