Food and Agriculture Organization of the United Nations

2025

IN BRIEF

THE STATE OF THE WORLD'S LAND AND WATER RESOURCES FOR FOOD AND AGRICULTURE

THE POTENTIAL TO PRODUCE MORE AND BETTER

This booklet contains the core messages and content from *The State of The World's Land and Water Resources for Food and Agriculture 2025*. The numbering of tables and figures corresponds to that publication, available at: https://doi.org/10.4060/cd7488en

Required citation:
FAO. 2025. *In Brief to The State of The World's Land and Water Resources for Food and Agriculture 2025 – The potential to produce more and better.* Rome. https://doi.org/10.4060/cd7598en

ISBN 978-92-5-140290-0

COVER PHOTOGRAPH © Quang Nguyen Vinh

VIET NAM. A lone farmer walks between rice paddy fields in Yen Bai.

CONTENTS

CORE MESSAGES

Challenges for land and water resources

➔ Land, soil and water are the foundations of agricultural production. Agricultural production and productivity were able to keep up with the increasing needs of a rapidly growing population in the past, but this was achieved at a substantial environmental and social cost.

➔ Human-induced land degradation affects cropland, pastures and forested land, on which people depend for their livelihoods. Intensive agricultural practices and unsustainable use of chemicals increasingly lead to pollution and the depletion of land, soil and water resources.

Status and trends in the management of land and water resources

➔ During the 60-year period between 1964 and 2023, most of the increase in agricultural production was achieved through intensification, while the expansion of agricultural land was limited to just 8 percent.

➔ More than 1 660 Mha of land, corresponding to more than 10 percent of the world's land area, have been degraded by unsustainable land-use and management practices, with more than 60 percent of this degradation occurring on agricultural lands (including cropland and pastureland).

➔ Future agricultural development pathways need to be based on the transformation of agrifood systems for better production, better nutrition, a better environment and a better life, leaving no one behind. The additional production required to satisfy the future increase in demand must be realized through more efficient, inclusive, resilient and sustainable production systems that address the socioeconomic and environmental dimensions of sustainable development.

Producing more and better: the potential

➔ The potential exists to feed the 9.7 billion people predicted to make up the world's population by 2050, and the approximately 10.3 billion people when the global population is projected to peak around 2085. The conditions under which this food production takes place will determine the associated environmental, social and economic costs. However, the potential for agricultural expansion is limited, as further land conversion to cropland would have impacts on other ecosystems and their services, including forests, grasslands and wetlands.

➔ There is scope for significant increases in land productivity in most developing regions and for most types of crops. The bulk of increased food production should come from reductions in yield gap, the selection of crops suitable for agroecological conditions, and the adoption of sustainable management practices adapted to each crop.

➔ Climate change affects land suitability for many crops, with suitable areas for given crops usually moving to higher latitudes and altitudes. For some crops, agricultural water demand will increase in future climate scenarios, while the available water resources become more variable and less reliable.

➔ In areas where land and water resources are scarce, satisfying competing societal objectives (agriculture, industry, urbanization, energy, biodiversity conservation) often implies trade-offs and difficult choices in resource allocation. Integrated land and water resource planning provides tools to manage the competition for resources and optimize resource use.

Sustainable land and water resources management: technical solutions

➔ Multiple technical solutions exist to achieve sustainable land, soil and water management. They depend on the socioecological context and production system, of which there are a wide variety around the world. An appropriate enabling environment is required for the successful adoption of solutions by land and water users.

➔ The productivity of rainfed agriculture can be improved through a more systematic adoption of conservation agriculture and the use of drought-tolerant crop varieties and drought-resilient practices such as soil moisture conservation, crop diversification and organic composting. These practices have the potential to make a significant contribution to the food security of millions of smallholder producers and to enhance soil health and on-farm biodiversity.

➔ Integrating sectoral solutions offers a unified model for sustainable land, water, forest and aquatic resource management that addresses multiple aspects of food security, climate resilience and environmental sustainability. Agroforestry, rotational grazing and forage improvement, and rice–fish farming are just a few examples of such integrated approaches. Together, these technologies and practices create a framework where sustainable resource use is tailored to specific landscapes and enhances resilience to climate change.

An enabling environment for sustainable solutions

➔ Integrated land-use planning, integrated landscape management, integrated water resources management, the Water–Energy–Food–Ecosystems nexus, agroecology, and the agrifood systems approach are essential sustainable and integrated approaches to address the climate, land, soil, water and biodiversity crises, while recognizing that there is no one-size-fits-all solution.

➔ In order for such integrated land, soil and water resources management solutions to be implemented coherently at scale, the following enablers will need to be set in place: policy coherence across sectors; governance of natural resources; data, information and technology; risk management systems including early warning and adaptation and resilience strategies; sustainable financing and investment; innovation; and institutionalized capacity development.

FOREWORD

Land, soil and water resources are the foundations for agricultural production and global food security. By 2050, the global population is projected to reach 9.7 billion, and agriculture will need to produce around 50 percent more food, feed and fibre than in 2012. Meeting this demand will place additional pressure on resources that are already under severe strain: over 60 percent of human-induced land degradation occurs on agricultural lands (including cropland and pastureland), and agriculture accounts for more than 70 percent of global freshwater withdrawal. With 95 percent of food produced on land, the combined threats of land degradation, water scarcity and weather extremes pose significant challenges to agrifood systems, livelihoods, and biodiversity.

This third edition of *The State of the World's Land and Water Resources for Food and Agriculture* examines how we can produce more, and better, while safeguarding the world's finite resources. It focuses on the potential of major cultivated crops – both now and under future climate scenarios – and on the policies, practices and technologies that can help close yield gaps sustainably.

While past gains in agricultural production and productivity have been able to keep pace with the increasing needs of a rapidly growing population, mainly through intensification, these achievements have often come at a high environmental and social cost.

In many regions, food security and agrifood systems are at risk. Yet solutions exist. Sustainable agricultural practices can counter this risk by restoring land, soil and water resources and by generating valuable ecosystem benefits. In parallel, sustainable management of land, soil and water resources can significantly mitigate the effects of – and strengthen adaptation to – climate change.

Future gains must come from smarter – not just increased – food production, by closing yield gaps, diversifying the selection of suitable and resilient crops, and applying locally adapted, resource-efficient practices suited to land, soil and water conditions. There is no single pathway – no one-size-fits-all solution.

The report explores practical options for sustainable land, soil and water use and management. It presents actions and solutions, illustrated with examples, and identifies the key enablers required to scale them up for lasting and sustained impact and to make our agrifood systems more efficient, inclusive, resilient and sustainable.

FAO's work on land, soil and water resources, guided by the FAO Conceptual Framework for Integrated Land and Water Resources Management, supports Members in developing policies, programmes, best practices and management tools that ensure productive and efficient use of land, soil and water resources.

I invite you to explore this edition of *The State of the World's Land and Water Resources for Food and Agriculture*, and to join us in transforming agrifood systems for better production, better nutrition, a better environment and a better life for all, leaving no one behind. The choices we make today for the management of land and water resources will determine how we meet current and future demands while protecting the world for generations to come.

Qu Dongyu
FAO Director-General

METHODOLOGY

The first edition of *The State of the World's Land and Water Resources for Food and Agriculture*, published in 2011, presented up-to-date and comprehensive information and analyses on the global state, trends and challenges of land and water resources. The 2011 edition also elaborated on options and strategies for addressing evolving issues such as water scarcity and land degradation.

