

COUNTRY DOSSIER

Lebanon Dossier

Water, climate, fertilisers and crops: Figures by governorate and by crop, potential benefits of our products, external trade

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Foreword

This dossier describes Lebanon from the angle of irrigation water, climate, fertilisers and crops. It is intended for the authorities in charge of agriculture and water, and for economic players in the sector. It answers three questions: Where is water used, for which crops, and with what reserves? It then examines what our products can change, and what that may be worth.

Reading the sources. Every figure refers to a source, identified 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 (FAO, World Bank, agricultural census, European Commission).
> • **B**: Research institute, university, public body outside statistics, or recognised climate model.
> • **C**: Manufacturer's statement, non-independent demonstration, press, or estimate.
> • "bn" means billions; "M" means millions; "Mm³" means millions of cubic metres.
> • A "scenario" is a calculation based on cited trials. It is not a measurement made in Lebanon.

What the dossier does not do. It does not turn a trial carried out elsewhere into a Lebanese result. Water savings and yield gains by crop are scenarios, built from the trials cited. The dossier gives no sales price.

What remains to be completed. Irrigation volumes measured by governorate, the recent breakdown of irrigated crops, and the irrigation water tariffs of the regional water establishments. Section 11 details them.

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Summary

The seven points below summarise the dossier. The key figures come from public sources (FAO, World Bank, agricultural census, PVGIS). Water savings are scenarios, described in Annex B.

882 Mm³
Of water demanded each year for irrigation (national water strategy, 2020).

113,000 ha
Irrigated in 2010, i.e. 49% of the utilised agricultural area (census).

147 Mm³
Of water saved per year in the central scenario, i.e. 17% of irrigation water.

39%
Of the national water deficit estimated by the World Bank (373 Mm³ per year).

$2.74 bn
Of agricultural imports in 2024, against $476 M of exports (FAOSTAT).

16,794 t
Of mineral nitrogen used in 2024 (FAOSTAT). Indicative spending: At least $21.3 M.

Seven key points

1. **Irrigation is the main use of water.** The National Water Sector Strategy (NWSS, 2020) puts irrigation demand at 882 million m³ per year, against about 350 million for households, industry and tourism combined.
2. **Half of the cultivated land is irrigated.** The 2010 agricultural census counts 230,995 ha of utilised agricultural area, of which 112,956 ha are irrigated (48.9%). The Bekaa and Baalbek-Hermel account for 55% of it.
3. **Very uneven rainfall.** From 347 mm per year in Baalbek to 703 mm in Tripoli (1991–2020 average, ERA5-Land model). The Bekaa, where the large irrigated areas lie, is the driest region.
4. **The 2025 drought showed how fragile the system is.** Inflows to Lake Qaraoun fell to about 45 million m³, against 350 million on average (Litani River Authority). Climate projections announce 10 to 20% less rainfall by 2040.
5. **The potential water saving is large.** In the central scenario, 147 million m³ per year, i.e. 17% of irrigation water and 42% of the average inflows to Lake Qaraoun. The range runs from 73 to 293 million m³.
6. **The gains are concentrated on a few crops.** Potatoes and vegetables provide 59% of the water saved in the central scenario, because published trials exist for these crops. Fruit trees rest on a generic assumption.
7. **The country imports most of its cereals.** In 2024, 496 thousand tonnes of wheat and 453 thousand tonnes of maize were imported, for a wheat production of 159 thousand tonnes in 2023.

Next steps

- Obtain the irrigation volumes measured by regional water establishment (Litani, Bekaa, North, South) and the tariffs in force.
- Update the breakdown of irrigated crops, known in detail only for 2003.
- Choose two governorates, for example the Bekaa and Akkar, for a comparative trial on potatoes and vegetables, before any extension.

Key figures

Key indicators for Lebanon

Indicator	Value	Year	Source (level)
Irrigation water demand	882 million m³	2020	NWSS 2020 (A12, B)

Indicator	Value	Year	Source (level)
Irrigated area	112,956 ha (48.9% of the UAA)	2010	Agricultural census (A7, A)
Solar radiation (governorate capitals)	1,696 to 2,009 kWh/m²/year	2005–2020	PVGIS (A9, A)
Average rainfall (governorate capitals)	347 to 703 mm/year	1991–2020	ERA5-Land (A10, B)
Mineral nitrogen used	16,794 t	2024	FAOSTAT (A5, A)
Potential water saving (central)	147 million m³/year	Scenario	Calculation (Annex B)

Source: See the "Source" column; levels explained in the foreword.

1. Green Solutions and our products

Green Solutions develops products for water, fertilisation and crop protection. Four product families concern this dossier. The performances 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 retainer)	Retains rain or irrigation water as a gel, close to the roots	Trials on maize, potato, watermelon, date palm, soybean (sections 8 and 9)	B to C
ECOSORB® (water retainer made from maize starch)	Same use; lasts 2 to 3 years depending on the site	Soybean trial (China); laboratory acrylamide analysis	B to C
ECOFERT® (fertiliser)	Fertiliser certified by SOHISCERT and EU Organic	Published certificate; potato trial combined with EVERGREEN	A (certificate), C (results)
Paulownia ALTIFOLIA®	Fast-growing tree for agroforestry	Website figures; no trial in Lebanon	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, sources A20 to A27.

A market-gardening training institute in France is among our pilot trials in market gardening with ECOSORB® and ECOFERT®. It is a field reference, not statistical evidence (level C).

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

2. Lebanon in figures

Lebanon has about 5.85 million inhabitants (2025) on just over 10,000 km². Its economy, which has contracted sharply since the 2019 crisis, amounts to 26.0 billion dollars (2024). Agriculture accounts for 1.0% of gross domestic product according to the World Bank, but food represents 19% of merchandise exports. The table below gives the most recent national benchmarks.

National benchmarks

Indicator	Value	Year	Source
Population	5.85 million inhabitants	2025	World Bank (A1)
Gross domestic product	26.0 billion current US$	2024	World Bank (A1)
GDP per capita	US$ 4,473	2024	World Bank (A1)
Agricultural value added	1.0% of GDP	2024	World Bank (A1)
Agricultural employment	3.5% of employment	2023	World Bank (A1)
Agricultural land	63.7% of the country's area	2024	World Bank (A1)

Indicator	Value	Year	Source
Cropland (arable land and permanent crops)	275,950 ha	2023	FAOSTAT (A4)
Utilised agricultural area (UAA)	230,995 ha	2010	Agricultural census (A7)
Irrigated area	112,956 ha, i.e. 48.9% of the UAA	2010	Agricultural census (A7)
Area equipped for irrigation	90,000 ha	2023	FAOSTAT (A4)
Fertiliser used	259 kg/ha of arable land	2024	World Bank (A1)
Freshwater withdrawals	37.8% of internal resources	2022	World Bank (A1)
Internal water resources	836 m³ per inhabitant per year	2022	World Bank (A1)
Average precipitation	661 mm per year	2022	World Bank (A1)
Cereal yield	2,661 kg/ha	2024	World Bank (A1)
Food exports	19.1% of merchandise exports	2024	World Bank (A1)
Food imports	18.5% of merchandise imports	2024	World Bank (A1)

Source: World Bank, WDI database (A1); FAOSTAT (A4); 2010 agricultural census (A7).

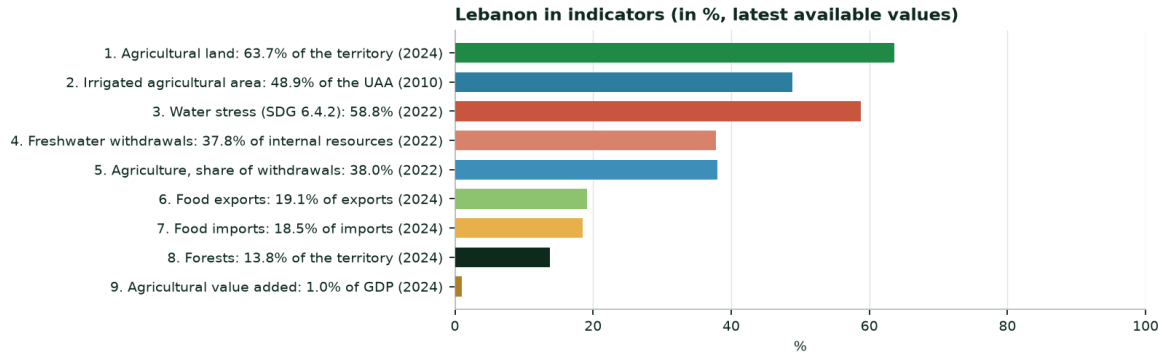


Figure 1. Lebanon in indicators (in %, latest available values). Source: World Bank (A1); agricultural census (A7); author's calculation

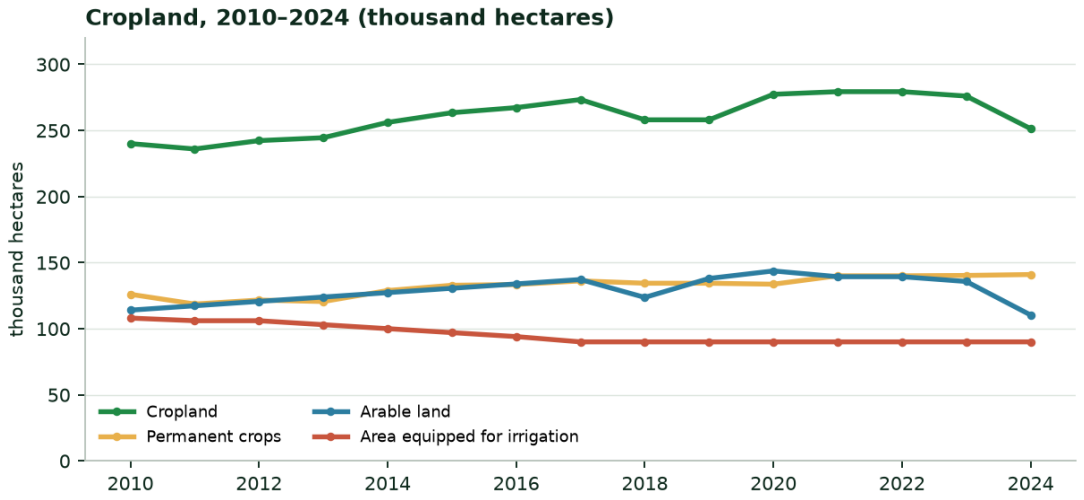
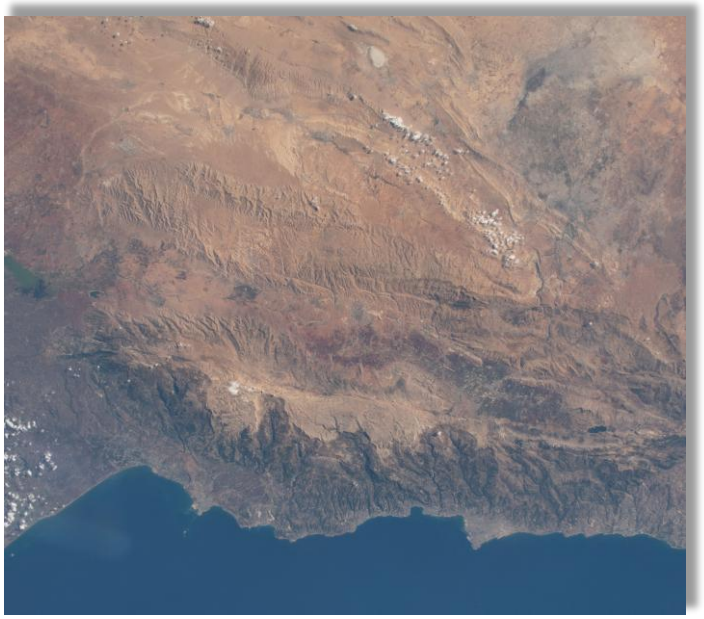


Figure 2. Cropland, 2010–2024 (thousand hectares). Source: FAOSTAT, land use (A4)

According to FAOSTAT, cropland rose from 240 thousand hectares in 2010 to 277 thousand in 2020, then fell back to 251 thousand in 2024. The recent decline concerns arable land (144 thousand hectares in 2020, 110 in 2024); permanent crops (olive groves, orchards, vineyards) are increasing, from 126 to 141 thousand hectares. The area equipped for irrigation has fallen from 108 to 90 thousand hectares.

