COUNTRY DOSSIER

Peru

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

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The Colca valley and its terraces (Arequipa).

Foreword

This dossier describes Peru 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 in short supply? For which crops? In which regions? It then examines what difference our products can make, 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, Peruvian public bodies (INEI, MIDAGRI, SENASA, National Water Authority ANA)).
- **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 Peru.

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Summary

The points below summarise the dossier. The figures come from public sources: The World Bank, FAO (FAOSTAT, AQUASTAT), Peruvian public bodies (INEI, MIDAGRI, SENASA, National Water Authority ANA), PVGIS and NASA POWER. The production gains and water savings are scenarios, described in Annex B.

34.58 M
Inhabitants in 2025 (World Bank)

461,207 ha
Of maize (corn) harvested in 2024, the main crop

2.58 M ha
Equipped for irrigation (2024)

+30,628 t
Of potato per 10,000 ha treated, central scenario

2,444 Mm³
Of irrigation water saved a year, central scenario

12,426 M$
Of agricultural exports in 2024 (FAOSTAT)

Key points

• **Irrigation, a pillar of production.** 2.58 million hectares equipped for irrigation in 2024, or 42% of the 6.20 million hectares of cropland.

• **Maize (corn): The main crop.** 461,207 ha harvested in 2024, for 1.69 million tonnes, or 3.66 t/ha.

• **Water is not scarce over the year as a whole; it is scarce between rainfall events.** National water stress is only 4.8%, but at Piura, atmospheric water demand exceeds rainfall by 1,967 mm.

• **In rainfed farming, the gain is counted in tonnes.** In the central scenario, an additional 30,628 t of potato and 3,126 t of maize per 10,000 ha treated.

• **In irrigated farming, the water saved could allow irrigation schemes to be expanded.** 2,443.7 Mm³ a year in the central scenario, enough to irrigate about 298,613 more ha, or 11.6% of the equipped area.

• **An organic supply chain.** 186,410 ha of certified organic cropland in 2023: ECOFERT® is EU Bio certified.

• **All nitrogen is imported.** 222,210 t of nitrogen used in 2024, 517,548 t imported, no national production.

• **Farm trade.** $12,426 million of exports and $6,515 million of imports in 2024. Leading export: Other berries ($2,212 million). Leading import: Maize (corn) ($1,001 million).

Key figures

Key indicators for Peru

Indicator	Value	Year	Source (level)
Population	34.58 M	2025	World Bank (A1)
GDP per capita	9,684 $	2025	World Bank (A1)
Agriculture's share of GDP	7.5%	2024	World Bank (A1)
Agricultural employment	23.1%	2025	World Bank (A1)
Cropland	6,197,050 ha	2024	FAOSTAT (A6)
Area equipped for irrigation	2,579,770 ha	2024	FAOSTAT (A6)
Harvested area: Maize (corn)	461,207 ha	2024	FAOSTAT (A2)
Certified organic cropland	186,410 ha	2023	FAOSTAT (A6)
Agricultural exports	12,426 M$	2024	FAOSTAT (A4)

Indicator	Value	Year	Source (level)
Agricultural imports	6,515 M$	2024	FAOSTAT (A4)
Mineral nitrogen, agricultural use	222,210 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 reported in 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 Peru. 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.



Avocado harvest in Aguar-Caujul.

2. Peru in figures

Peru had 34.58 million inhabitants in 2025, 14% of them in rural areas. Agriculture accounts for 7.5% of gross domestic product and employs 23% of the labour force. The country covers 1,280.0 thousand km², of which 19% is agricultural land. Undernourishment affects 5.7% of the population.

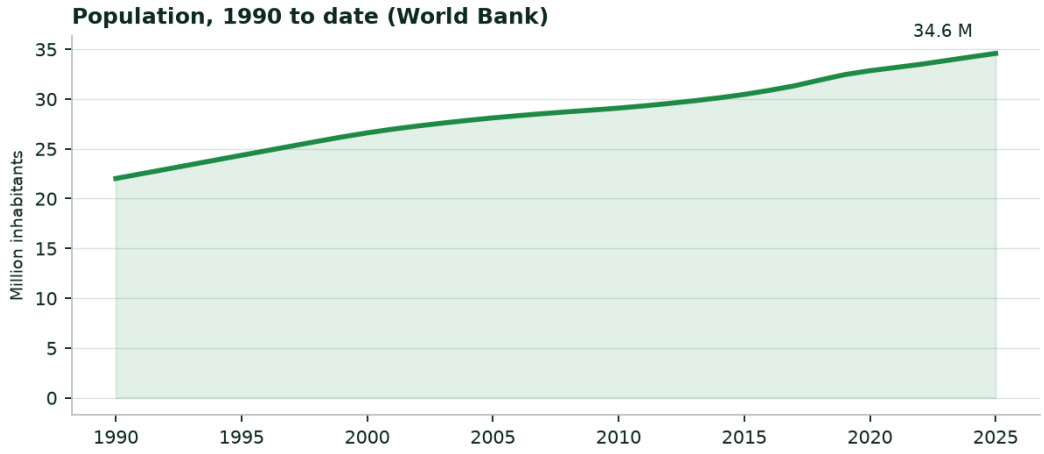


Figure 1. Population of Peru, 1990 to date. Source: World Bank (A1)

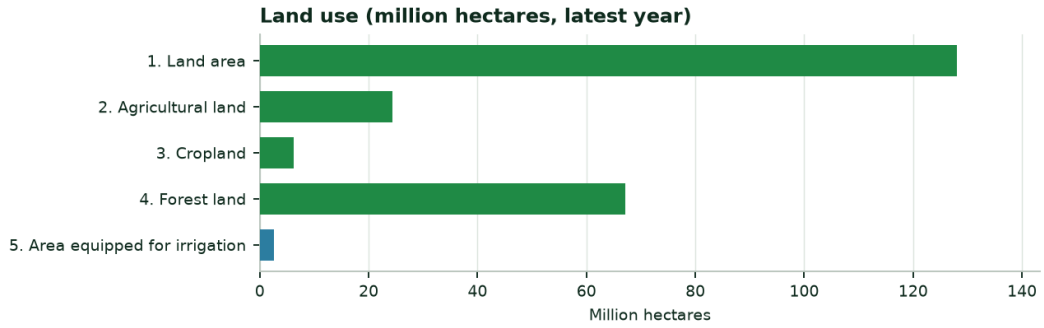


Figure 2. Land use, latest year published. Source: FAOSTAT (A6)

Agricultural and water indicators, latest year published

Indicator	Value	Year	Source
Cropland certified organic	186,410 ha	2023	FAOSTAT (A6)
Average cereal yield	4,851 kg/ha	2024	World Bank (A1)
Fertiliser use per hectare of arable land	93.5 kg/ha	2024	World Bank (A1)
Water withdrawals, agricultural share	81.5%	2022	World Bank (A1)
Internal freshwater resources	1,641.0 km³	2022	World Bank (A1)
Internal resources per inhabitant	49,021 m³	2022	World Bank (A1)



The irrigated countryside of Arequipa.

3. Sunshine, rainfall and climate change

3.1 Sunshine

Global solar radiation reaches 1,602 to 2,471 kWh/m² a year depending on the region. Energy is not the limiting factor: Water available at the right time determines the harvest.