The second edition, published in 2021, provided an update of the knowledge base, accompanied by a suite of related recommendations and actions for decision-makers.

This 2025 edition of *The State of the World's Land and Water Resources for Food and Agriculture* focuses on the hidden and untapped potential of land and water resources to enhance sustainable agricultural production for main crops and food security. While the report looks at land and water in an integrated way, considering crops, rangeland, fisheries and aquaculture, as well as forests, particular attention is paid to crops through a thorough analysis of main crop production potential based on data and information derived from version 5 of the Global Agro-Ecological Zoning (GAEZ) assessment co-led by FAO and the International Institute for Applied Systems Analysis (IIASA).

TABLE 8 SUITABILITY CLASSES CONSIDERED IN THE GLOBAL AGRO-ECOLOGICAL ZONING ANALYSIS

Category of land suitability	GAEZ suitability class	Attainable percentage of maximum yield	Farm economics
Prime land	VS – very suitable	80–100	Prime land offering best conditions for economic crop production
Good land	S – suitable	60–80	Good land for economic crop production
	MS – moderately suitable	40–60	Moderate land with substantial climate and/or soil/terrain constraints requiring high product prices for profitability
Marginal land	mS – marginally suitable	20–40	Commercial production not viable; land could be used for production when no other land is available
	vmS – very marginally suitable	<20	Economic production not feasible
Unsuitable land	NS – not suitable	0	Production not possible

SOURCE: Fischer, G., Nachtergaele, F.O., van Velthuizen, H.T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D. & Tramberend, S. 2021. *Global Agro-Ecological Zones (GAEZ v4) – Model Documentation*. Rome, FAO. https://doi.org/10.4060/cb4744en

The GAEZ methodology, developed by FAO and IIASA, models the crop cultivation potential as the attainable limit to produce individual crops under given agroclimatic, soil and terrain conditions for specific levels of agricultural inputs and management.

The levels of inputs and management are a central element of the GAEZ methodology. There are two main levels: high input and low input.

The analysis further classifies GAEZ crop-specific categories of land suitability into prime land, good land, marginal land and unsuitable land.

This latest edition of *The State of the World's Land and Water Resources for Food and Agriculture* targets policymakers, decision-makers, experts and practitioners from government and non-governmental organizations, academia and research, producers' organizations and the private sector; it promotes the sustainable use and management of land, soil and water resources to enable the transformation of agrifood systems to become more efficient, more resilient and more sustainable. ■

SUMMARY

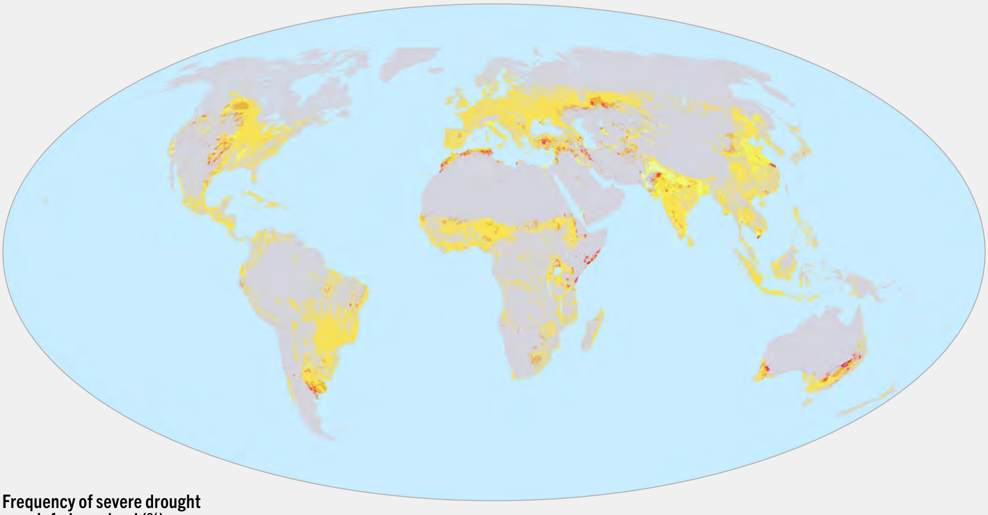
In order to meet the demands of a growing global population, agriculture needs to produce about 50 percent more food, feed and fibre by 2050 compared with the volumes it generated in 2012, according to estimates by the Food and Agriculture Organization of the United Nations (FAO). Achieving such objectives will place additional pressure on the world's already overstretched water, land and soil resources. In an increasing number of regions, food security and agrifood systems are at risk from unsustainable natural resource management practices, urban expansion, higher demand for food, water, energy and biomaterials, and persisting social and gender inequalities in access to and governance of resources.

FAO estimates that more than 1.6 billion hectares (ha) of land, corresponding to more than 10 percent of the world's land area, have been degraded by unsustainable land-use and management practices. More than 60 percent of this degradation occurs on agricultural lands (including cropland and pastureland), creating unprecedented pressure on the world's agrifood systems. Globally, urban areas more than doubled in size in just two decades, growing from 33 million hectares (Mha) in 1992 to 71 Mha in 2015. This expansion consumed 24 Mha of some of the most fertile croplands, 3.3 Mha of forestlands and 4.6 Mha of shrubland.

Climate change is exerting additional stress on land and water resources, exacerbating existing risks to livelihoods, biodiversity and agrifood systems. This trend is predicted to continue due to the increased demand for food and other products, land degradation, climate change and biodiversity loss. With consequences for all components of agrifood systems, including land, soil and water resources, the impacts of climate change are increasingly evident in the form of rising temperatures, changing precipitation patterns, and mounting incidence of extreme events such as droughts and floods.

The growing frequency and intensity of disasters caused by extreme weather events are taking an unparalleled toll on food production, with annual losses estimated at USD 123 billion, equivalent to 5 percent of global agricultural gross domestic product. This bleak picture is aggravated by an alarming rise in

FIGURE 9 HISTORICAL DROUGHT FREQUENCY ON RAINFED CROPLAND, 1984–2023



Frequency of severe drought on rainfed cropland (%)

- ≤10
- 10–20
- 20–30
- >30
- No data
- No rainfed cropland

Refer to the disclaimer on the copyright page for the names and boundaries used in this map.

SOURCES: Authors' own elaboration based on the methodology in FAO. 2020. *The State of Food and Agriculture 2020 – Overcoming water challenges in agriculture*. Rome. https://doi.org/10.4060/cb1447en; data from Historic agricultural drought frequency (Global – 1 km) – FAO ASIS. [Accessed on 23 July 2025]. https://data.apps.fao.org/catalog/iso/f8568e67-46e7-425d-b779-a8504971389b. Licence: CC BY-SA 4.0.

social instability and conflicts in many countries and regions, which affected an estimated 1.9 billion ha or nearly 40 percent of agricultural land in 2023.

Despite the scale of the challenges facing the Earth's natural resources, agriculture – if managed and practised in a sustainable manner – has the potential to meet the needs of the world's growing population, which is projected to increase to 9.7 billion by 2050 and to peak at 10.3 billion by 2085. Sustainable agricultural practices can lead to direct improvements in the state of land, soil and water resources and generate valuable ecosystem benefits. In parallel, sustainable management of land, soil and water resources can make a significant contribution in terms of both mitigation of and adaptation to climate change.