Two figures for irrigation

The 2010 agricultural census counts 112,956 irrigated hectares. FAOSTAT uses 90,000 ha "equipped for irrigation", a value carried over from year to year. The difference comes from definitions and dates: The census counts the irrigated areas declared by farmers, FAOSTAT the equipped areas. The dossier keeps the census for the breakdown by governorate, and the volume of the national water strategy for the water-saving calculations.



Lebanon seen from the International Space Station: Coast, Mount Lebanon and the Bekaa.

3. Sunshine, rainfall and climate change

3.1 Sunshine

Global horizontal solar radiation ranges from 1,696 kWh/m² per year in Halba (Akkar) to 2,009 kWh/m² in Zahle (Bekaa). The whole country receives high sunshine, favourable to photosynthesis but also to evaporation. The values are those of each governorate's capital.

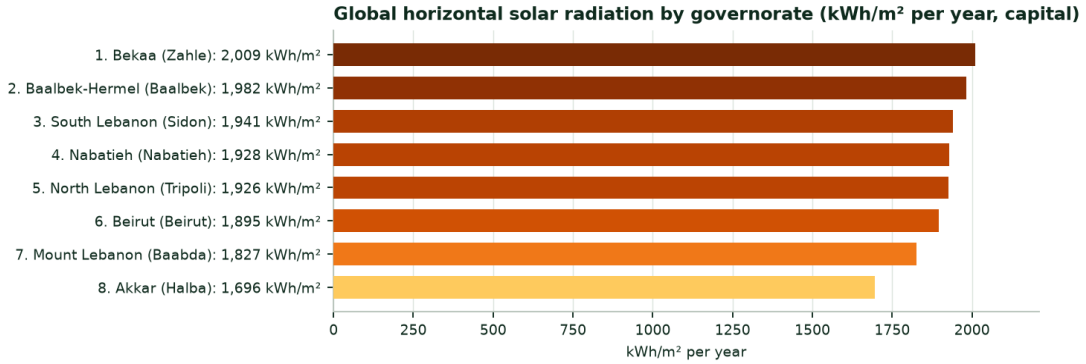


Figure 3. Global horizontal solar radiation by governorate (kWh/m² per year, governorate capital). Source: PVGIS 5.2, European Commission (A9); 2005–2020 average

3.2 Rainfall

Rainfall benchmarks

Benchmark	Value	Period	Source (level)
Average precipitation, country	661 mm per year	2022	World Bank (A1, A)
Wettest governorate capital (Tripoli)	703 mm per year	1991–2020	ERA5-Land (A10, B)
Driest governorate capital (Baalbek)	347 mm per year	1991–2020	ERA5-Land (A10, B)
Potential evapotranspiration	1,100 mm on the coast, 1,200 mm in the Bekaa	2000s	FAO AQUASTAT (A8, A)

Source: See the "Source" column.

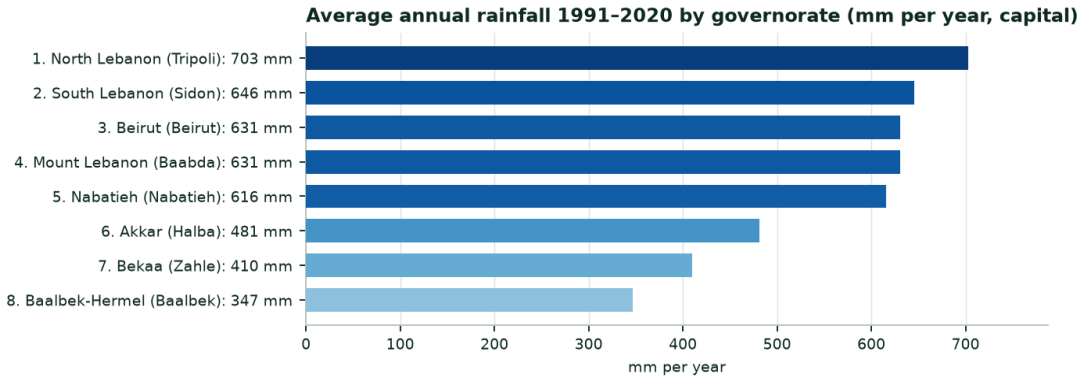


Figure 4. Average annual rainfall 1991–2020 by governorate (mm per year, governorate capital). Source: ERA5-Land, European Centre reanalysis (A10); author's calculation

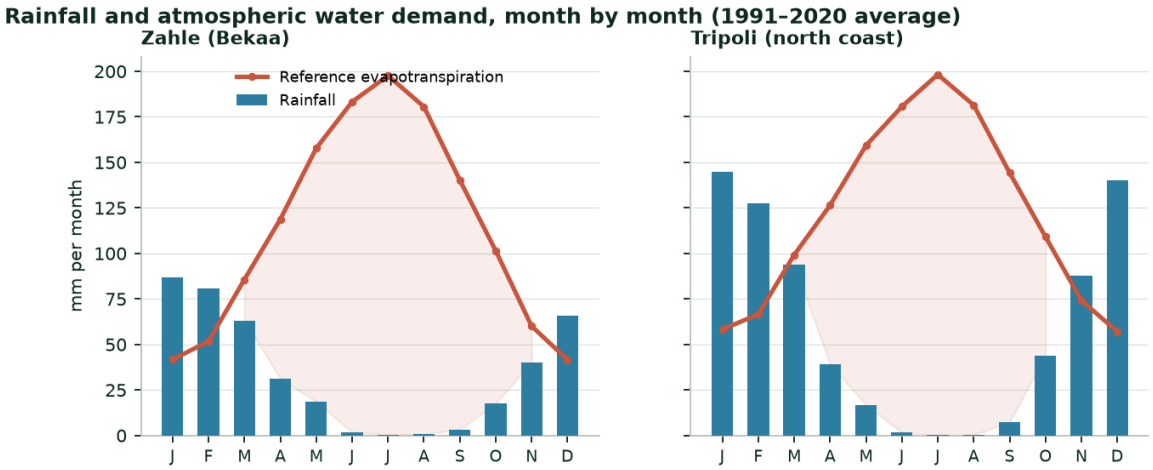


Figure 5. Rainfall and reference evapotranspiration month by month, in Zahle and Tripoli (mm, 1991–2020 average). Source: ERA5-Land (A10); author's calculation

From June to September there is almost no rain, while the atmosphere demands 150 to 200 mm of water per month. Every summer crop depends on irrigation or on water stored in the soil. Keeping winter water and the water of each irrigation in the soil directly reduces this need.

What is missing

The official climate normals of the Lebanese meteorological service could not be obtained. The values by governorate capital come from a model with a grid of about 9 km: They smooth out the relief and probably underestimate mountain rainfall.

3.3 Climate change

Lebanon's national communications to the United Nations Framework Convention on Climate Change announce a hotter and drier climate. The figures below come from the second communication (2011); the third (2016) gives a smaller fall in rainfall.

Projections for Lebanon

Projection	Horizon	Value or trend	Source (level)
Temperature	2040	+1 °C on the coast to +2 °C inland	2nd national communication (A14, B)
Temperature	2090	+3.5 to +5 °C	2nd national communication (A14, B)
Rainfall	2040	−10 to −20%	2nd national communication (A14, B)
Rainfall	2090	−25 to −45%	2nd national communication (A14, B)
Drought periods	2040 and 2090	+9 days and +18 days	2nd national communication (A14, B)
Snow cover	+2 °C and +4 °C	−40% and −70%	2nd national communication (A14, B)
Rainfall	2100	−4 to −11%	3rd national communication, cited in 2024 (A15, B)

Source: See the "Source" column.

Snow on Mount Lebanon feeds springs and rivers until summer. Its decline will reduce the water available when crops need it most. Retaining water in the soil, close to the roots, then becomes a lever for adaptation.

4. Irrigation water: Volumes, prices, investment, drought

Agriculture is the largest water user in Lebanon. The sources do not agree on the exact volumes: They measure sometimes withdrawals, sometimes demand, at different dates. The dossier presents them side by side and uses the national strategy.

4.1 Volumes withdrawn

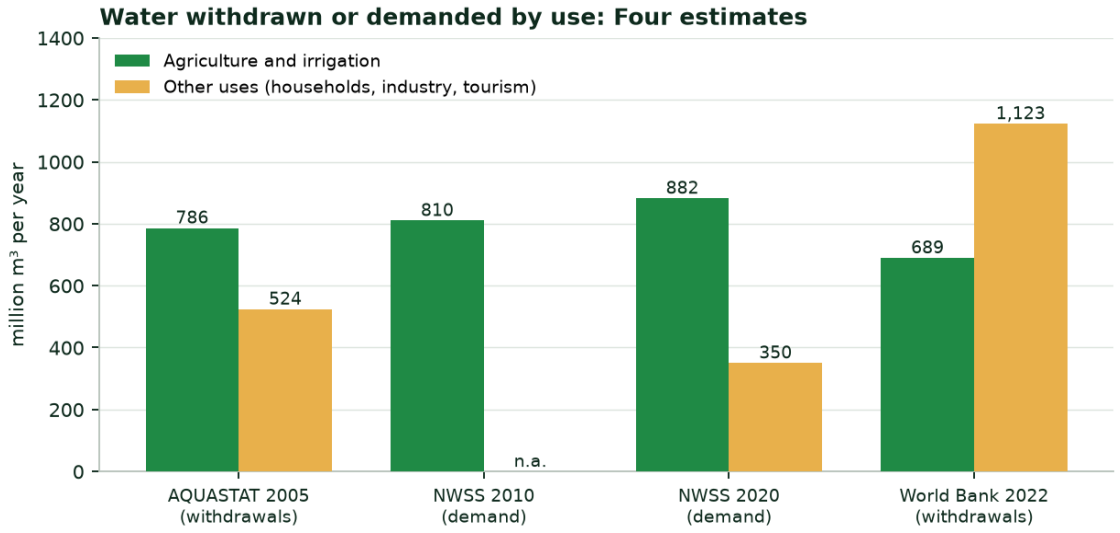


Figure 6. Water withdrawn or demanded by use, four estimates (million m³ per year). Source: FAO AQUASTAT (A8); NWSS 2010 and 2020, Fanack summary (A12); World Bank (A1)

Water volumes, in million m³ per year

Estimate	Agriculture	Total	Source (level)
Withdrawals 2005	≈ 786 (about 60%)	1,310	FAO AQUASTAT (A8, A)
Demand 2010	810	1,473	NWSS, Fanack summary (A12, B)
Demand 2020	882	1,232	NWSS 2020, Fanack summary (A12, B)
Withdrawals 2022	689 (38%)	1,812	World Bank (A1, A)

Source: See the "Source" column.