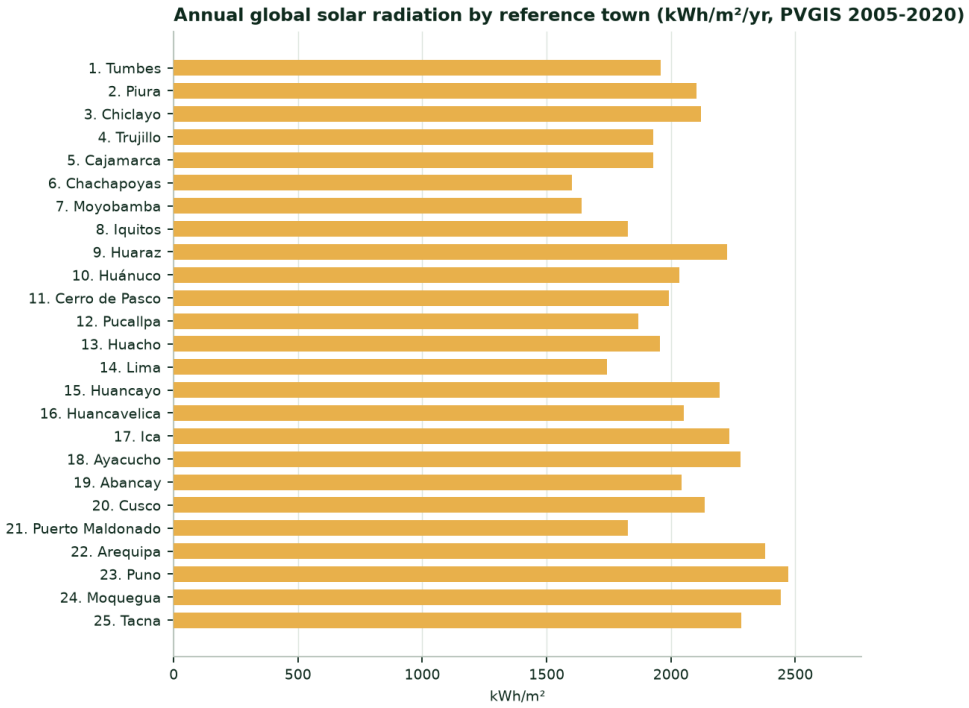


Figure 3. Annual global solar radiation in each reference town. Source: PVGIS (A8)

3.2 Rainfall and evapotranspiration

Annual rainfall is 2,837 mm at Iquitos, but only 25 mm at Lima, where reference evapotranspiration reaches 1,370 mm. The coast is a desert where it almost never rains: All its farming is irrigated by rivers coming down from the Andes. In the Andes, rain falls from November to March; the Amazon forest is humid all year.

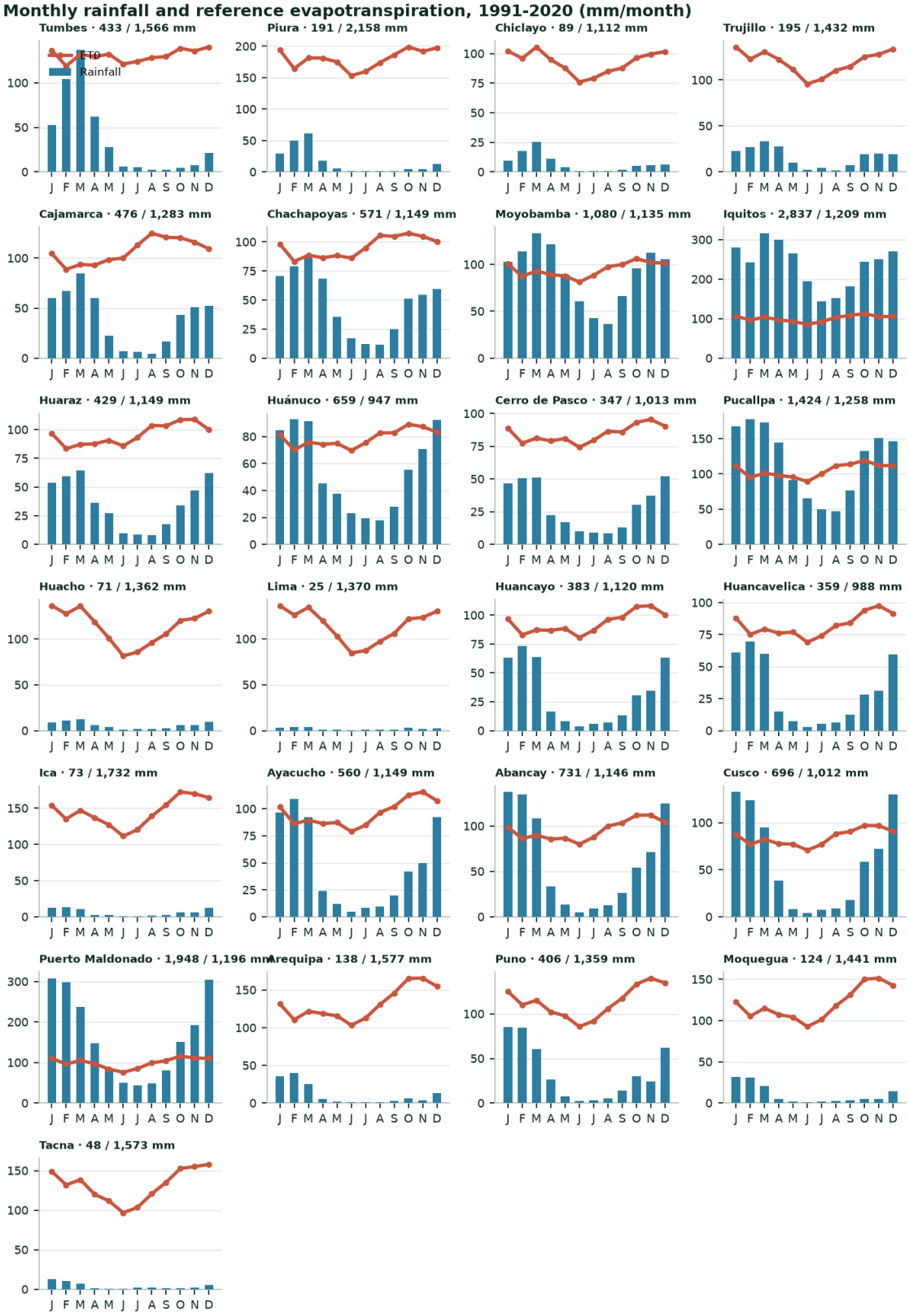


Figure 4. Monthly rainfall and reference evapotranspiration by city, 1991-2020. Source: NASA POWER (A9)

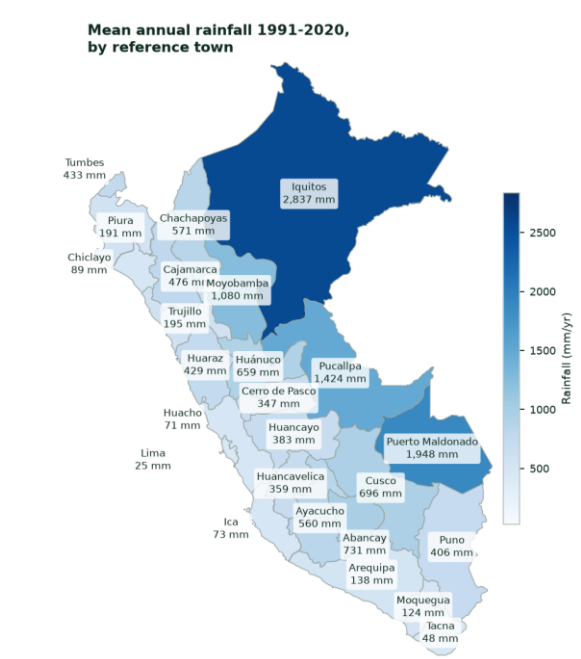
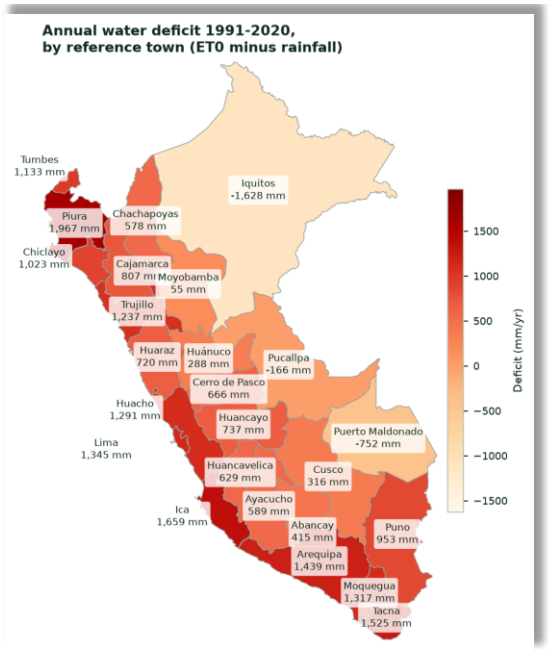


Figure 5. Mean annual rainfall 1991-2020, by region. Source: NASA POWER (A9), Natural Earth (A10).