Any strategy aimed at achieving sustainable agricultural production and management of land and water resources requires a profound shift in the way that such critical resources are managed, underpinned by accurate information and finance, and accompanied by synergistic efforts and initiatives from beyond the domain of natural resource management. In the specific and critical sphere of climate change, the currently inadequate levels of investment and climate finance need to be stepped up. It is also important to keep in mind that any measures aimed at climate mitigation and adaptation must be carefully planned to avoid maladaptation or unintended consequences, including additional pressure on scarce water resources or further degradation of land and soil resources.

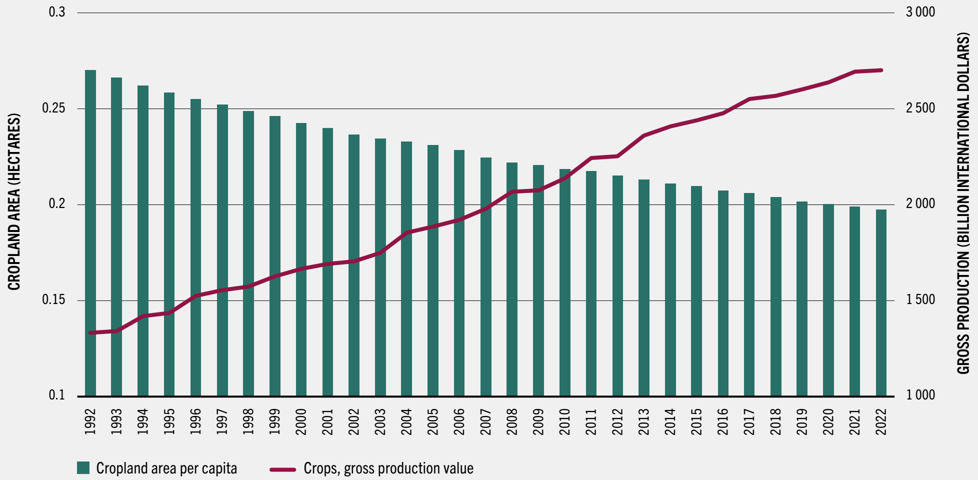
This third edition of *The State of the World's Land and Water Resources for Food and Agriculture* – for the first time part of FAO's flagship State of the World series of publications – focuses on the potential for improving food, feed and fibre production, examining how to produce more and better to meet the needs of a growing population, and how best to manage the Earth's land, soil and water resources to achieve that aim.

Taking a wide-ranging and detailed look at land, soil and water – which form the foundation of agricultural production – the report considers crops, rangeland, forests, fisheries and aquaculture. There is a special focus on the scope for improved production of the main cultivated crops, now and under future climate scenarios, through a thorough analysis of data derived from the latest Global Agro-Ecological Zoning (GAEZ) assessment co-led by FAO and the International Institute for Applied Systems Analysis (IIASA). The report leverages key data and knowledge to support and inform policymaking at all levels. Furthermore, it explores options for the sustainable use and management of land, soil and water resources, with the aim of narrowing the yield gap of main crops and thereby increasing agricultural production. It proposes actions and solutions illustrated by examples, and identifies the enablers that would be required to scale up such actions and solutions for sustained impact. The overall goal of the report is to analyse and promote opportunities for agrifood systems transformation through the sustainable use and management of land, soil and water resources, so that these three critical components of agrifood systems can become more resilient and more productive now and in the future.

HUMAN-INDUCED NATURAL RESOURCE DEGRADATION

In recent decades, advances in agricultural production and productivity have made it possible to keep pace with increasing demand from a rapidly growing population, but this progress has exacted a high price in environmental and social terms.

FIGURE 1 GLOBAL TRENDS IN CROPLAND AREA PER CAPITA AND GROSS PRODUCTION VALUE OF CROPS, 1992–2022



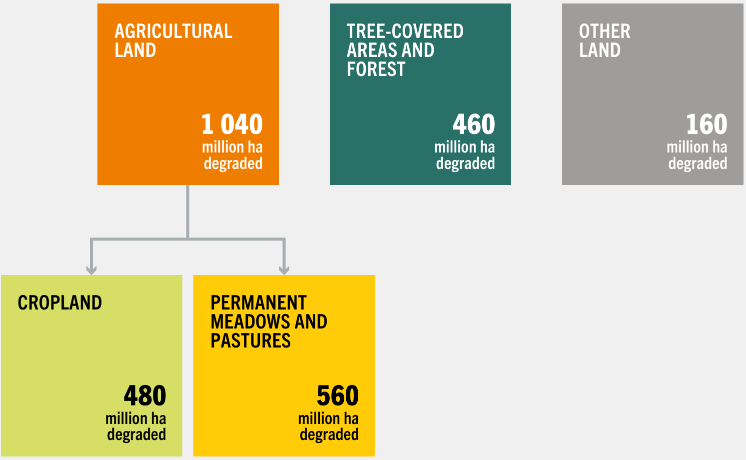
SOURCES: Authors' own elaboration based on FAO. 2025. FAOSTAT: Land Use. [Accessed on 13 February 2025]. https://www.fao.org/faostat/en/#data/RL. Licence: CC-BY-4.0; FAO. 2025. FAOSTAT: Value of Agricultural Production. https://www.fao.org/faostat/en/#data/QV. [Accessed on 13 February 2025]. Licence: CC-BY-4.0.

https://doi.org/10.4060/cd7488en-fig01

The substantial increases in land productivity required to feed, clothe, shelter and generate livelihoods for growing numbers of people have had an often deleterious impact on biodiversity, other ecosystem functions and services, and on the quality and quantity of land and water resources. Human-induced land degradation has negatively affected cropland, pastures and forested land, jeopardizing the ability to produce food, fuel and fibre for the generations to come. Intensive agricultural practices and excessive use of chemicals have increasingly led to pollution and the depletion of land, soil and water resources.

Extending over 4.8 billion ha – the equivalent of one-third of the Earth's land surface – agriculture has a greater impact on land and water resources than any other economic sector. In an increasingly vicious circle, unprecedented pressure on land, soil and water resources has seriously compromised the performance and future prospects of agriculture itself, resulting in further loss of productive land and reduced water availability for

FIGURE 2 HUMAN-INDUCED LAND DEGRADATION, 2020



SOURCES: Authors' own elaboration based on FAO. 2022. *The State of the World's Land and Water Resources for Food and Agriculture – Systems at breaking point*. Rome. https://doi.org/10.4060/cb9910en; Ziadat, F., Conchedda, G., Haddad, F., Njeru, J., Brès, A., Dawelbait, M. & Li, L. 2025. Desertification and Agrifood Systems: Restoration of Degraded Agricultural Lands in the Arab Region. *Agriculture*, 15: 1249. https://doi.org/10.3390/agriculture15121249