The share of agriculture published by the World Bank (38% in 2022) is markedly lower than that of national sources (60 to 80%). It rests on international modelling. The dossier uses the volume of the national strategy: 882 million m³ per year for irrigation.

According to AQUASTAT, groundwater provides 53% of withdrawals, surface water 30%, and recycled drainage water 13%. A large part of irrigation therefore relies on private wells, whose pumping depends on the price of energy.

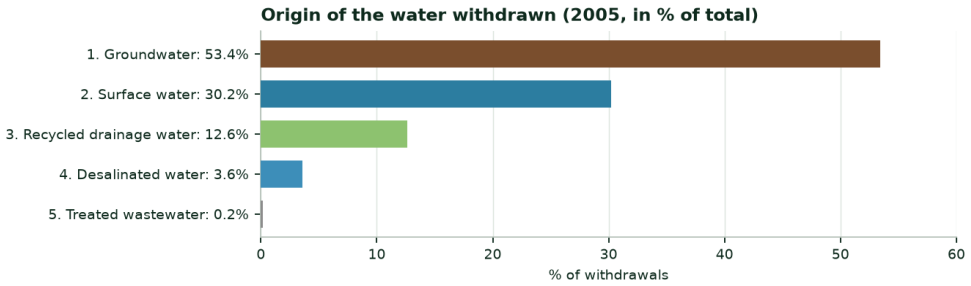


Figure 7. Origin of the water withdrawn (2005, in % of the total). Source: FAO AQUASTAT (A8)

4.2 Irrigated area and water per hectare

The 2010 census counts 112,956 irrigated hectares out of 230,995 ha of utilised agricultural area. Related to this area, the 2020 irrigation demand represents about 7,808 m³ per irrigated hectare per year. The national strategy cites 9,000 m³ per hectare and targets 8,400 m³ in 2035.

Irrigation benchmarks

Benchmark	Value	Year	Source (level)
Irrigated area (census)	112,956 ha	2010	Agricultural census (A7, A)
Area harvested under irrigation	105,293 ha, of which 51% in the Bekaa	2003	FAO AQUASTAT (A8, A)
Irrigated cropping intensity	117%	2000	FAO AQUASTAT (A8, A)
Water per irrigated hectare (calculation)	7,808 m³	2020	Calculation: A12 ÷ A7
Water per hectare (national strategy)	9,000 m³, target 8,400 m³ in 2035	2020	NWSS 2020 (A12, B)

Source: See the "Source" column.



The Litani reservoir (Qaraoun), the country's main surface water reserve.

4.3 Water prices

There is no single price for irrigation water. In public schemes served by gravity, water is billed at a flat rate. In the Litani schemes served by pressurised pipes, it is metered. The available references are old.

Water price references

Reference	Price	Context	Source (level)
Domestic subscription (1 m³ per day)	$0.12 to $0.42/m³	Water establishment tariffs, 2001	FAO AQUASTAT (A8, A)
Water delivered by tanker truck	$5 to $10/m³	Household purchases during shortages	FAO AQUASTAT (A8, A)
Public gravity schemes	Flat rate	No price per m³	FAO AQUASTAT (A8, A)
Pressurised Litani schemes	Metered	Tariff not published in the sources consulted	FAO AQUASTAT (A8, A)

Source: See the "Source" column.

To put a figure on the water saved, the dossier therefore uses three reference values: 0.10, 0.25 and 0.50 dollar per m³. The central value lies within the range of domestic tariffs. These are assumptions, not official tariffs.

4.4 Public investment

Water programmes and projects

Programme	Amount or purpose	Timetable	Source (level)
Water plan 2000–2010	$1.327 bn, almost two thirds of it for dams and reservoirs	2000–2010	FAO AQUASTAT (A8, A)
National Water Sector Strategy (NWSS)	2020 update; demand and deficit to 2035	2020–2035	Fanack summary (A12, B)
Bisri dam (World Bank)	Financing cancelled in 2020	2014–2020	World Bank (A13, B)
Green Plan (Ministry of Agriculture)	Hill lakes and small reservoirs	Ongoing	FAO AQUASTAT (A8, A)

Source: See the "Source" column.

The World Bank estimated the country's water deficit at 373 million m³ per year, with a 30% increase expected by 2035, to 482 million m³. A water saving in the fields acts on this deficit without any new infrastructure.

4.5 Drought

The 2024–2025 season was the driest on record. Inflows to Lake Qaraoun fell to about 45 million m³, against 350 million on average and 230 million the previous season. The volume stored fell from 183 to 63 million m³.

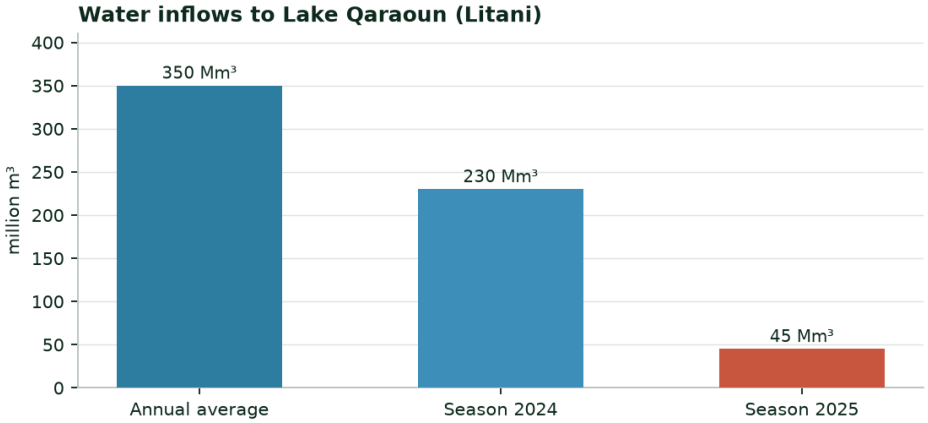


Figure 8. Water inflows to Lake Qaraoun (million m³). Source: Litani River Authority, cited by the press in 2025 (A16, C)



Lake Qaraoun and the southern Bekaa seen from the International Space Station.

According to the national farmers' union, 70% of potato growers in the Bekaa did not sow for lack of reliable irrigation.

Early estimates by the Ministry of Agriculture and FAO announced an apple harvest down by 25%, mainly in Akkar and the northern Bekaa (A17, A18, level C). In October 2024, the main pipeline of the Qasmieh scheme, which irrigates about 6,000 ha on the southern coast, had also been damaged during the hostilities.



The Litani in southern Lebanon.

5. Fertilisers: Quantities, prices, spending

5.1 Quantities used

Lebanese agriculture used 16,794 t of nitrogen (N) in 2024, against 7,564 t in 2022. Quantities vary greatly from one year to the next, in step with imports: The country does not produce nitrogen fertilisers. It does, however, produce phosphate fertilisers, largely exported.

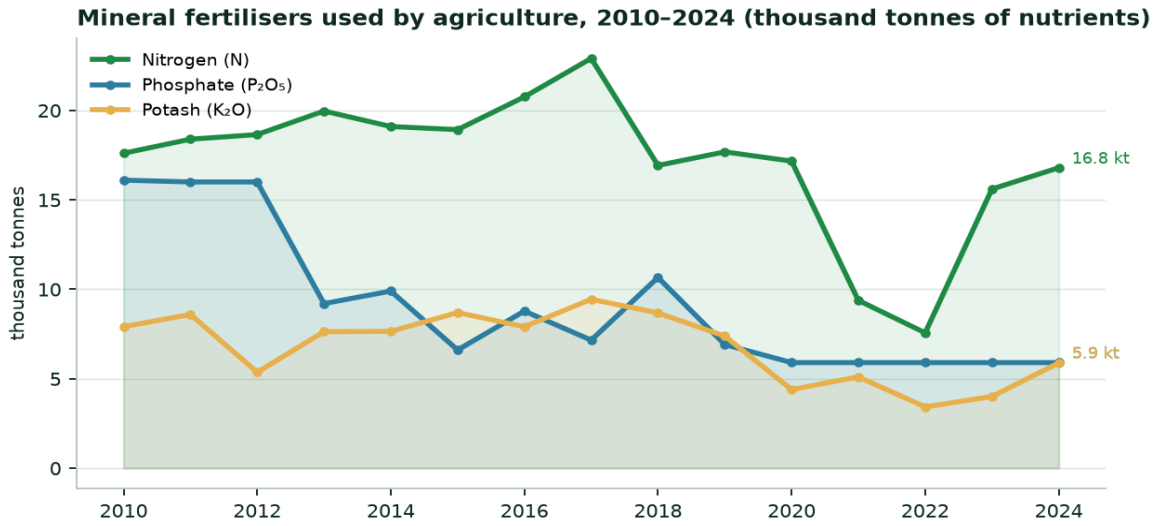


Figure 9. Mineral fertilisers used by agriculture, 2010–2024 (thousand tonnes of nutrients). Source: FAOSTAT, fertilisers by nutrient (A5)

Fertilisers used and phosphates exported, in tonnes of nutrients

Year	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	P_2O_5 exported
2019	17,681	6,911	7,382	78,890
2020	17,165	5,900	4,393	55,481
2021	9,379	5,900	5,103	67,174
2022	7,564	5,900	3,423	61,672
2023	15,603	5,900	4,008	35,820
2024	16,794	5,900	5,884	59,056

Source: FAOSTAT (A5). The value for phosphate used is a constant FAO estimate.

5.2 Prices

International fertiliser prices doubled in 2021–2022, then fell back. In 2024, urea cost 338 dollars per tonne and potassium chloride 295 dollars. The prices paid by Lebanese farmers, including transport and margins, are higher.