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

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

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tumbes	53	104	137	62	28	6	5	2	3	4	7	21
Piura	30	50	61	18	6	2	2	1	2	4	4	12
Chiclayo	9	18	25	11	4	1	1	1	2	5	6	6
Trujillo	22	27	34	28	10	3	4	2	7	19	20	19
Cajamarca	60	67	85	60	23	7	7	4	17	43	51	52
Chachapoyas	71	79	86	68	35	17	12	12	25	51	54	60
Moyobamba	102	114	133	122	89	60	43	36	66	96	112	106
Iquitos	280	242	316	300	265	194	143	152	181	244	251	270
Huaraz	54	59	65	36	27	10	9	8	18	34	47	62
Huánuco	85	93	91	46	38	23	19	18	28	56	71	92
Cerro de Pasco	46	51	51	22	17	10	9	8	13	30	37	52
Pucallpa	168	177	173	145	91	66	50	47	77	132	151	147
Huacho	9	11	13	6	4	1	2	2	3	6	6	10
Lima	3	4	4	1	1	1	1	1	1	3	2	3
Huancayo	63	73	64	16	8	4	6	7	13	30	35	63
Huancavelica	61	70	60	15	7	3	5	6	13	28	31	59
Ica	12	14	11	3	3	1	1	2	3	6	6	12
Ayacucho	96	109	93	24	12	5	8	10	20	42	50	92
Abancay	138	135	108	34	13	5	10	13	26	54	71	125
Cusco	133	124	95	39	8	4	8	9	18	58	72	130
Puerto Maldonado	308	297	238	148	84	50	43	49	80	150	193	305
Arequipa	35	40	25	5	2	1	1	2	3	6	4	14
Puno	85	84	61	26	8	2	3	5	14	30	24	62
Moquegua	31	31	21	5	2	1	2	3	3	5	5	14
Tacna	13	10	7	2	0	1	2	2	2	1	2	5

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

3.3 Climate change

Mean annual temperature is rising. At Ica it went from 18.3 °C in 1981 to 19.6 °C in 2024, a trend of 0.18 °C per decade. At Arequipa the trend is 0.28 °C per decade, from 10.1 °C to 12.3 °C. Warmer air dries the soil faster between rainfall events.

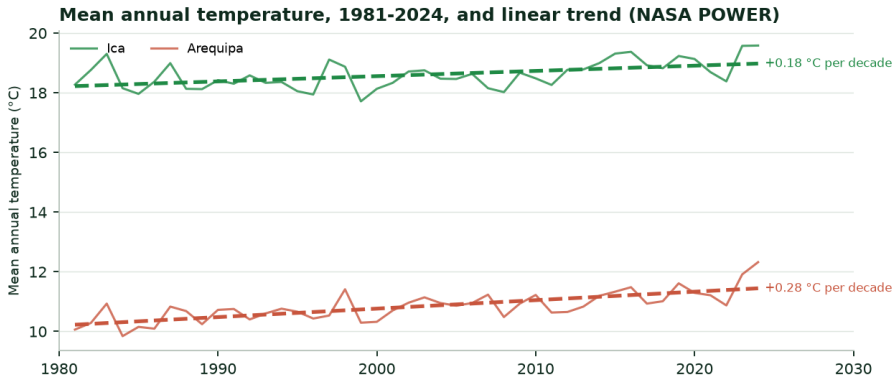
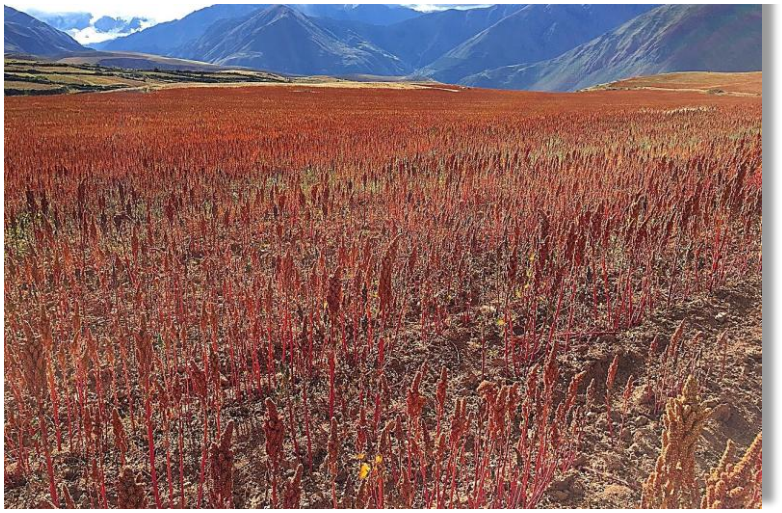


Figure 6. Mean annual temperature, 1981-2024, and linear trend. Source: NASA POWER (A9)



A field of red quinoa in the Andes.

4. Water: Resources, irrigated areas, withdrawals

4.1 Resources and withdrawals

Total freshwater withdrawals are 25,919 million m³ a year (2022). Agriculture accounts for 81.5% of these withdrawals, that is 21,112 Mm³. Internal resources are 1,641.0 km³ a year and water stress is 4.8%: The country has water, but little of it is mobilised for crops.

Freshwater: Withdrawals and resources

Indicator	Value	Year	Source
Total withdrawals	25,919 Mm³	2022	World Bank (A1)
Agricultural share	81.5%	2022	World Bank (A1)
Agricultural withdrawals	21,112.0 Mm³	2022	Calculated from A1
Area equipped for irrigation	2,579,770 ha	2024	FAOSTAT (A6)
Agricultural withdrawals per equipped hectare	8,184 m³/ha	—	Calculation (Annex B)
Water stress	4.8%	2022	World Bank (A1)

4.2 Irrigated areas

FAOSTAT gives 2,579,770 ha equipped for irrigation in 2024, 42% of the cropland (A6); no recent actually irrigated area is published there. Irrigation sustains the whole coast (export fruit, rice, cane, vegetables); in the Andes and the forest, farming is mostly rainfed.



An irrigation canal in Pisac (Cusco).

4.3 What the water saving represents

In the central scenario, the saving is 2,443.7 million m³ a year, or 11.6% of agricultural withdrawals. At 8,184 m³ per equipped hectare, this water would irrigate about 298,613 more hectares, or 11.6% of today's equipped area.

5. Fertilisers: Quantities, purchases, spending

5.1 Quantities used

In 2024, agricultural use reaches 222,210 tonnes of nitrogen, 60,479 tonnes of phosphate (P2O5) and 83,546 tonnes of potash (K2O). The country produces no nitrogen fertiliser: It imported 517,548 tonnes of nitrogen in the same year. Per hectare of arable land, use is 93.5 kg per hectare.