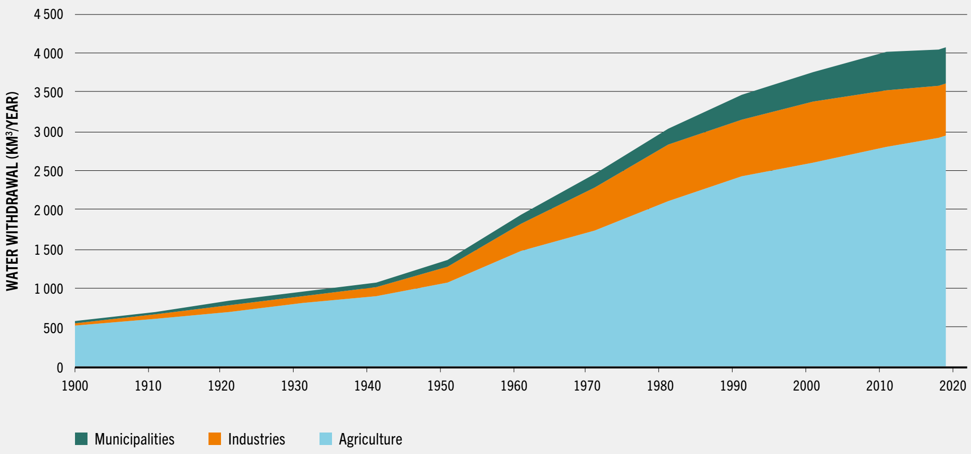
farming and other forms of agricultural production. Agricultural expansion drives deforestation and is one of the primary causes of the degradation of carbon-rich ecosystems such as peatlands. An estimated 64 percent of agricultural land is at risk of pesticide pollution, which damages biodiversity by destroying pollinators, harms soil microbiota and makes agrifood systems less resilient to pests, pathogens and climate change.

Accounting for 72 percent of global freshwater withdrawals – a figure predicted to rise further in the future – agriculture contributes to and is increasingly affected by water scarcity. Overexploitation of groundwater and seawater intrusion in coastal aquifers is widespread, with major implications for food security.

THE HIGH COST OF FEEDING A GROWING POPULATION

Between 1964 and 2023, most of the increases in agricultural production recorded worldwide were the result of intensification, with expansion of

FIGURE 13 EVOLUTION OF GLOBAL SECTORAL WATER WITHDRAWALS, 1900–2020



SOURCES: Authors' own elaboration based on FAO. 2020. *The State of Food and Agriculture 2020 – Overcoming water challenges in agriculture*. Rome. https://doi.org/10.4060/cb1447en

https://doi.org/10.4060/cd7488en-fig13

agricultural land limited to 8 percent. A case in point was cereal production, which underwent a global increase of 213 percent over this 60-year period; this was mostly due to higher yields and it compares with an increase in harvested area of just 10 percent.

During these six decades, the intensification that generated this significant upturn in agricultural production was achieved through improved crop varieties, seeds and agronomical practices, better access to water, and more systematic use of fertilizers. The world's total irrigated land area more than doubled during this period and by 2023, 23 percent of all croplands were equipped for irrigation. Irrigated croplands produce 48 percent of all crops in value terms, indicating that irrigated land is 3.2 times more productive than rainfed land in value terms. On average, the yield of irrigated land is 76 percent higher than that of rainfed land.

Global average use of fertilizer in 2023 was 116 kg per hectare of cropland, more than four times greater than in 1964. Areas planted with permanent crops, including oil palm, coffee, tea and other tree crops – mostly cultivated for global markets – increased by 42 percent or 56 Mha between 2001 and 2023 in nearly all regions and subregions of the world.

The degree of agricultural intensification contributed to limiting the need for further expansion of agricultural land – and the subsequent encroachment on other lands – to achieve the required levels of increased output. In some parts of the world, the intensification strategy even resulted in a reduction in agricultural land. Central and Northern America and Southern Europe recorded a net reduction in arable land between 2001 and 2023.

However, despite the benefits in terms of output, the increase in agricultural production, whether through expansion or intensification, came at a high environmental cost, contributing to a substantial share of greenhouse gas emissions and biodiversity loss, degrading land and inland water ecosystems, polluting soils and aquifers, and pushing water withdrawal beyond sustainability limits in an increasing number of regions. Unsustainable farming and management practices have led to the degradation of 996 Mha of agricultural lands; this accounts for over 60 percent of human-induced land degradation, which affects a total area of more than 1 660 Mha. Currently, an estimated 1.2 billion people, or about one-sixth of the global population, live in agricultural areas with severe water constraints.

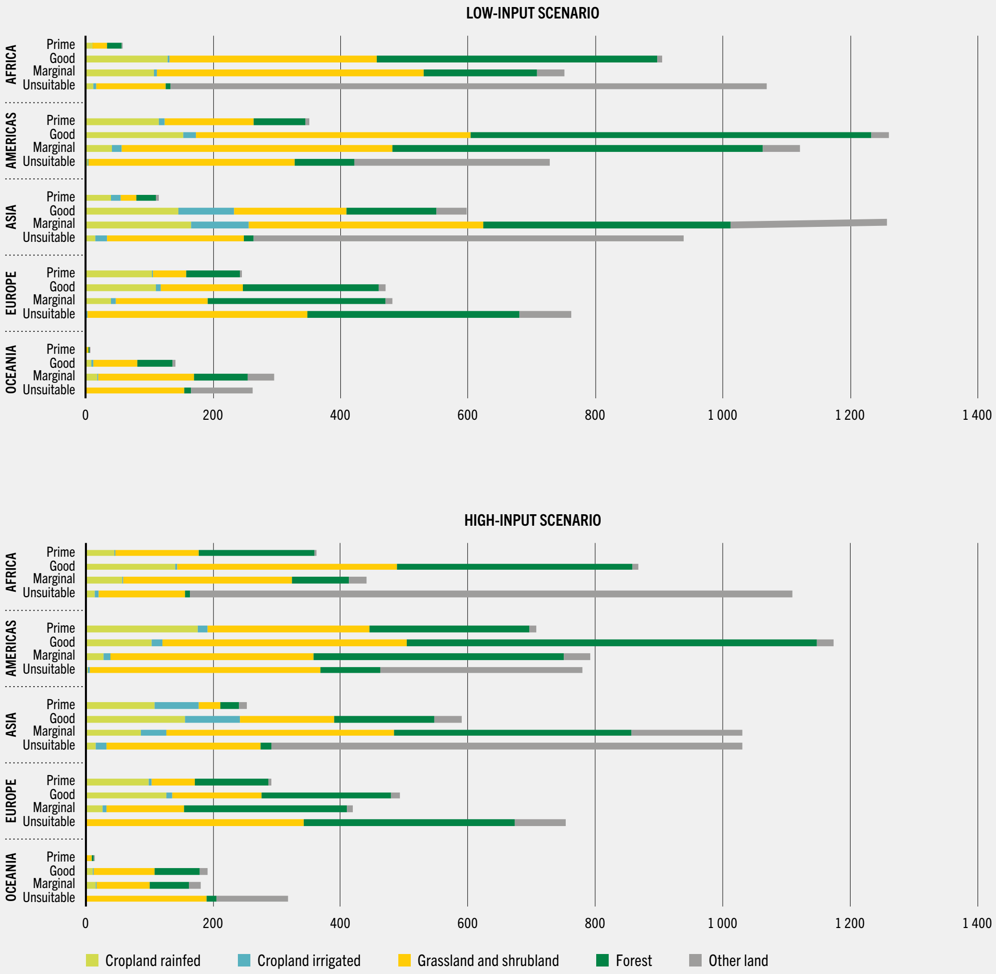
In order to achieve the much-needed increase in agricultural production, without unleashing the negative side effects that will inevitably compromise any such gains and their long-term prospects, future agricultural development models need to be radically overhauled. The additional production required to meet the increased needs has to be achieved in a much more sustainable manner, from both a biophysical and a socioeconomic perspective. More efficient use of land and water resources is an essential prerequisite of any such paradigm, ensuring that water withdrawal – whether from surface water or groundwater – takes place within the limits of sustainability, and that decisions on land use are based on the potential to produce food sustainably.