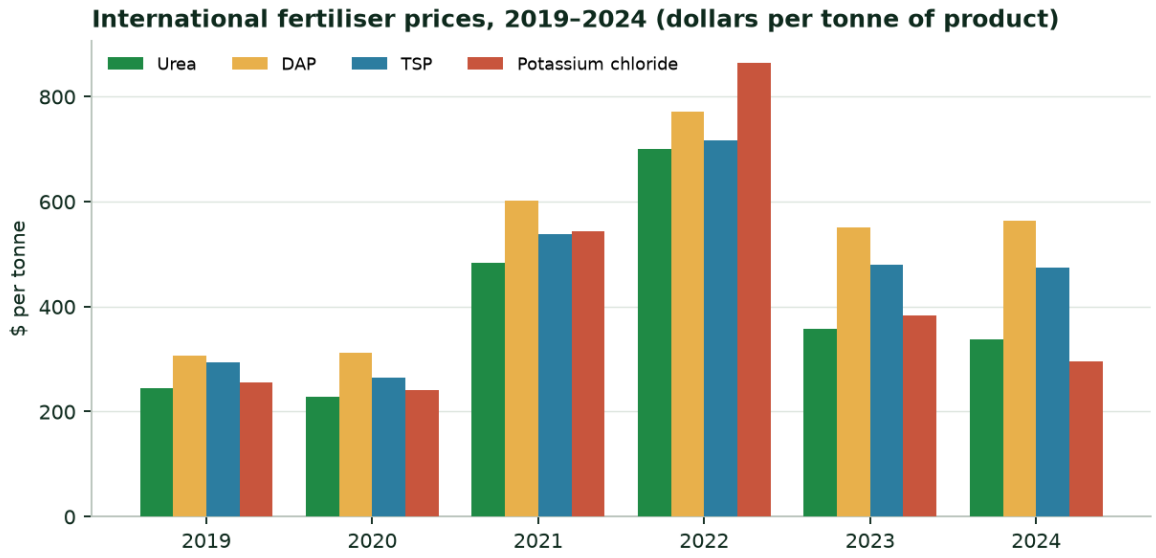


Figure 10. International fertiliser prices, 2019–2024 (dollars per tonne of product). Source: World Bank, Commodity Price Data (A11)

International prices, in dollars per tonne

Year	Urea	DAP	TSP	Potassium chloride
2019	245	306	294	256
2020	229	312	265	241
2021	483	601	538	543
2022	700	772	716	863
2023	358	550	480	383
2024	338	564	475	295

Source: World Bank (A11), annual averages.

5.3 Indicative spending

Converted into urea, superphosphate and potassium chloride, the nutrients used represent spending of at least 21.3 million dollars in 2024, and 25.6 million in 2022, the year of the price peak.

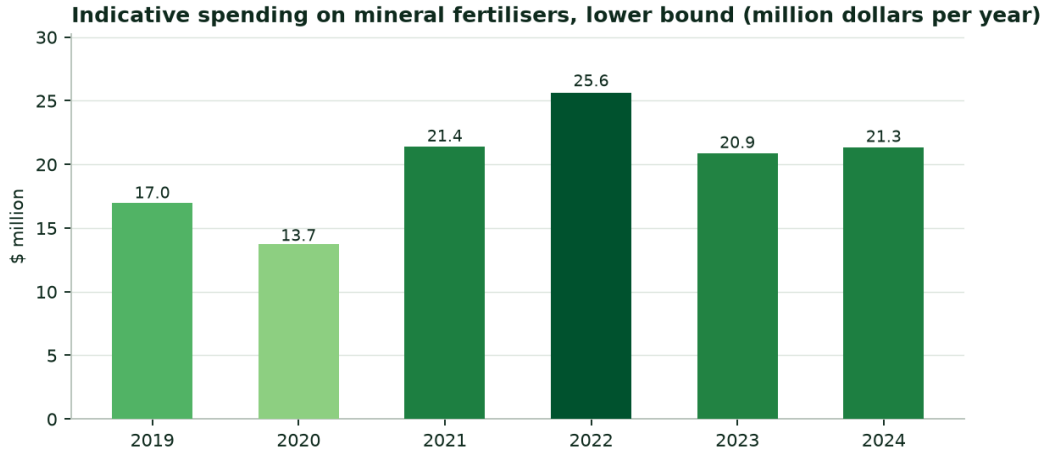


Figure 11. Indicative spending on mineral fertilisers, lower bound (million dollars per year). Source: Author's calculation from A5 and A11

Limits of the calculation

- International prices, without transport, duties or margins: Actual spending is higher.
- Compound fertilisers and foliar fertilisers are not distinguished.
- FAOSTAT quantities follow imports and can vary from one year to the next without any change in use.

6. By governorate

The 2010 agricultural census, conducted by the Ministry of Agriculture with FAO, is the only source that details areas by governorate. It distinguishes seven agricultural governorates; Beirut has no agricultural area. The Bekaa and Baalbek-Hermel account for 43% of the agricultural area and 55% of the irrigated areas.

Holdings and areas by governorate (2010)

Governorate	Holdings	UAA (ha)	Irrigated (ha)	Irrigated share	Greenhouses (ha)
Mount Lebanon	31,178	20,588	9,396	45.6%	525
North Lebanon	27,636	24,065	9,200	38.2%	477
Akkar	28,120	35,352	15,649	44.3%	1,574
Bekaa	12,516	41,649	29,866	71.7%	86
Baalbek-Hermel	21,569	57,625	31,703	55.0%	219
South Lebanon	22,111	25,621	12,203	47.6%	628
Nabatieh	26,382	26,095	4,939	18.9%	293
Lebanon	**169,512**	**230,995**	**112,956**	**48.9%**	**3,802**

Source: 2010 agricultural census, Ministry of Agriculture and FAO (A7).

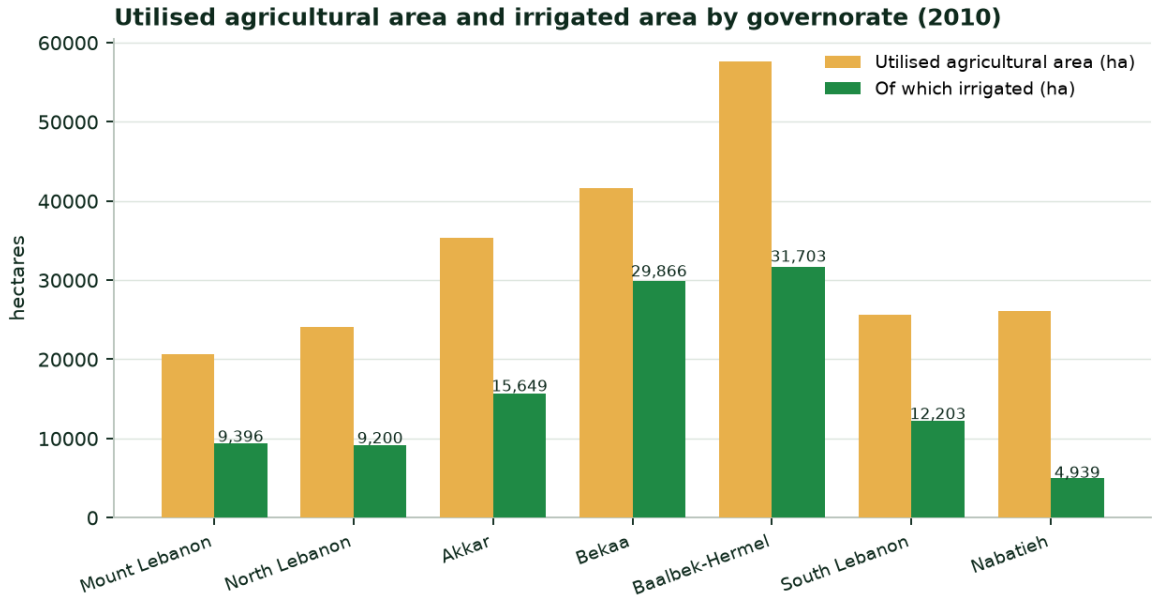


Figure 12. Utilised agricultural area and irrigated area by governorate (2010, hectares). Source: Agricultural census (A7)

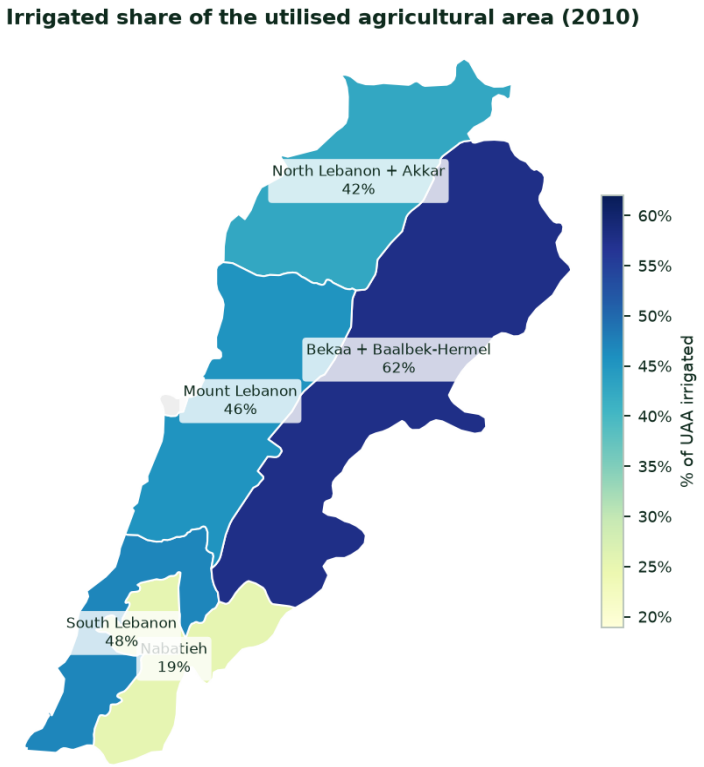


Figure 13. Irrigated share of the utilised agricultural area (2010). The map boundaries group Akkar with North Lebanon and Baalbek-Hermel with the Bekaa. Source: Agricultural census (A7); Natural Earth boundaries, public domain (A19)

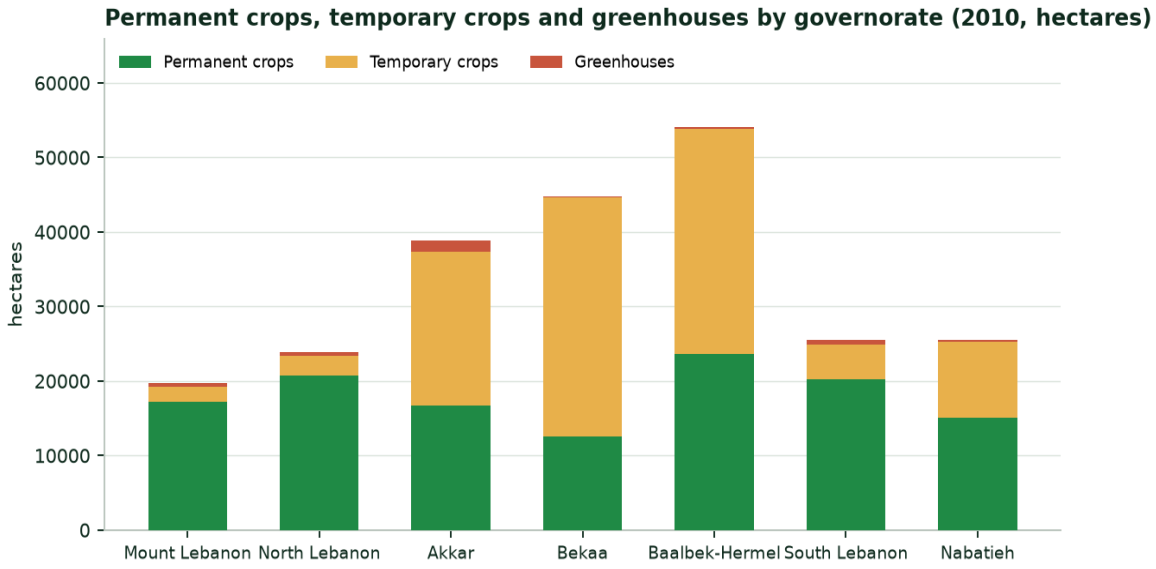


Figure 14. Permanent crops, temporary crops and greenhouses by governorate (2010, hectares). Source: Agricultural census (A7)