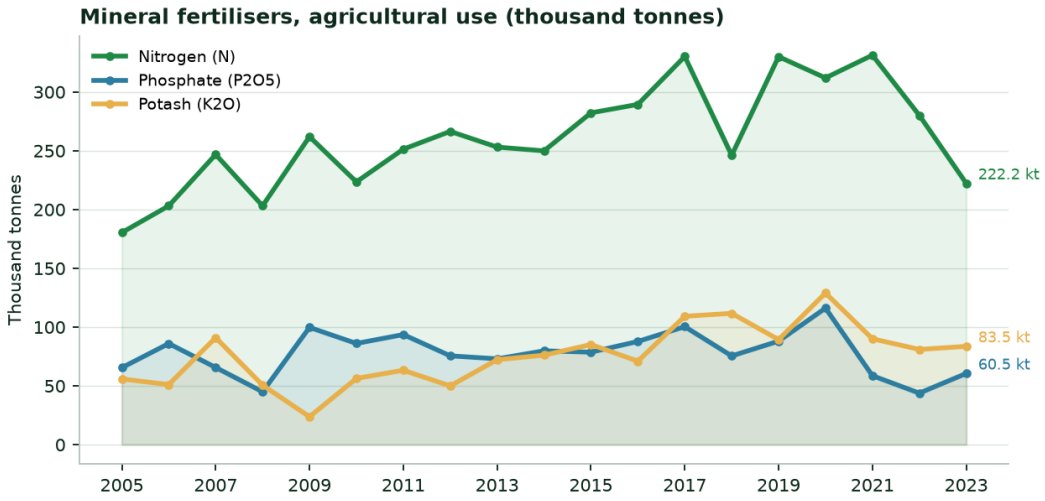


Figure 7. Mineral fertilisers, agricultural use, 2005-2023. Source: FAOSTAT (A5)

5.2 Regulatory framework

A draft regulation on fertilisers and related substances, entrusted to SENASA, was published by Ministerial Resolution No. 0178-2023-MIDAGRI; according to the sources consulted, it had not yet been adopted (A13).



Potatoes in flower in the Puno region.

5.3 Indicative spending

In 2024, the indicative minimum spending on mineral fertilisers reaches $267 million, at international fertiliser prices (calculation in Annex B, lower bound).

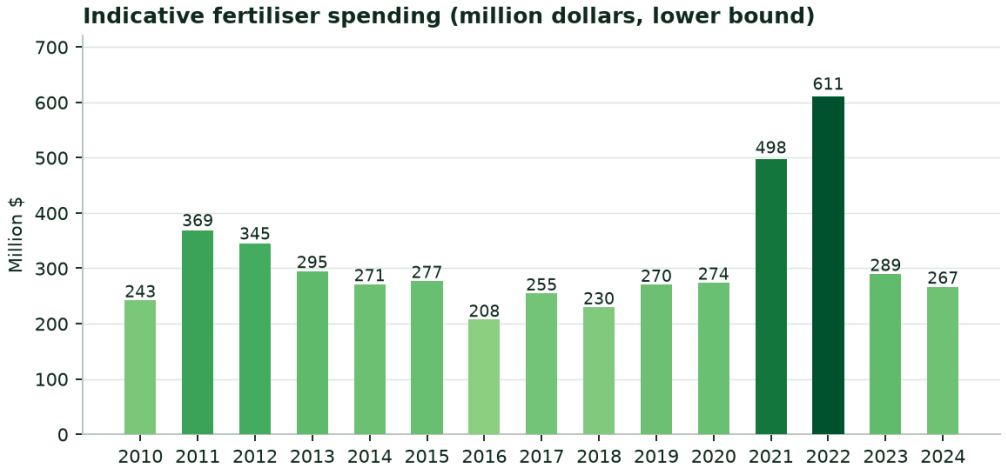


Figure 8. Indicative fertiliser spending, lower bound. Source: Author's calculation from A5 and A7

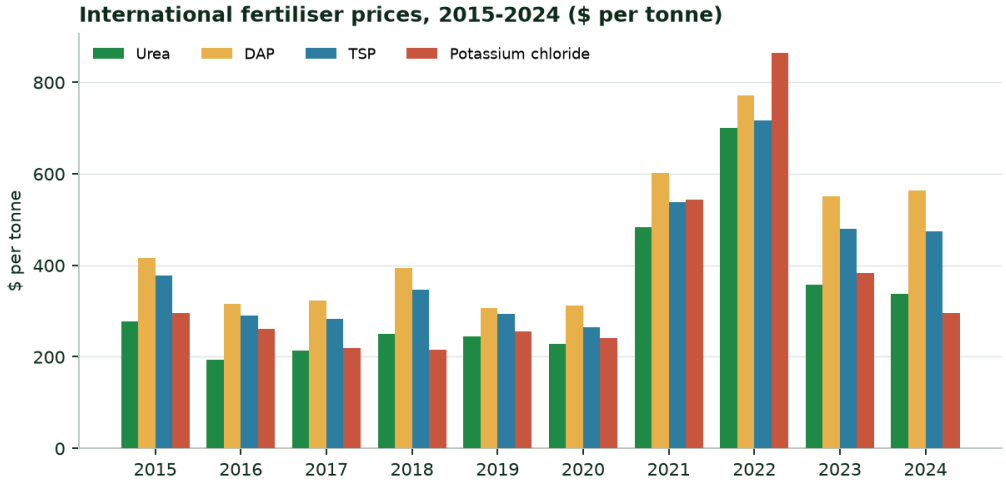


Figure 9. International prices of urea, DAP, TSP and potassium chloride. Source: World Bank, Pink Sheet (A7)

6. The regions at a glance

The table compares the twenty-four regions and Lima Province, each represented by a reference town. Callao is not studied. 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)
Tumbes (Tumbes)	433	1,566	1,133	1,958	24.7
Piura (Piura)	191	2,158	1,967	2,103	25.4
Lambayeque (Chiclayo)	89	1,112	1,023	2,120	20.5
La Libertad (Trujillo)	195	1,432	1,237	1,928	17.9
Cajamarca (Cajamarca)	476	1,283	807	1,930	14.3
Amazonas (Chachapoyas)	571	1,149	578	1,602	17.0
San Martín (Moyobamba)	1,080	1,135	55	1,641	22.1
Loreto (Iquitos)	2,837	1,209	-1,628	1,826	25.7
Áncash (Huaraz)	429	1,149	720	2,224	8.1
Huánuco (Huánuco)	659	947	288	2,033	9.7
Pasco (Cerro de Pasco)	347	1,013	666	1,992	7.1

Region (city)	Rainfall (mm/yr)	ET0 (mm/yr)	Deficit (mm/yr)	Radiation (kWh/m²/yr)	Temperature (°C)
Ucayali (Pucallpa)	1,424	1,258	-166	1,868	26.8
Lima Region (Huacho)	71	1,362	1,291	1,955	19.3
Lima Province (Lima)	25	1,370	1,345	1,742	18.2
Junín (Huancayo)	383	1,120	737	2,195	8.7
Huancavelica (Huancavelica)	359	988	629	2,051	5.2
Ica (Ica)	73	1,732	1,659	2,234	18.6
Ayacucho (Ayacucho)	560	1,149	589	2,278	9.2
Apurímac (Abancay)	731	1,146	415	2,043	11.9
Cusco (Cusco)	696	1,012	316	2,136	8.3
Madre de Dios (Puerto Maldonado)	1,948	1,196	-752	1,828	25.3
Arequipa (Arequipa)	138	1,577	1,439	2,378	10.9
Puno (Puno)	406	1,359	953	2,471	7.9
Moquegua (Moquegua)	124	1,441	1,317	2,442	7.2
Tacna (Tacna)	48	1,573	1,525	2,283	15.0