UNLOCKING THE POTENTIAL TO PRODUCE MORE AND BETTER

If land and water resources are managed carefully, the potential exists to produce enough food for the 9.7 billion people predicted to make up the world's population by 2050, and the approximately 10.3 billion people expected when the global population is projected to peak around 2085. This means that cropland would need to increase from its current 1.6 billion ha to 1.9 billion ha in 2050 and 2.1 billion ha in the mid-2080s, which is significantly less than the 4 billion ha of prime and good land currently available.

However, such global calculations do not factor in the substantial variations between regions and countries, nor the competition with other uses and the degradation of currently used land.

FIGURE 16 REGIONAL DISTRIBUTION OF LAND BY SUITABILITY FOR PREVALENT LAND COVER/LAND USE UNDER LOW-INPUT AND HIGH-INPUT MANAGEMENT SCENARIOS, AVERAGE 2001–2020

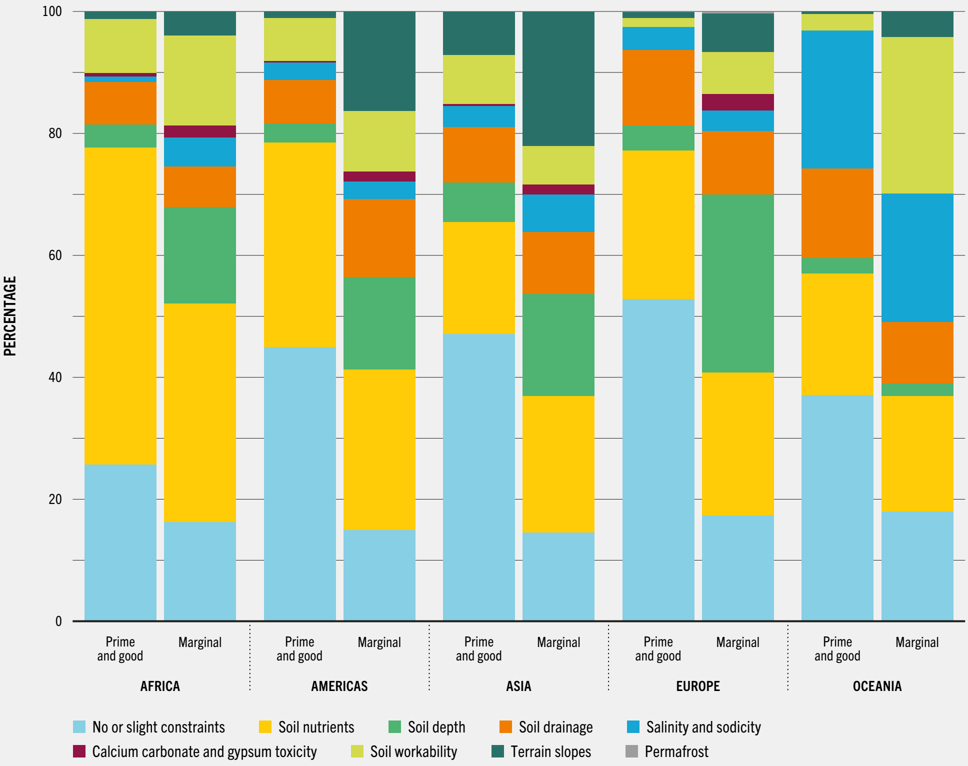


NOTE: Protected areas are excluded.

SOURCE: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en

https://doi.org/10.4060/cd7488en-fig16

FIGURE 20 MAIN SOIL AND TERRAIN CONSTRAINTS IN CONDITIONS OF LOW-INPUT MANAGEMENT IN CURRENT CROPLAND BY REGION AND SUITABILITY CLASS



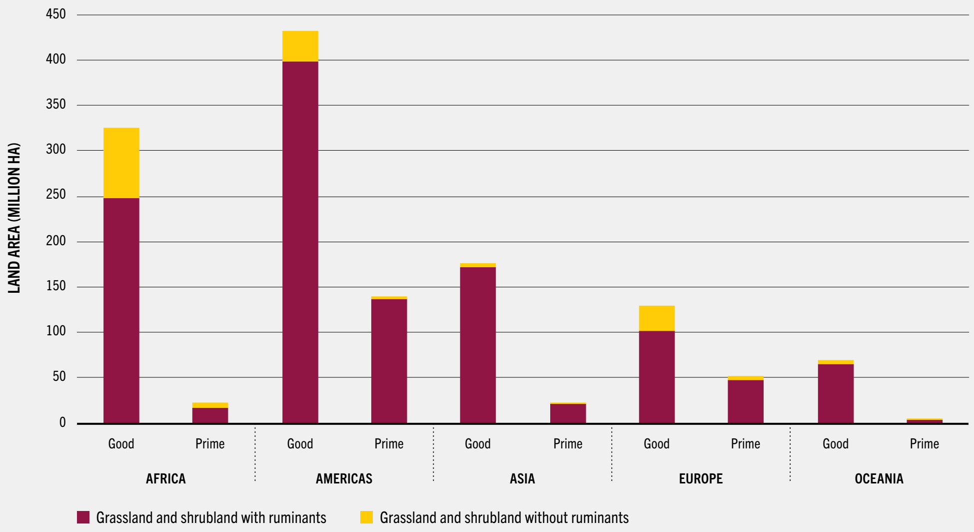
SOURCE: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en

https://doi.org/10.4060/cd7488en-fig20

In reality, the potential for agricultural expansion is very limited. This is because further land conversion to cropland would impact other ecosystems, including forests, grasslands and wetlands. Preserving these ecosystems is crucial to addressing the challenges of climate change and dwindling biological diversity.

Holistic approaches such as integrated land-use planning (ILUP) are required to optimize the use of available suitable land for food production, while managing

FIGURE 17 REGIONAL DISTRIBUTION OF PRIME AND GOOD LAND IN GRASSLANDS AND SHRUBLAND UNDER LOW-INPUT MANAGEMENT AND RAINFED CONDITIONS, WITH AND WITHOUT GRAZING ANIMALS, 2015



SOURCES: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en; FAO. 2025. Gridded Livestock of the World: Gridded livestock density (Global - 2015 - 10 km) - GLW4. [Accessed on 13 March 2025]. https://data.apps.fao.org/catalog//iso/15f8c56c-5499-45d5-bd89-59ef6c026704. Licence: CC-BY-4.0; Gilbert, M., Nicolas, G., Cinardi, G., Van Boeckel, T.P., Vanwambeke, S.O., Wint, G.R.W. & Robinson, T.P. 2018. Global distribution data for cattle, buffaloes, horses, sheep, goats, pigs, chickens and ducks in 2010. *Scientific Data*, 5(1): 180227. https://doi.org/10.1038/sdata.2018.227; FAO. 2022. Global Livestock Environmental Assessment Model (GLEAM) 3 Dashboard. Livestock emission data at a glance. [Accessed on 13 March 2025]. https://foodandagricultureorganization.shinyapps.io/GLEAMV3_Public. Licence: CC-BY-4.0.

https://doi.org/10.4060/cd7488en-fig17

competition across different land uses and other economic sectors.