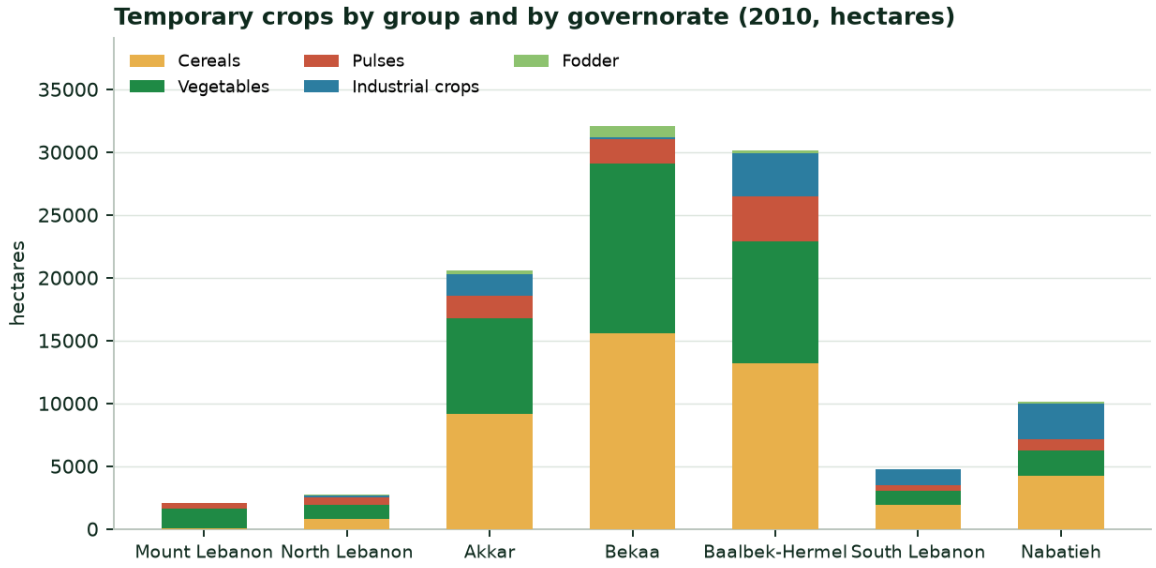


Figure 15. Temporary crops by group and by governorate (2010, hectares). Source: Agricultural census (A7)

Climate and water saved by governorate

Governorate	Capital	Radiation (kWh/m²/year)	Rainfall (mm/year)	Water saved, central (Mm³/year)
Mount Lebanon	Baabda	1,827	631	12.2
North Lebanon	Tripoli	1,926	703	11.9
Akkar	Halba	1,696	481	20.3
Bekaa	Zahle	2,009	410	38.8
Baalbek-Hermel	Baalbek	1,982	347	41.1
South Lebanon	Sidon	1,941	646	15.8
Nabatieh	Nabatieh	1,928	616	6.4

Source: PVGIS (A9); ERA5-Land (A10); author's calculation (Annex B).

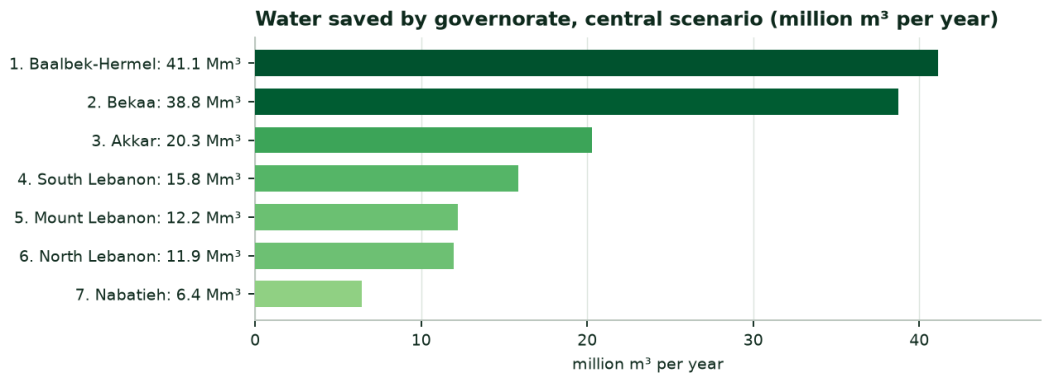


Figure 16. Water saved by governorate, central scenario (million m³ per year). Source: Author's calculation (Annex B)

Reading by governorate

• **Baalbek-Hermel and Bekaa**: The largest irrigated areas and the lowest rainfall. Cereals, potatoes, vegetables, vines. This is where the water saving weighs most.

• **Akkar**: Irrigated coastal plain, the country's largest greenhouse area (1,574 ha). Vegetables and potatoes.

• **South Lebanon and Nabatieh**: Citrus, bananas and olive trees on the coast; rain-fed crops inland. Qasmieh scheme.

• **Mount Lebanon and North Lebanon**: Terraced orchards (apples, cherries, stone fruit), olive trees; very small holdings.



Vineyards near Zahle, in the central Bekaa.

7. The twenty main crops: Three rankings

Three rankings complement each other: The area occupied, the irrigated area and the value of production. A very widespread but rain-fed crop, such as olives or wheat, weighs less in water savings than a smaller irrigated crop, such as potatoes.

7.1 By area

Twenty main crops by harvested area (2023)

Rank	Crop	Area (ha)	Production (t)	Yield (t/ha)
1	Olives	64,082	121,769	1.9
2	Wheat	55,368	158,754	2.9
3	Potatoes	27,647	656,375	23.7
4	Apples	16,647	219,770	13.2
5	Barley	12,262	27,453	2.2
6	Grapes	11,104	151,863	13.7
7	Unmanufactured tobacco	8,322	10,501	1.3
8	Avocados	6,107	119,467	19.6
9	Other fruits	5,772	54,652	9.5
10	Tomatoes	4,949	209,605	42.4
11	Almonds	4,946	10,526	2.1
12	Peaches and nectarines	4,599	61,848	13.4
13	Cherries	4,353	28,783	6.6
14	Lemons and limes	4,286	71,412	16.7
15	Oranges	3,895	69,578	17.9
16	Other fresh vegetables	3,886	10,236	2.6
17	Apricots	3,360	18,219	5.4
18	Dry onions	2,980	111,053	37.3
19	Cucumbers	2,940	130,052	44.2
20	Eggplants	2,848	49,618	17.4

Source: FAOSTAT, crop production 2023 (A2); aggregates excluded.

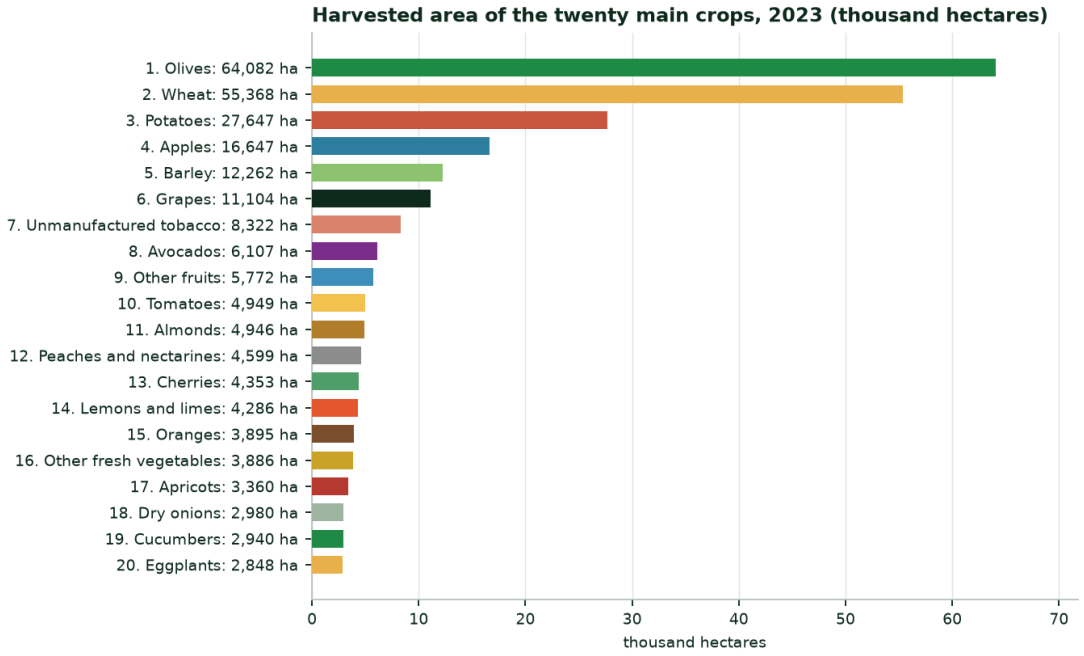


Figure 17. Harvested area of the twenty main crops, 2023 (thousand hectares). Source: FAOSTAT (A2)

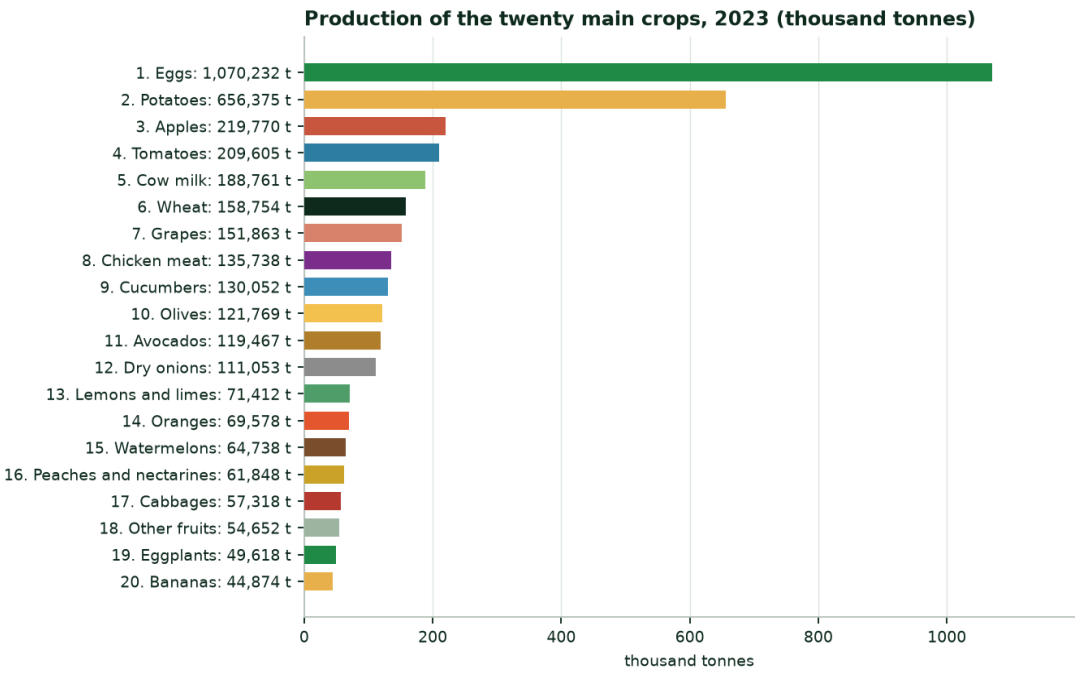


Figure 18. Production of the twenty main crops, 2023 (thousand tonnes). Source: FAOSTAT (A2)

7.2 By irrigated area

The breakdown of irrigated crops is published in detail only for 2003. Cereals (mainly wheat) occupy 24% of the area harvested under irrigation, potatoes 18%, citrus 16% and vegetables 14%. This breakdown serves as the key for the calculations in section 8.