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

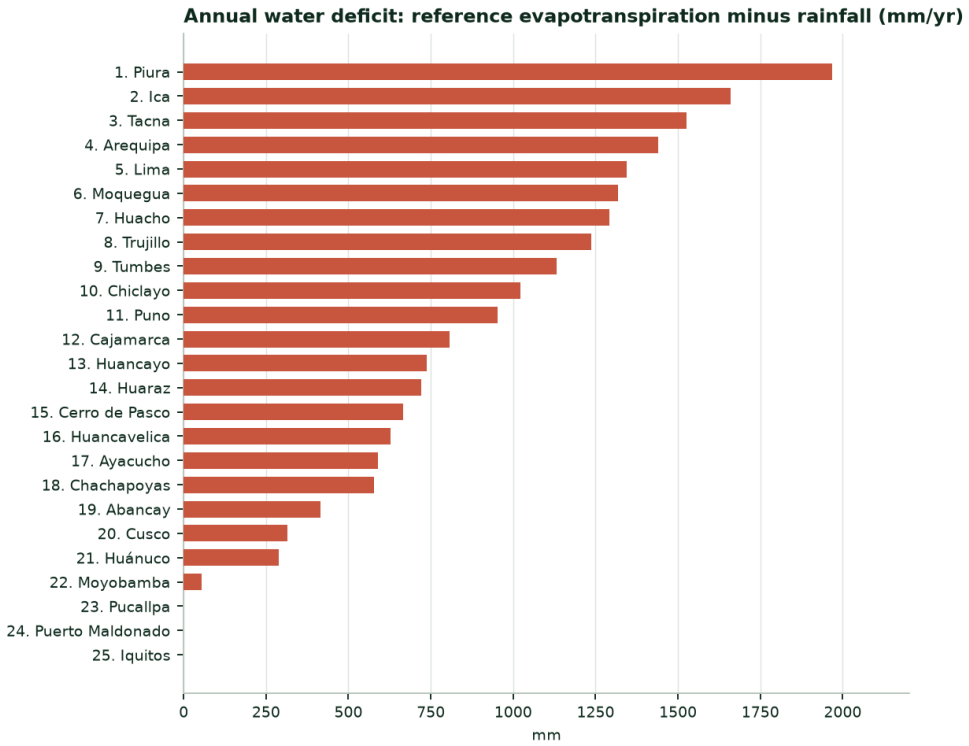


Figure 10. Annual water deficit: Reference evapotranspiration minus rainfall. Source: NASA POWER (A9)



Rice fields of Tarapoto (San Martín).

7. The twenty main crops: Three rankings

7.1 By harvested area

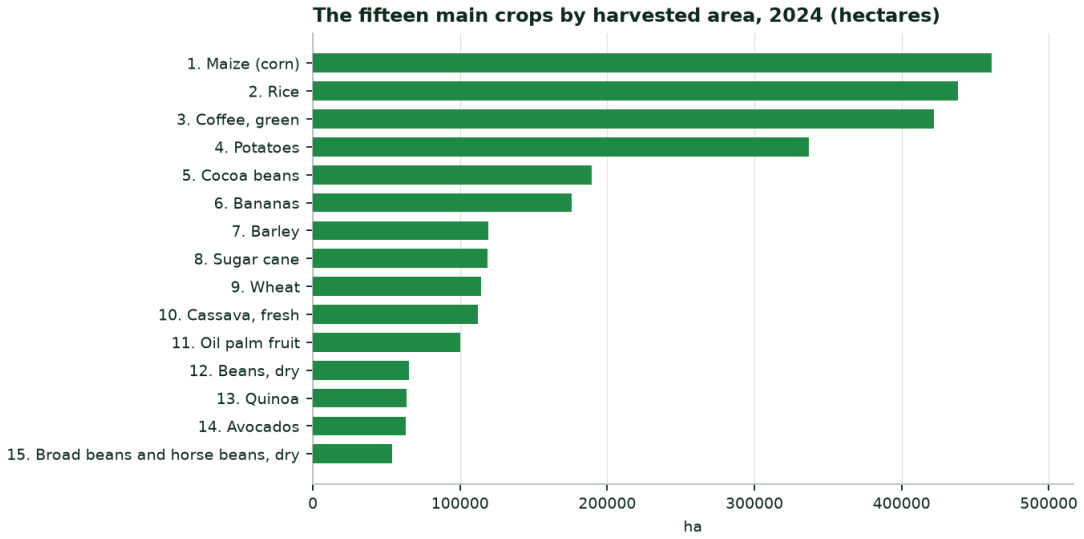


Figure 11. The fifteen main crops by harvested area, 2024 (hectares). Source: FAOSTAT (A2)

The ten main crops by area, 2024

Crop	Harvested area (ha)	Production (t)	Yield (t/ha)
Maize (corn)	461,207	1,686,077	3.66
Rice	438,228	3,640,432	8.31

Crop	Harvested area (ha)	Production (t)	Yield (t/ha)
Coffee, green	421,972	358,994	0.85
Potatoes	337,281	6,579,754	19.51
Cocoa beans	189,602	157,252	0.83
Bananas	175,712	2,343,311	13.34
Barley	119,255	244,114	2.05
Sugar cane	118,456	12,038,562	101.63
Wheat	114,474	203,522	1.78
Cassava, fresh	112,068	1,425,272	12.72

Source: FAOSTAT (A2).

7.2 By production

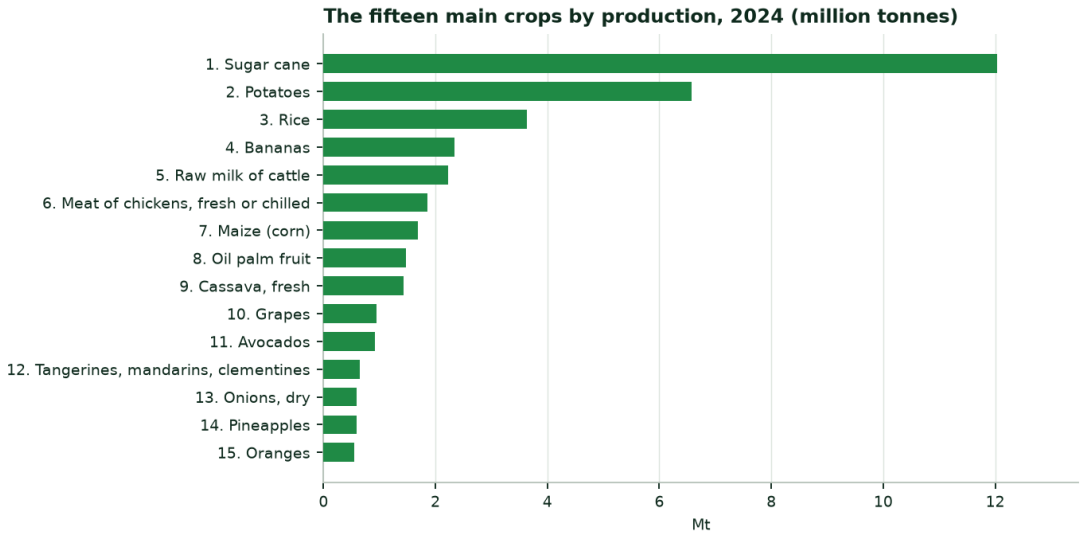


Figure 12. The fifteen main crops by production, 2024 (million tonnes). Source: FAOSTAT (A2)

7.3 By production value

By production value, the three main crops are: Potatoes, rice and bananas (FAOSTAT, 2023, constant international dollars).