In addition, the conditions under which any increased production is accomplished will be pivotal in determining any environmental, social and economic impacts that may ensue. Any increase in cropland will be at the expense of other land uses and will further increase agriculture's own very considerable environmental footprint. It is therefore essential to evaluate the repercussions and trade-offs in terms of further degradation, especially of biodiversity and ecosystems' regulating functions. At a more local level, in areas where land and water resources are scarce, integrated land and water resource planning offers scope for managing the

FIGURE 27 THE NINE STEPS OF THE FAO GUIDELINES FOR INTEGRATED LAND-USE PLANNING

SOURCE: Adapted from FAO. (forthcoming). *Guidelines for integrated land-use planning – an update*. Rome.

competition between different sectors for resources and optimizing resource use.

Decision-making about extending crop cultivation must take geographical and biophysical factors into account. Regions such as Africa and South America have scope for further expansion, while Asia has broadly reached its limit. In addition, while agricultural production is mostly practised on prime or good agricultural land, in some areas producers are obliged to work on marginal land. Despite the constraints, there is potential for increasing production and productivity on marginal lands, using sustainable management practices and techniques, while also addressing and eliminating the root causes and drivers of land degradation. Such practices must be adapted to local conditions and need to be supported by appropriate financial and policy instruments.

The alternative to cropland expansion as a strategy for increased agricultural production is intensification – increasing production on existing agricultural land. The yield gap analysis highlights the potential for increasing the production of current agricultural lands, now and in the future. This approach is critical to producing enough food for the projected rise in the global population, but it is also vital to pursue intensification in a far more sustainable manner compared with the past. In most developing regions, there is potential to achieve substantial increases in land productivity for most types of crops, using a three-pronged approach based on reducing the yield gap, selecting crops that are suitable for agroecological conditions (e.g. opportunity crops) and adopting sustainable management practices adapted to each crop.

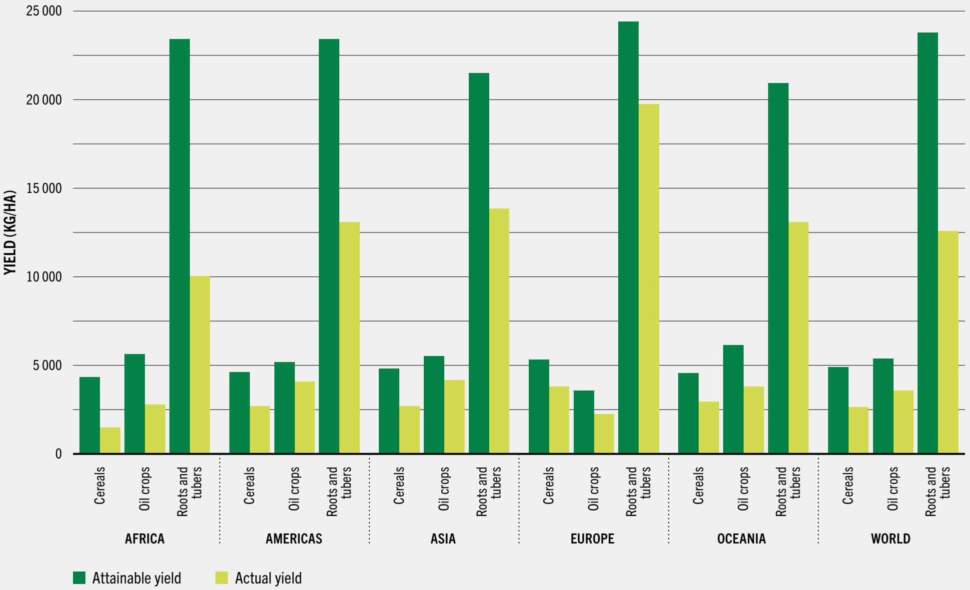
NARROWING THE YIELD GAP

Yield gap refers to the difference between current yield and attainable yield – a calculation that reveals opportunities for improvement in many regions where crop yields are lower than the potential yield under optimum management.

A clear example is sub-Saharan Africa, where the yield of rainfed crops is only 24 percent of the potential yield under appropriate management practices. In order to identify areas where an increase in food production is achievable, the report analyses the scope for narrowing the yield gap for selected crop groups and crops in different regions under different management conditions following the GAEZ methodology and using the latest available GAEZ assessment. The GAEZ methodology matches available global georeferenced datasets on agroclimatic, soil and terrain conditions with specific crop requirements to determine suitable agricultural land-use options and model the agronomically attainable yield for 52 crops. These factors are used to evaluate the suitability of land and the production potential of individual crops under various input and management conditions, estimate yield gaps by comparing current yield with attainable yield, and identify hotspots where more productive land use is possible.

Irrigation addresses a key constraint to cropland suitability and increased production by ensuring adequate and regular soil moisture for crops. However, its use can have negative consequences and it is important that careful assessments and planning are conducted at farm, river basin and aquifer levels to ensure sustainability. Introducing better agricultural practices, including improving nutrient-use efficiency and fertilizer application, integrating organic inputs and using sustainable mechanization, can help to combat soil depletion, which is a major limiting factor for production levels in many areas. Also important are the adoption of suitable crop varieties and the promotion of

FIGURE 18 ATTAINABLE AND ACTUAL YIELDS, GLOBAL AND REGIONAL RESULTS FOR CEREALS, OIL CROPS, AND ROOTS AND TUBERS, AVERAGE 2001–2020



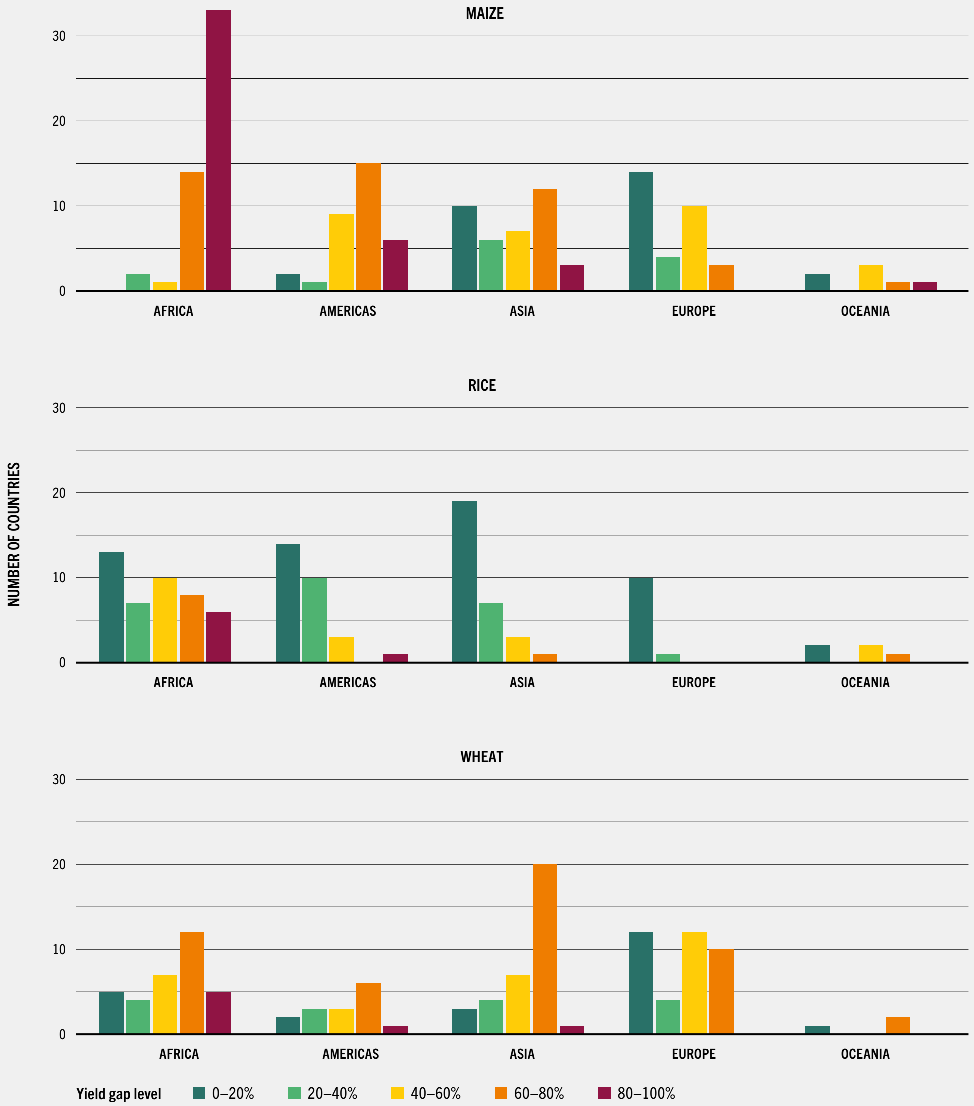
SOURCES: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en; FAO. 2025. FAOSTAT: Crops and livestock products. [Accessed on 13 February 2025]. https://www.fao.org/faostat/en/#data/QCL. Licence: CC-BY-4.0