Areas harvested under irrigation by crop (2003)

Rank	Crop	Irrigated area (ha)	Share of total
1	Potatoes	19,166	18.2%
2	Wheat	16,940	16.1%
3	Citrus	16,426	15.6%
4	Vegetables	14,341	13.6%
5	Tobacco	8,983	8.5%
6	Barley	5,140	4.9%
7	Other perennial crops	4,900	4.7%
8	Pulses	4,310	4.1%
9	Other roots and tubers	4,156	3.9%
10	Maize	3,490	3.3%
11	Other annual crops	3,400	3.2%
12	Bananas	2,754	2.6%
13	Groundnuts	718	0.7%
14	Flowers	508	0.5%
15	Other cereals	61	0.1%

Source: FAO AQUASTAT, based on the Ministry of Agriculture and FAO (A8).

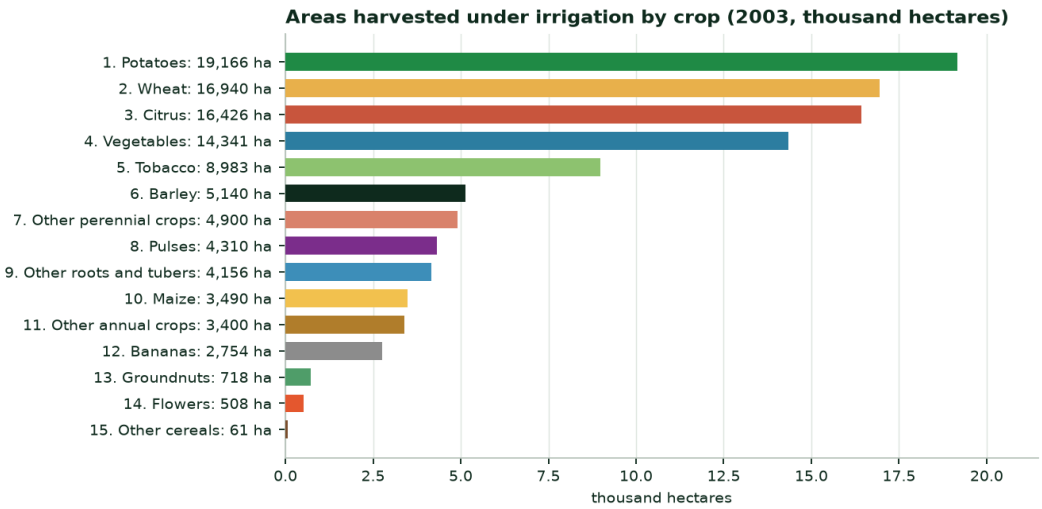


Figure 19. Areas harvested under irrigation by crop (2003, thousand hectares). Source: FAO AQUASTAT (A8)



Local tomatoes grown in Bteghrine (Metn).

7.3 By value of production

By value, potatoes come first, ahead of grapes, olives, avocados, apples and tomatoes. The twenty main crops account for 87% of the total value of crops, i.e. 1.36 billion international dollars in 2023. The dossier uses constant 2014–2016 prices: Since the crisis of the Lebanese pound, values in current dollars are no longer comparable.

Value of production by crop (2023, constant 2014–2016 prices)

Rank	Crop	Value (international $ M)	Share of crops
1	Potatoes	164.3	12.1%
2	Grapes	130.1	9.6%
3	Olives	129.9	9.6%
4	Avocados	109.1	8.0%
5	Apples	103.7	7.6%
6	Tomatoes	99.8	7.4%
7	Almonds	53.2	3.9%
8	Cherries	50.7	3.7%

Rank	Crop	Value (international $ M)	Share of crops
9	Cucumbers	48.7	3.6%
10	Dry onions	46.2	3.4%
11	Lemons and limes	41.3	3.0%
12	Peaches and nectarines	37.7	2.8%
13	Wheat	37.6	2.8%
14	Unmanufactured tobacco	23.5	1.7%
15	Other fruits	23.4	1.7%
16	Oranges	22.7	1.7%
17	Bananas	16.0	1.2%
18	Pears	15.5	1.1%
19	Watermelons	15.0	1.1%
20	Apricots	14.9	1.1%

Source: FAOSTAT, value of production (A3).

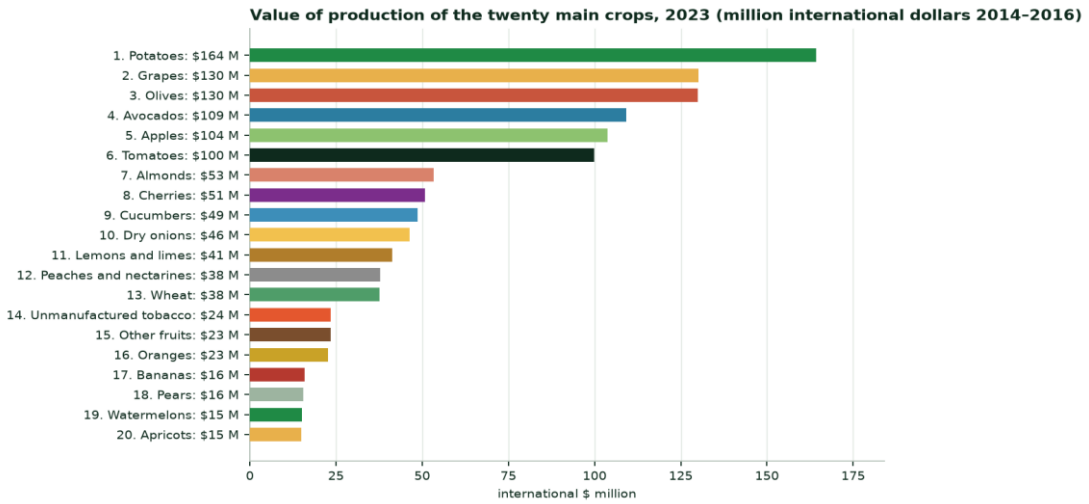


Figure 20. Value of production of the twenty main crops, 2023 (million international dollars). Source: FAOSTAT (A3)

8. Extrapolation by crop and water savings

8.1 Method

Method in brief

• **Irrigation water**: 882 million m³ per year (NWSS 2020), shared between crops according to their share of the irrigated area (AQUASTAT 2003).

• **Water saving**: For each crop group, a quarter (prudent), half (central) or all (strong) of the saving measured in the closest trial. Without a trial, 5%, 10% or 20%.

• **Yield gain**: Same rule, applied to the average FAOSTAT 2023 yields and valued at constant 2014–2016 prices.

• **Value of water**: 0.10, 0.25 or 0.50 dollar per m³ (section 4.3).

• **What the calculation does not contain**: No product price, no application cost.

8.2 Trials used as analogues

Trials cited and their use in the calculation

Trial	Published water saving	Published yield gain	Use in the dossier	Level
Maize, Turkey (TIGEM, 2025)	−39%	+17.1%	Maize	C
Potato, South Africa (2025–2026)	−52%	+31.4%	Potatoes and tubers	C
Watermelon, Mexico (2023)	−60.5%	+30%	Vegetables	C
Soybean, China (Shandong)	Not measured	+11.2 to 11.4%	Yield of cereals and pulses	B
Date palm, United Arab Emirates (ICBA, 2020–2021)	−82%	+20%	Not used (no date palms in Lebanon)	B

Source: Trials published on the Green Solutions website (A20 to A24).



Greenhouse wheat trials at the Terbol research station (ICARDA), in the Bekaa.

8.3 Parameters by crop group

Water saving and yield gain used, by scenario (prudent / central / strong)

Group	Analogue	Water	Yield
Cereals (wheat, barley)	Water: Generic assumption; yield: Soybean, China	5.0% / 10.0% / 20.0%	2.8% / 5.7% / 11.3%
Maize	Maize, Turkey (TIGEM, 2025)	9.8% / 19.5% / 39.0%	4.3% / 8.6% / 17.1%
Potatoes and other tubers	Potato, South Africa (2025-2026)	13.0% / 26.0% / 52.0%	7.8% / 15.7% / 31.4%
Vegetables	Watermelon, Mexico (2023)	15.1% / 30.2% / 60.5%	7.5% / 15.0% / 30.0%
Pulses	Water: Generic assumption; yield: Soybean, China	5.0% / 10.0% / 20.0%	2.8% / 5.7% / 11.3%
Tobacco	Generic assumption, no trial	5.0% / 10.0% / 20.0%	—
Other annual crops (groundnuts, flowers…)	Generic assumption, no trial	5.0% / 10.0% / 20.0%	—
Citrus	Generic assumption, no trial	5.0% / 10.0% / 20.0%	—
Bananas	Generic assumption, no trial	5.0% / 10.0% / 20.0%	—
Other perennial crops (apple trees, stone fruit…)	Generic assumption, no trial	5.0% / 10.0% / 20.0%	—

Source: Author's calculation (Annex B).

8.4 National results

147 Mm³
Of water saved per year in the central scenario (17% of irrigation water).

73 to 293
Million m³ per year, from the prudent to the strong scenario.

165,000 t
Of additional production in the central scenario (potatoes, vegetables, cereals).

Water saving and value per year, by scenario and value of water

Scenario	Water saved (Mm³/year)	Share of irrigation	Water at $0.10 ($ M)	Water at $0.25 ($ M)	Water at $0.50 ($ M)	Yield ($ M)
Prudent	73	8.3%	7.3	18.3	36.6	25.4
Central	147	16.6%	14.7	36.6	73.3	50.9
Strong	293	33.2%	29.3	73.3	146.6	101.8

Source: Author's calculation (Annex B).

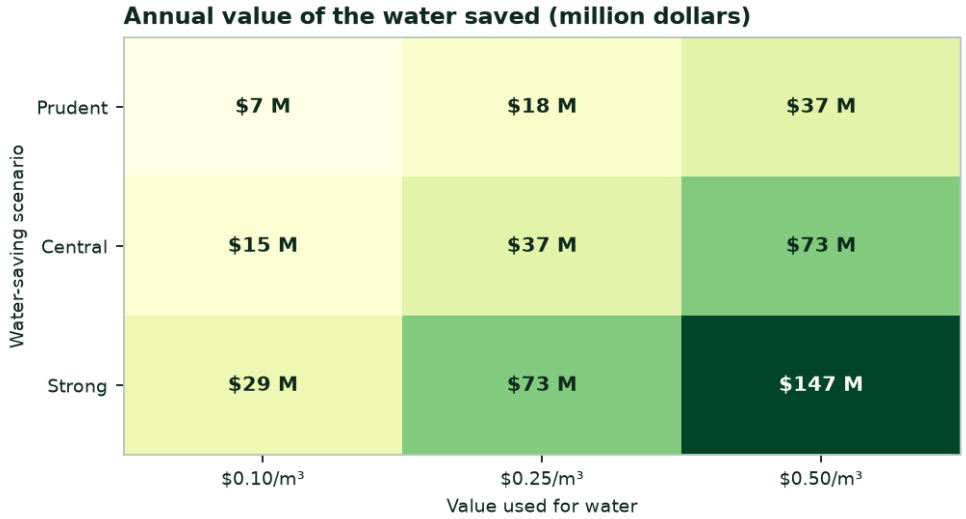


Figure 21. Annual value of the water saved (million dollars), by scenario and value of water. Source: Author's calculation

In the central scenario, the total value reaches about 88 million dollars per year: 37 million for water at $0.25/m³, and 51 million for the yield gain.