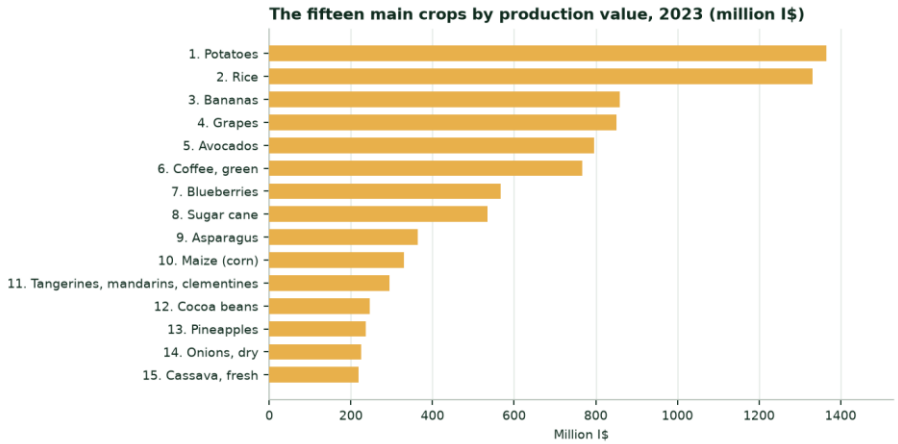


Figure 13. The fifteen main crops by production value, 2023 (million I$). Source: FAOSTAT (A3)



Asparagus in the Huarmey valley (Áncash).

8. Extrapolation by crop: Irrigation and rainfed crops

8.1 Method

Method in brief

• **Irrigation.** National agricultural water is shared between irrigated crops (vegetables and melons, export fruit, rice, sugar cane and other irrigated land), in proportion to their harvested areas; the equipped area is shared the same way.

• **Rainfed crops.** For crops that have a trial (potato and maize), the production gain is calculated per 10,000 ha treated, at the national average 2024 yield.

• Each calculation applies the effect of the trial cited: A quarter (cautious), half (central) or the full effect (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: Yield
Soybean, China	Soybean	Assumption	+11.3%	Not used; cited for reference
Watermelon, Mexico (2023)	Watermelon	-60.5%	+30.0%	Vegetables and melons: Water and yield
Potato, South Africa (2025)	Potato	-52.0%	+31.4%	Potato: Yield
Date palm, UAE (ICBA, 2021)	Palm	-82.0%	+20.0%	Not used; cited for reference

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

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

8.3 Rainfed crops: Potato and Maize

Average 2024 yields (FAOSTAT): Potato 19.51 t/ha and maize 3.66 t/ha. A water-retention polymer retains water from each rainfall event near the roots and helps the crop through dry days during the season.

Extra production per 10,000 ha treated (tonnes a year)

Crop	Average yield (t/ha)	Cautious	Central	High
Potato	19.51	15,314	30,628	61,256
Maize	3.66	1,563	3,126	6,251

Source: FAOSTAT (A2); trials A14 to A18; author's calculation (Annex B).

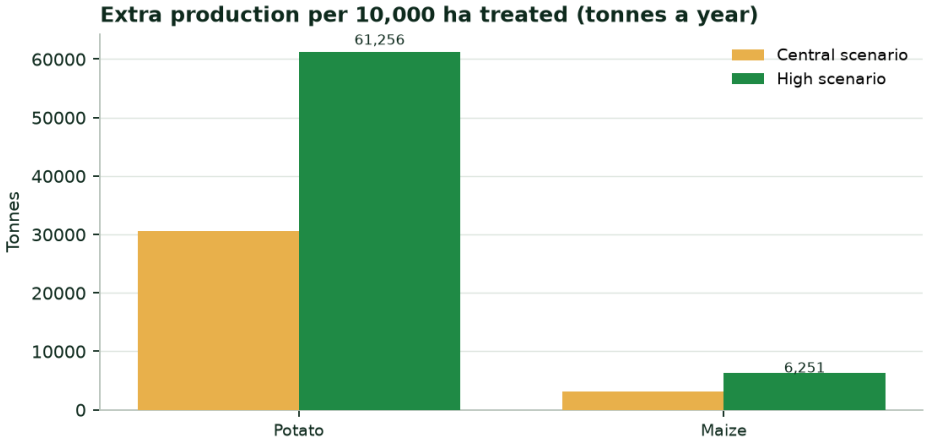


Figure 14. Extra production per 10,000 ha treated, central and high scenarios. Source: Author's calculation

8.4 Irrigation: Vegetables and melons, Export fruit, Rice and Sugar cane

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

Crop group	Equipped area (ha)	Share	Trial or assumption	Water saved (Mm³/yr)
Vegetables and melons (onion, asparagus, sweet corn, others)	200,670	7.8%	Watermelon, Mexico (2023)	496.8
Export fruit (grape, avocado, mango, citrus, blueberry, olive)	318,896	12.4%	Generic assumption, no trial	261.0
Rice	438,228	17.0%	Generic assumption, no trial	358.6
Sugar cane (irrigated on the coast)	118,456	4.6%	Generic assumption, no trial	96.9
Other irrigated land (coastal maize, cotton, lucerne, fodder)	1,503,520	58.3%	Generic assumption, no trial	1,230.4

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	1,221.9	149,306	238,075
Central	2,443.7	298,613	476,151
High	4,887.5	597,225	952,302

Source: Author's calculation (Annex B).

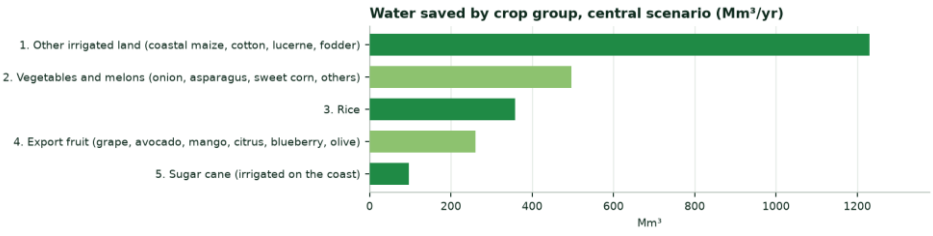


Figure 15. Water saved by crop group, central scenario. Source: Author's calculation

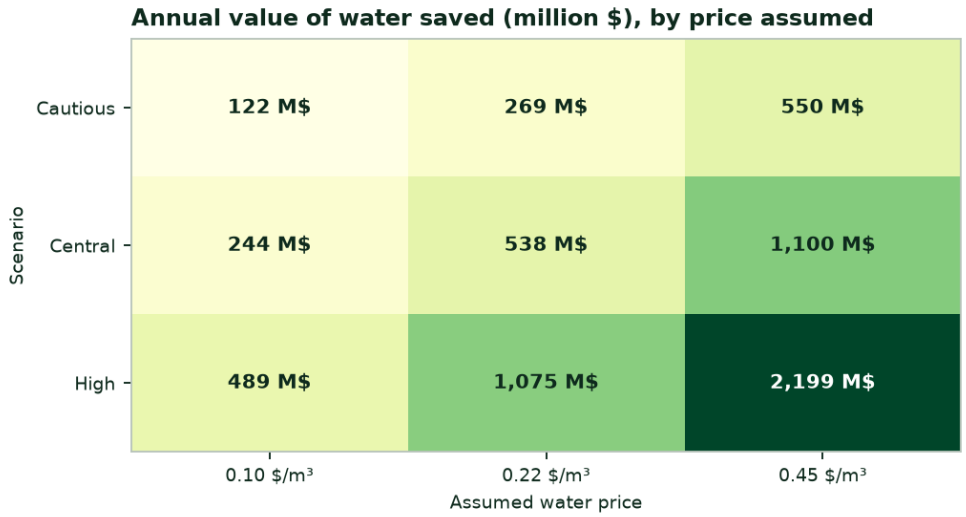


Figure 16. Annual value of the water saved, by price assumed per cubic metre. Source: Author's calculation; prices assumed, no national tariff

8.5 Reading the results

Key points

• The "other irrigated land" group gives 50% 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 the confidence level and limitations of each.