https://doi.org/10.4060/cd7488en-fig18

agrobiodiversity, including the cultivation of opportunity crops adapted to specific conditions and cultures.

Given the significant impact of climate change on agriculture, and the prospects of its influence on land suitability for many crops in the future, this edition of the report makes a detailed analysis of how changes in temperature, precipitation and other factors are likely to affect land suitability. Using GAEZ data and applying Intergovernmental Panel on Climate Change climate scenarios, the report assesses the impact of climate change on land suitability, crop water demand and crop production potential for selected crop groups. The findings show that climate change is likely to alter the distribution of suitable areas for the crops analysed under rainfed conditions, with

FIGURE 19 YIELD GAPS FOR MAIZE, RICE AND WHEAT BY SEVERITY LEVEL, AVERAGE 2001–2020

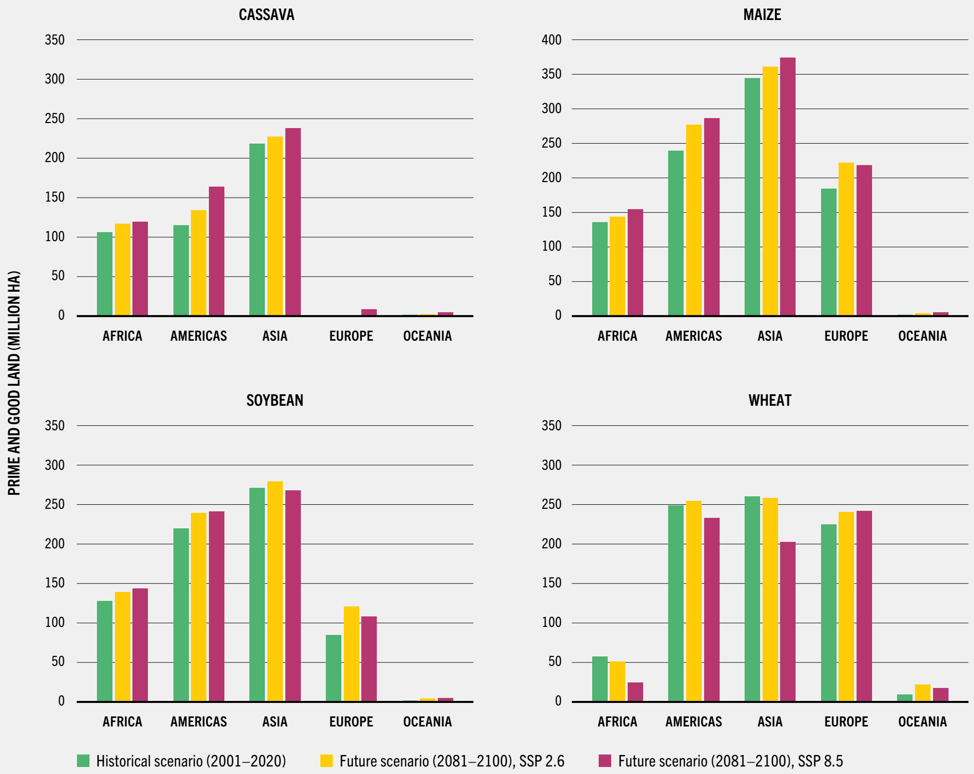


NOTE: Level of severity of yield gap: limited (0–20 percent); moderate (20–40 percent); significant (40–60 percent); severe (60–80 percent); and very severe (80–100 percent).

SOURCES: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en; FAO. 2025. FAOSTAT: Crops and livestock products. [Accessed on 13 February 2025]. https://www.fao.org/faostat/en/#data/QCL. Licence: CC-BY-4.0.

https://doi.org/10.4060/cd7488en-fig19

FIGURE 23 HISTORICAL AND PROJECTED EXTENT OF SUITABLE (PRIME AND GOOD) LAND UNDER RAINFED CONDITIONS BY REGION FOR FOUR MAIN CROPS UNDER DIFFERENT CLIMATE SCENARIOS



NOTES: SSP – Shared Socioeconomic Pathway. The analysis compares the extent of suitable land between the historical scenario (2001–2020) and future projections (2081–2100) under the SSP 2.6 (low emissions) and SSP 8.5 (high emissions) climate scenarios. Totals include suitable land with prime and good suitability for each crop under rainfed conditions.

SOURCE: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en

https://doi.org/10.4060/cd7488en-fig23

projected outcomes depending on the climate model applied. For some crops, agricultural water demand will increase under future climate scenarios, while the available water resources become more variable and less reliable.