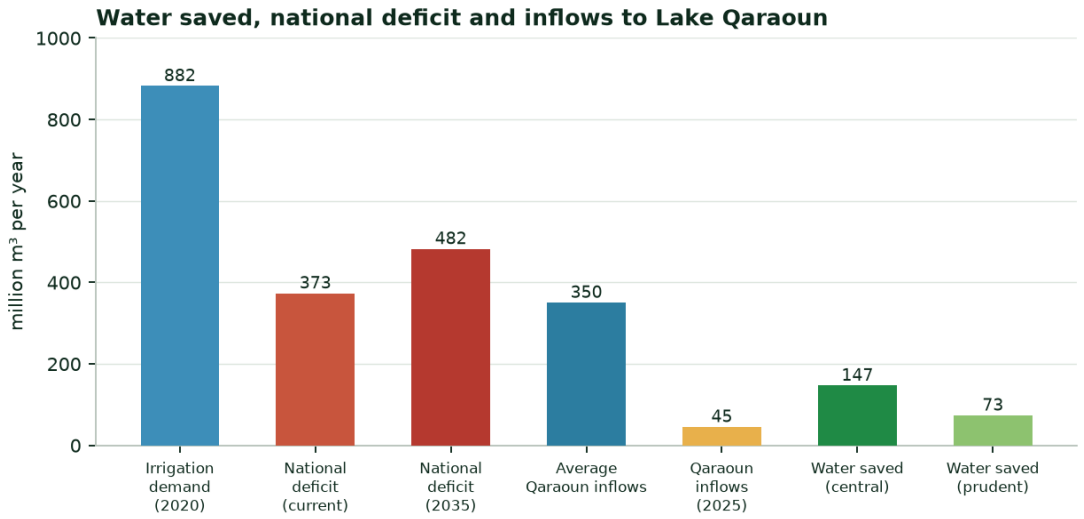


Figure 22. Water saved compared with the national deficit and the inflows to Lake Qaraoun (million m³ per year). Source: World Bank (A13); Litani River Authority (A16); author's calculation

8.5 Water saved by crop (central scenario)

Water saved by crop group (central scenario)

Group	Share of irrigated area	Irrigation water (Mm³/year)	Water saved (Mm³/year)	Yield gain (t)
Potatoes and other tubers	22.1%	195	50.8	86,930
Vegetables	13.6%	120	36.3	72,807
Cereals (wheat, barley)	21.0%	185	18.5	3,587
Citrus	15.6%	138	13.8	—
Tobacco	8.5%	75	7.5	—
Maize	3.3%	29	5.7	895
Other perennial crops (apple trees, stone fruit…)	4.7%	41	4.1	—
Other annual crops (groundnuts, flowers…)	4.4%	39	3.9	—
Pulses	4.1%	36	3.6	454
Bananas	2.6%	23	2.3	—

Source: Author's calculation (Annex B).

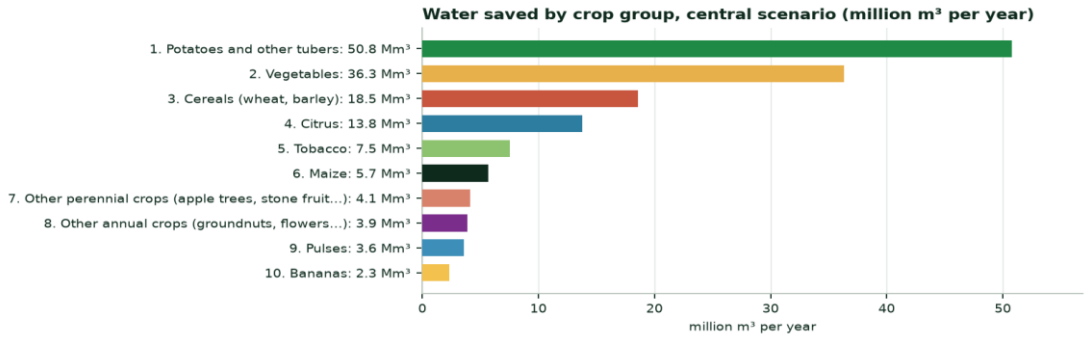


Figure 23. Water saved by crop group, central scenario (million m³ per year). Source: Author's calculation

8.6 Reading the results

Key points

• The central water saving (147 Mm³ per year) is equivalent to 39% of the national deficit estimated by the World Bank, and to 42% of the average annual inflows to Lake Qaraoun.

• Potatoes and vegetables provide most of the result: They are the irrigated crops for which published trials exist.

• Citrus, bananas and orchards rest on a generic assumption: A local trial on these crops would change the result considerably.

• The irrigated cereals of the Bekaa cover a large area: A modest gain there weighs heavily.

9. Potential benefits of our products

The table sets each expected benefit against what has been published, its source and its limit. It contains no promise of yield.

Benefits, evidence and limits

Benefit	What has been published	Source (level)	Limit
Less irrigation water	−39% (maize), −52% (potato), −60.5% (watermelon), −82% (date palm)	Green Solutions and ICBA trials (A20 to A24, B to C)	Trials outside Lebanon, often on a single plot

Benefit	What has been published	Source (level)	Limit
Yield maintained or increased	+17.1% (maize), +31.4% (potato), +30% (watermelon), +11% (soybean)	Same trials (B to C)	No statistical replication for most
Resistance to drought	Plants without visible water stress with less frequent irrigation (date palm)	ICBA (A20, B)	Sandy soil; to be checked on Lebanese calcareous soil
Lower fertiliser losses	Higher nutrient levels in the root zone (date palm)	ICBA (A20, B)	Not quantified in fertiliser saved
Organic fertilisation	ECOFERT® certified by SOHISCERT and EU Organic	Certificate (A25, A)	Own agronomic effect not isolated

Source: See the "Source" column.

What this dossier does not use

- The cotton figures in Turkey (+93% yield): Demonstration under extreme stress, not representative.
- The effects claimed for Water Vital® and NAPEMA®: No independent source in the documents consulted.
- Any product or application price.

10. External trade: Exports and imports

10.1 Overview, 2024

Agricultural trade of Lebanon

Indicator	2023	2024	Variation
Agricultural exports ($ M)	444	476	7.2%
Agricultural imports ($ M)	2,593	2,736	5.5%
Agricultural balance ($ M)	-2,149	-2,260	—
Share of merchandise exports	—	12.6%	—
Share of merchandise imports	—	15.8%	—

Source: FAOSTAT, trade in agricultural products (A6); subtotals excluded.

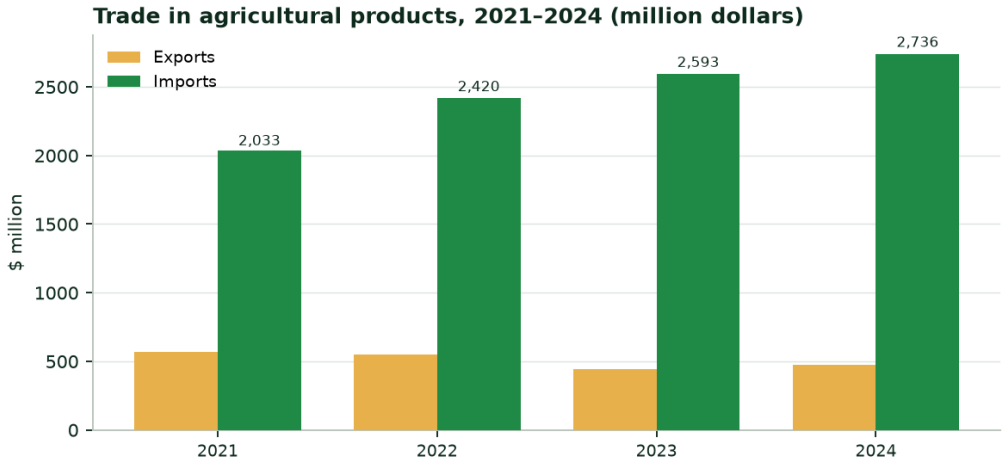


Figure 24. Trade in agricultural products, 2021–2024 (million dollars). Source: FAOSTAT (A6); subtotals excluded

Lebanon imports about 5.7 times more agricultural products than it exports. Imports are mainly cereals, oils, sugar, livestock and dairy products; exports are olive oil, grapes, potatoes, bananas, apples, avocados, wine and tobacco.

10.2 Exports

Exports of water-sensitive products, 2024

Product	Value 2024 ($ M)	Volume 2024 (t)	Value 2023 ($ M)
Olive oil	69.1	6,880	36.5
Grapes	28.5	29,137	22.0
Potatoes	15.2	36,011	11.7
Bananas	13.1	20,005	21.5
Apples	11.5	27,144	22.3
Avocados	6.4	6,559	4.5
Unmanufactured tobacco	12.1	2,870	6.9
Wine	20.8	2,192	22.7

Source : FAOSTAT (A6).

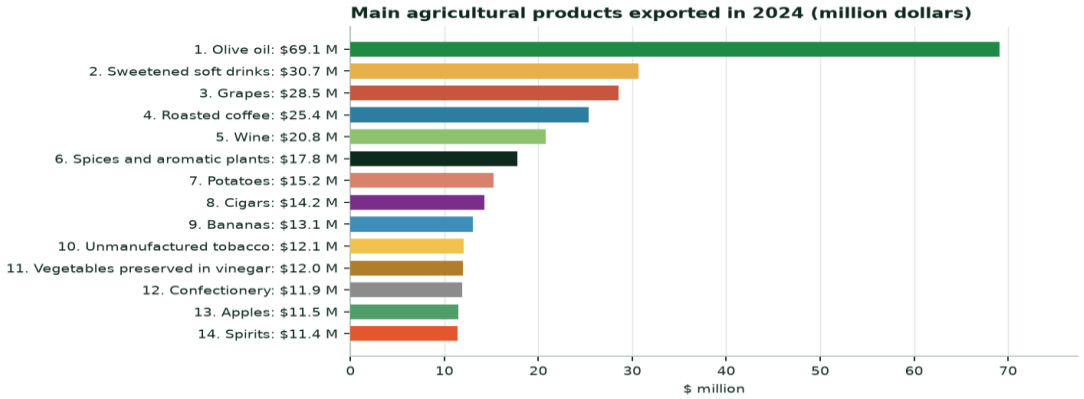


Figure 25. Main agricultural products exported in 2024 (million dollars). Source: FAOSTAT (A6)

10.3 Imports

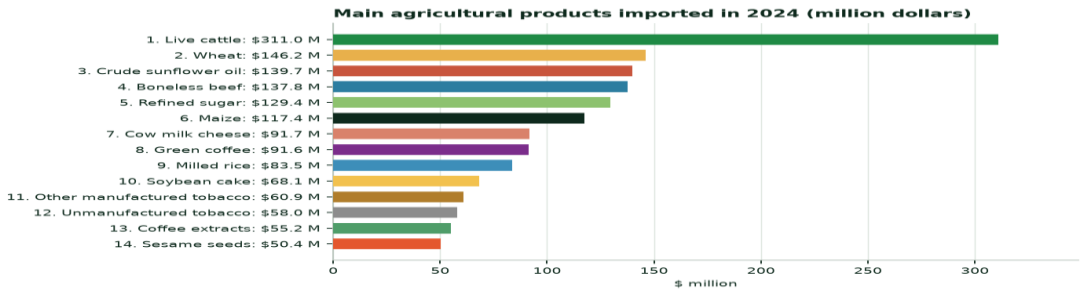


Figure 26. Main agricultural products imported in 2024 (million dollars). Source: FAOSTAT (A6)

Imports of cereals and staple products, 2024

Product	Volume 2023 (t)	Volume 2024 (t)	Value 2024 ($ M)
Wheat	460,009	496,117	146.2
Maize	391,704	453,145	117.4
Milled rice	58,219	79,734	83.5
Barley	37,792	50,857	12.6
Potatoes	59,006	83,195	44.6
Soybean cake	140,368	134,480	68.1
Crude sunflower oil	108,361	120,059	139.7
Refined sugar	132,224	172,376	129.4

Source : FAOSTAT (A6).