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 Peru
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 Peru

Source: Annex A.



Bananas harvested in the Piura region.

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)	10,222	12,426
Agricultural imports (crops and livestock)	6,420	6,515
Exports, all merchandise	60,756	70,250
Imports, all merchandise	52,306	55,165

Source: FAOSTAT (A4).

10.2 Exports

The three main farm products exported in 2024 are: Other berries ($2,212 million), grapes ($1,726 million) and avocados ($1,247 million).

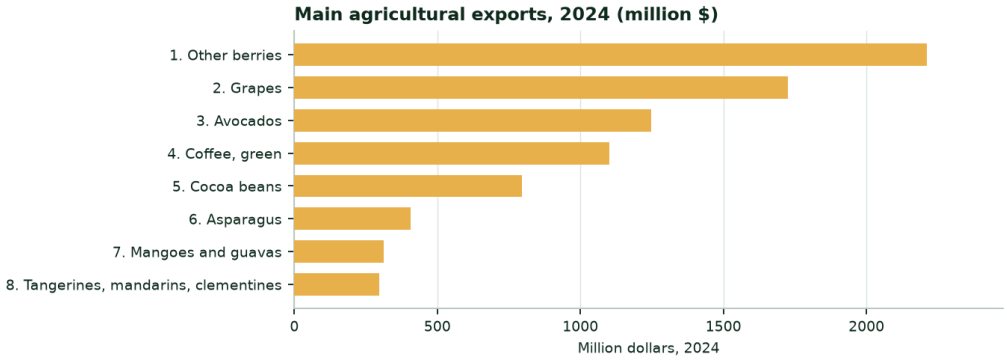


Figure 17. Main agricultural exports, 2024. Source: FAOSTAT (A4)

10.3 Imports

The main farm purchases are: Maize (corn) ($1,001 million), soya bean cake ($690 million) and wheat ($668 million).

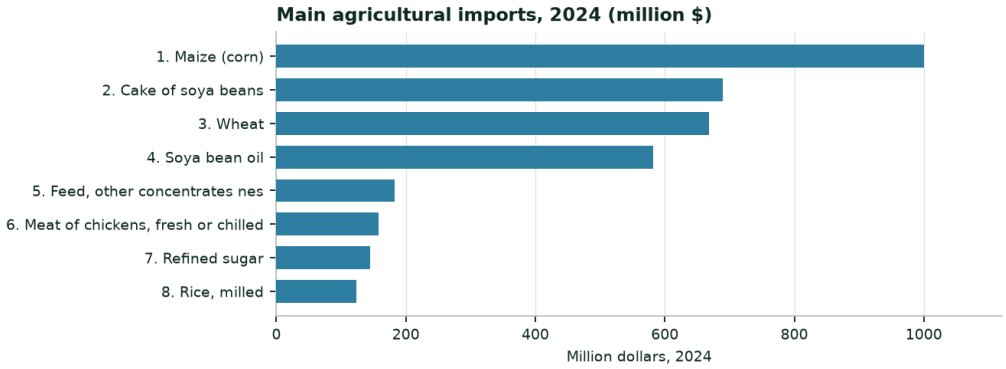


Figure 18. Main agricultural imports, 2024. Source: FAOSTAT (A4)



Figure 19. A cocoa pod on the Alto el Sol cocoa route.



Vegetables at the Pisac Sunday market.

10.4 Importing water-retention polymers into Peru

What to know

• **Customs duty (subheading 3906.90):** The four national lines range from 0 to 6%, with a simple average of 4.5% (A11). Peru's trade agreements can bring this duty down to zero depending on the product's origin.

• **Sales tax:** IGV of 16% plus 2% municipal promotion tax, 18% in total (A12).

• **Placing on the market:** A draft regulation on fertilisers and related substances, entrusted to SENASA, was published in 2023; according to the sources consulted, it had not yet been adopted (A13). The rules applicable to a water-retaining agent are to be confirmed with SENASA.

• **Classification:** Code 3906.90 is an inference for our products; SUNAT (customs) 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 scarcest. The description of crops is qualitative.



Terraces of Uyo-Uyo, in the Colca valley.

Tumbes (Tumbes)

Tumbes: Organic bananas, rice and shrimp farming, on the wettest stretch of coast.

Indicator	Value
Annual rainfall, 1991-2020	433 mm
Reference evapotranspiration	1,566 mm
Annual water deficit	1,133 mm
Months with less than 50 mm of rain	8
Global solar radiation	1,958 kWh/m²
Mean temperature	24.7 °C

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

Piura (Piura)

Piura: Mangoes, table grapes, organic bananas, rice and limes, irrigated from the Poechos and San Lorenzo dams.

Indicator	Value
Annual rainfall, 1991-2020	191 mm
Reference evapotranspiration	2,158 mm
Annual water deficit	1,967 mm
Months with less than 50 mm of rain	11
Global solar radiation	2,103 kWh/m²
Mean temperature	25.4 °C

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

Lambayeque (Chiclayo)

Lambayeque: Rice, sugar cane, mangoes and avocados, in irrigated coastal valleys.

Indicator	Value
Annual rainfall, 1991-2020	89 mm
Reference evapotranspiration	1,112 mm
Annual water deficit	1,023 mm

Indicator	Value
Months with less than 50 mm of rain	12
Global solar radiation	2,120 kWh/m²
Mean temperature	20.5 °C

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

La Libertad (Trujillo)

La Libertad: Asparagus, blueberries, avocados and sugar cane grown under the Chavimochic irrigation project.

Indicator	Value
Annual rainfall, 1991-2020	195 mm
Reference evapotranspiration	1,432 mm
Annual water deficit	1,237 mm
Months with less than 50 mm of rain	12
Global solar radiation	1,928 kWh/m²
Mean temperature	17.9 °C

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

Cajamarca (Cajamarca)

Cajamarca: Milk, potato, maize and coffee, in the northern highlands.

Indicator	Value
Annual rainfall, 1991-2020	476 mm
Reference evapotranspiration	1,283 mm
Annual water deficit	807 mm
Months with less than 50 mm of rain	6
Global solar radiation	1,930 kWh/m²
Mean temperature	14.3 °C

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

Amazonas (Chachapoyas)

Amazonas: Coffee, rice and cocoa, between the Andes and the forest.

Indicator	Value
Annual rainfall, 1991-2020	571 mm
Reference evapotranspiration	1,149 mm
Annual water deficit	578 mm
Months with less than 50 mm of rain	5
Global solar radiation	1,602 kWh/m²
Mean temperature	17.0 °C

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

San Martín (Moyobamba)

San Martín: Cocoa, coffee, rice and oil palm grown in the upper forest.

Indicator	Value
Annual rainfall, 1991-2020	1,080 mm

Indicator	Value
Reference evapotranspiration	1,135 mm
Annual water deficit	55 mm
Months with less than 50 mm of rain	2
Global solar radiation	1,641 kWh/m²
Mean temperature	22.1 °C

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

Loreto (Iquitos)

Loreto: Cassava, plantains and riverbank rice, in the Amazon forest.

Indicator	Value
Annual rainfall, 1991-2020	2,837 mm
Reference evapotranspiration	1,209 mm
Annual water deficit	-1,628 mm
Months with less than 50 mm of rain	0
Global solar radiation	1,826 kWh/m²
Mean temperature	25.7 °C

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

Áncash (Huaraz)

Áncash: Potato and cereals in the Callejón de Huaylas; irrigated fruit on the coast.

Indicator	Value
Annual rainfall, 1991-2020	429 mm
Reference evapotranspiration	1,149 mm
Annual water deficit	720 mm
Months with less than 50 mm of rain	8
Global solar radiation	2,224 kWh/m²
Mean temperature	8.1 °C

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

Huánuco (Huánuco)

Huánuco: Potato, maize, coffee and cocoa, from the Andes to the forest.