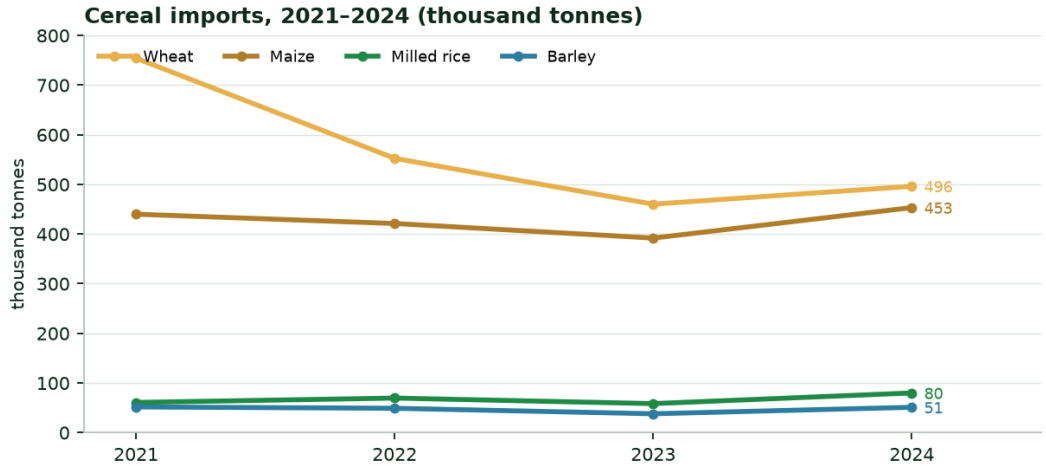


Figure 27. Cereal imports, 2021–2024 (thousand tonnes). Source: FAOSTAT (A6)

Wheat and maize dominate cereal imports: 496 and 453 thousand tonnes in 2024. Imported maize mainly feeds livestock and poultry.

10.4 Water and imports

Imported wheat (496 thousand tonnes in 2024) represents about 3.1 times the 2023 national production (159 thousand tonnes). For maize, the gap is even wider. The country exports 36 thousand tonnes of potatoes and imports 83: Irrigated production in the Bekaa and Akkar does not cover the whole year.

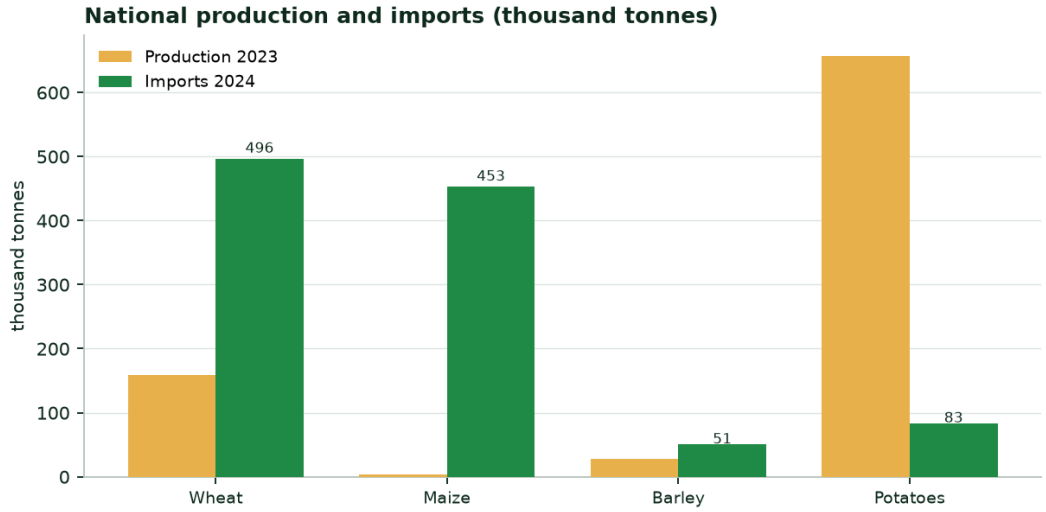


Figure 28. National production (2023) and imports (2024), in thousand tonnes. Source: FAOSTAT (A2, A6)

10.5 Drought and the 2025 season

The 2025 drought reduces irrigated production of potatoes, vegetables and fruit, and increases import needs. Every cubic metre kept in the soil of irrigated plots reduces this dependence. The final figures for the 2025 season had not been published in the sources consulted.

11. Limits and points to complete

What remains to be completed

• **Measured irrigation volumes**: The dossier uses an estimated demand (NWSS 2020), not volumes measured by scheme.

• **Irrigated crops**: The detailed breakdown dates from 2003; the 2010 census does not give it by crop.

• **Rainfall**: Official normals not obtained; the values by governorate capital come from a reanalysis model.

• **Water prices**: No recent irrigation tariff per m³; three reference values are used.

• **Value of production**: Constant 2014–2016 prices, for lack of reliable current prices since the crisis of the Lebanese pound.

• **Fertilisers**: FAOSTAT quantities vary greatly from one year to the next; international prices, not prices paid in Lebanon.

• **Trials**: No trial of our products has yet been carried out in Lebanon; all results are scenarios.

• **Statistics after 2019**: The economic crisis and the 2024 hostilities disrupted data collection; several series stop or are estimated.

Annex A. Sources and confidence levels

List of sources

Ref.	Source	Publisher or author	Edition	Level	Link or reference
A1	World Development Indicators (WDI)	World Bank	2022–2025	A	api.worldbank.org
A2	Crop production (QCL)	FAO, FAOSTAT	2023	A	fao.org/faostat
A3	Value of agricultural production (QV)	FAO, FAOSTAT	2023	A	fao.org/faostat
A4	Land use (RL)	FAO, FAOSTAT	2023	A	fao.org/faostat
A5	Fertilisers by nutrient (RFN)	FAO, FAOSTAT	2010–2024	A	fao.org/faostat
A6	Trade in agricultural products (TCL)	FAO, FAOSTAT	2023–2024	A	fao.org/faostat
A7	Agricultural census 2010, main results	Ministry of Agriculture and FAO	2010	A	data.unhcr.org, document 44733
A8	Irrigation in the Middle East region in figures, Lebanon chapter	FAO, AQUASTAT	2008	A	fao.org/aquastat
A9	PVGIS 5.2, monthly radiation	European Commission, JRC	2005–2020	A	re.jrc.ec.europa.eu/pvg_tools
A10	ERA5-Land reanalysis, daily rainfall	European Centre (ECMWF), via Open-Meteo	1991–2020	B	open-meteo.com
A11	Commodity Price Data (Pink Sheet)	World Bank	2019–2024	A	worldbank.org/commodities
A12	National Water Sector Strategy, 2020 update	Ministry of Energy and Water; Fanack summary	2020	B	water.fanack.com
A13	Project document P125184 (Bisri dam)	World Bank	2014–2020	B	worldbank.org/projects
A14	Second national communication to the UNFCCC	Ministry of Environment	2011	B	climatechange.moe.gov.lb
A15	Lebanon country profile (citing the 3rd communication)	Red Cross Red Crescent Climate Centre	2024	B	climatecentre.org
A16	Inflows to Lake Qaraoun	Litani River Authority, cited by L'Orient-Le Jour and This is Beirut	2025	C	lorientlejour.com
A17	Drought and agriculture in 2025	Arab News	2025	C	arabnews.com
A18	Apple harvest estimate	Ministry of Agriculture and FAO, cited by the press	2025	C	Press
A19	Administrative boundaries	Natural Earth (public domain)	Version 5	A	naturalearthdata.com

Ref.	Source	Publisher or author	Edition	Level	Link or reference
A20	Date palms, Dubai	ICBA	2020–2021	B	Green Solutions website, trials
A21	Watermelons, Hermosillo (Mexico)	Green Solutions	2023	C	Green Solutions website, trials
A22	Maize, Konya (Turkey)	Green Solutions, D.I.S. and TIGEM	2025	C	Green Solutions website, trials
A23	Potatoes, Bloemfontein (South Africa)	Afrinest Farm Group	2025–2026	C	Green Solutions website, trials
A24	Soybean, Shandong (China)	Shandong Institute of Soil and Fertiliser	Undated	B	Green Solutions website, trials
A25	ECOFERT® certificate	SOHISCERT	In force	A	Green Solutions website
A26	Claimed performance, doses and uses	Green Solutions	2026	C	Green Solutions website
A27	Calculations in this dossier	Author of the dossier	—	—	Annex B

Annex B. Calculation method

Radiation. Sum of the PVGIS monthly global horizontal radiation values (192 values), divided by the number of years (16). Capital of each governorate.

Rainfall. Sum of ERA5-Land daily rainfall from 1991 to 2020 at the governorate capital, divided by 30.

Water per irrigated hectare. 2020 irrigation demand (882 million m³) ÷ 2010 irrigated area (112,956 ha) = 7,808 m³/ha.

Sharing of water between crops. Share of each crop in the area harvested under irrigation in 2003 (105,293 ha) × irrigation volume. The calculation assumes the same quantity of water per hectare for all crops.

Water saved. Irrigation water of the group × water saving of the scenario.

Yield gain. Irrigated area of the group × average FAOSTAT 2023 yield (t/ha) × yield gain of the scenario.

Value created. Water saved × value of water (0.10, 0.25 or 0.50 $/m³) + yield gain × implicit price (FAOSTAT 2023 value at constant 2014–2016 prices ÷ production).

Scenarios. Prudent: 25% of the trial effect. Central: 50%. Strong: Published effect. Crops without a trial: 5%, 10% and 20% water saving, with no yield gain.

By governorate. National result × share of the governorate in the 2010 irrigated area.

Fertiliser spending. Nitrogen ÷ 0.46 × urea price + phosphate ÷ 0.46 × TSP price + potash ÷ 0.60 × potassium chloride price, at World Bank international prices. This is a lower bound.

General limits. National averages; a single coefficient per crop group; 2003 breakdown of irrigated crops; no product cost is included in the dossier's calculations.



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