Indicator	Value
Annual rainfall, 1991-2020	659 mm
Reference evapotranspiration	947 mm
Annual water deficit	288 mm
Months with less than 50 mm of rain	6
Global solar radiation	2,033 kWh/m²
Mean temperature	9.7 °C

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

Pasco (Cerro de Pasco)

Pasco: Livestock and potato on the cold high plateaus; coffee in Oxapampa.

Indicator	Value
Annual rainfall, 1991-2020	347 mm
Reference evapotranspiration	1,013 mm
Annual water deficit	666 mm
Months with less than 50 mm of rain	9
Global solar radiation	1,992 kWh/m²
Mean temperature	7.1 °C

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

Ucayali (Pucallpa)

Ucayali: Oil palm, cocoa, plantains and cattle, in the forest.

Indicator	Value
Annual rainfall, 1991-2020	1,424 mm
Reference evapotranspiration	1,258 mm
Annual water deficit	-166 mm
Months with less than 50 mm of rain	2
Global solar radiation	1,868 kWh/m²
Mean temperature	26.8 °C

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

Lima Region (Huacho)

Lima Region: Fruit, vegetables, maize and sugar cane grown in the irrigated Huaura and Cañete valleys.

Indicator	Value
Annual rainfall, 1991-2020	71 mm
Reference evapotranspiration	1,362 mm
Annual water deficit	1,291 mm
Months with less than 50 mm of rain	12
Global solar radiation	1,955 kWh/m²
Mean temperature	19.3 °C

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

Lima Province (Lima)

Lima Province: Vegetable growing in the Rímac, Chillón and Lurín valleys, with almost no rain.

Indicator	Value
Annual rainfall, 1991-2020	25 mm
Reference evapotranspiration	1,370 mm
Annual water deficit	1,345 mm
Months with less than 50 mm of rain	12
Global solar radiation	1,742 kWh/m²
Mean temperature	18.2 °C

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

Junín (Huancayo)

Junín: Potato and maize grown in the Mantaro valley; coffee and fruit grown in the central forest.

Indicator	Value
Annual rainfall, 1991-2020	383 mm
Reference evapotranspiration	1,120 mm
Annual water deficit	737 mm
Months with less than 50 mm of rain	8
Global solar radiation	2,195 kWh/m²
Mean temperature	8.7 °C

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

Huancavelica (Huancavelica)

Huancavelica: Potato, barley and alpaca herding, in poor highlands.

Indicator	Value
Annual rainfall, 1991-2020	359 mm
Reference evapotranspiration	988 mm
Annual water deficit	629 mm
Months with less than 50 mm of rain	8
Global solar radiation	2,051 kWh/m²
Mean temperature	5.2 °C

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

Ica (Ica)

Ica: Table grapes, asparagus, avocados and citrus irrigated from a heavily used aquifer, in the desert.

Indicator	Value
Annual rainfall, 1991-2020	73 mm
Reference evapotranspiration	1,732 mm
Annual water deficit	1,659 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,234 kWh/m²
Mean temperature	18.6 °C

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

Ayacucho (Ayacucho)

Ayacucho: Potato, maize, quinoa and cocoa of the VRAEM valley.

Indicator	Value
Annual rainfall, 1991-2020	560 mm
Reference evapotranspiration	1,149 mm
Annual water deficit	589 mm
Months with less than 50 mm of rain	8
Global solar radiation	2,278 kWh/m²
Mean temperature	9.2 °C

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

Apurímac (Abancay)

Apurímac: Potato, maize, avocados and cereals of the Andean valleys.

Indicator	Value
Annual rainfall, 1991-2020	731 mm
Reference evapotranspiration	1,146 mm
Annual water deficit	415 mm
Months with less than 50 mm of rain	6
Global solar radiation	2,043 kWh/m²
Mean temperature	11.9 °C

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

Cusco (Cusco)

Cusco: Sacred Valley maize, potato, quinoa, and coffee from La Convención.

Indicator	Value
Annual rainfall, 1991-2020	696 mm
Reference evapotranspiration	1,012 mm
Annual water deficit	316 mm
Months with less than 50 mm of rain	6
Global solar radiation	2,136 kWh/m²
Mean temperature	8.3 °C

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

Madre de Dios (Puerto Maldonado)

Madre de Dios: Brazil nuts, cocoa and cattle, in the southern forest.

Indicator	Value
Annual rainfall, 1991-2020	1,948 mm
Reference evapotranspiration	1,196 mm
Annual water deficit	-752 mm
Months with less than 50 mm of rain	2
Global solar radiation	1,828 kWh/m²
Mean temperature	25.3 °C

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

Arequipa (Arequipa)

Arequipa: Dairy farming and irrigated onions, garlic, lucerne and rice in the Majes valley.

Indicator	Value
Annual rainfall, 1991-2020	138 mm
Reference evapotranspiration	1,577 mm
Annual water deficit	1,439 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,378 kWh/m²
Mean temperature	10.9 °C

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

Puno (Puno)

Puno: Quinoa, potato and alpacas on the Altiplano of Lake Titicaca.

Indicator	Value
Annual rainfall, 1991-2020	406 mm
Reference evapotranspiration	1,359 mm
Annual water deficit	953 mm
Months with less than 50 mm of rain	8
Global solar radiation	2,471 kWh/m²
Mean temperature	7.9 °C

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

Moquegua (Moquegua)

Moquegua: Avocados, pisco grapes and lucerne, in irrigated desert valleys.

Indicator	Value
Annual rainfall, 1991-2020	124 mm
Reference evapotranspiration	1,441 mm
Annual water deficit	1,317 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,442 kWh/m²
Mean temperature	7.2 °C

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

Tacna (Tacna)

Tacna: Olives, oregano and grapes, irrigated in the southern desert.

Indicator	Value
Annual rainfall, 1991-2020	48 mm
Reference evapotranspiration	1,573 mm
Annual water deficit	1,525 mm
Months with less than 50 mm of rain	12
Global solar radiation	2,283 kWh/m²
Mean temperature	15.0 °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), Peru	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
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

Ref.	Source	Level
A11	World Bank, WITS (UNCTAD TRAINS database), Peru, applied MFN duties, subheading 3906.90 (four national lines), 2023	A
A12	PwC, Worldwide Tax Summaries, Peru, other taxes: General sales tax (IGV) and municipal promotion tax	C
A13	MIDAGRI, Ministerial Resolution No. 0178-2023-MIDAGRI publishing the draft supreme decree on the regulation of fertilisers and related substances; CIRAD, "Insumos agropecuarios y políticas públicas en América Latina", on its adoption status	B
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 (25,919 Mm³, 2022) × agricultural share (81.45%) = 21,112.0 Mm³.

2. Irrigation. The equipped area (2,579,770 ha) and agricultural water are shared between irrigated groups (vegetables and melons, export fruit, rice, sugar cane and other irrigated land) in proportion to their harvested areas (2,579,770 ha), without exceeding each group's harvested area. Our sources provide no irrigation statistics 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 selected irrigable crops: The difference forms an "other irrigated land" group (coastal yellow maize, cotton, lucerne, fodder), with the generic assumption. Sugar cane is treated as irrigated, as on the coast; potato, maize, Andean cereals, coffee and cocoa are treated as rainfed.

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

4. Extra hectares. Water saved ÷ water per equipped hectare (8,184 m³/ha).

5. Rainfed crops. Gain per 10,000 ha = 10,000 × average 2024 yield (production ÷ harvested area, FAOSTAT) × trial effect on yield (potato 31.4% and maize 17.1%), using the same quarter, half and full trial effect.

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

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Farming terraces near Cabanaconde (Colca).

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