FIGURE 24 IMPACT OF CLIMATE CHANGE ON THE EXTENT OF PRIME AND GOOD LAND FOR FOUR CROPS UNDER RAINFED CONDITIONS, SSP 8.5

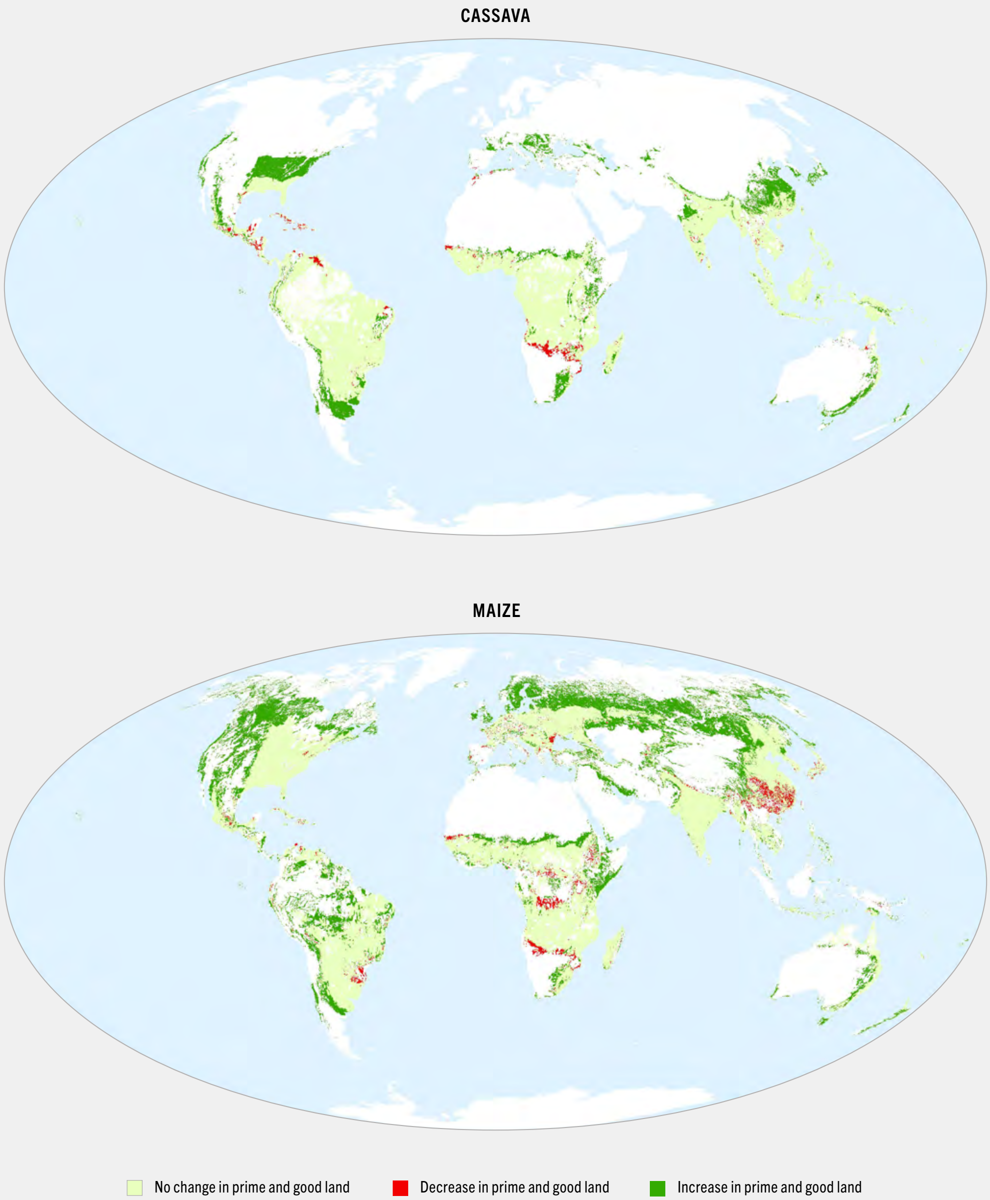
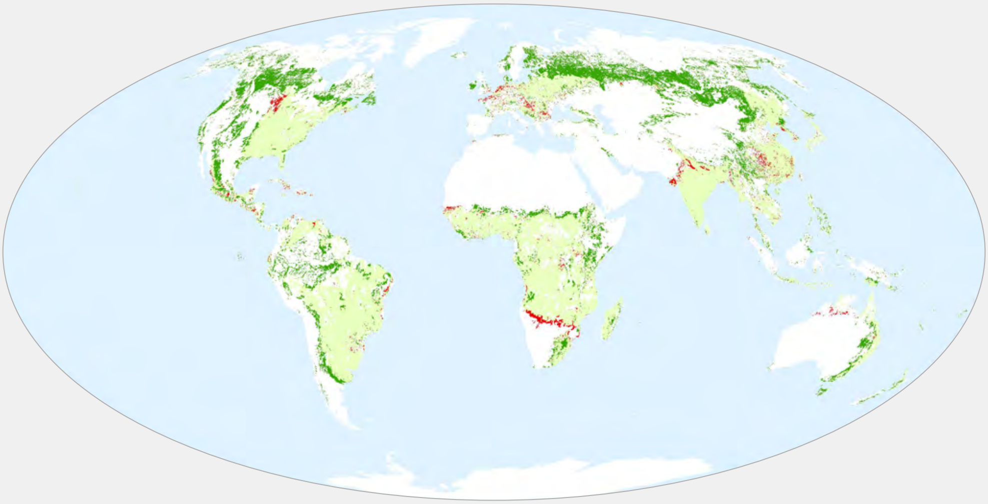
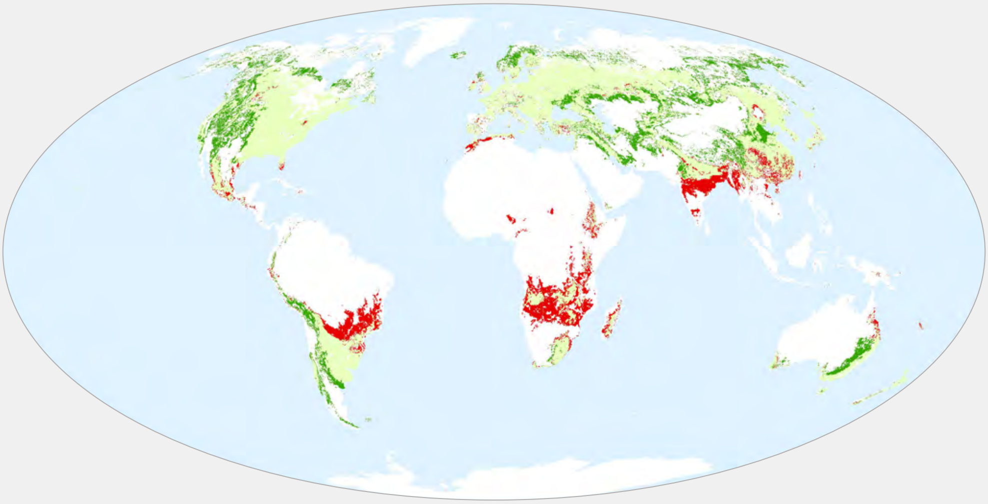


FIGURE 24 (Continued)

SOYBEAN



WHEAT



No change in prime and good land | Decrease in prime and good land | Increase in prime and good land

Refer to the disclaimer on the copyright page for the names and boundaries used in these maps.

NOTE: The analysis compares the distribution of suitable land between the historical scenario (2001–2020) and future projections (2081–2100) under the SSP 8.5 high-emissions climate scenario.

SOURCE: Authors' own elaboration based on FAO & IIASA. 2025. *Global Agro-ecological Zoning version 5 (GAEZ v5) Model Documentation*. [Cited 13 February 2025]. https://www.fao.org/gaez/en

A ROADMAP FOR BALANCING INCREASED FOOD PRODUCTION WITH ECOSYSTEM HEALTH

Given the interconnected nature of land, water, forest and aquatic resources, their sustainable management depends on a holistic approach that blends complementary technical solutions, generating overall benefits that are greater than the sum of their parts. Examining some of the multiple technologies and approaches available to achieve sustainable land, soil and water management, the report outlines a roadmap for decision-makers seeking to balance improved food production with ecosystem health. The roadmap underscores how integrated management practices are essential to building efficient, inclusive, resilient and sustainable agrifood systems.

Together, the complementary strategies presented – each of which is context-specific and dependent on the appropriate enabling environment – address challenges caused by water scarcity, soil and land degradation, deforestation and biodiversity loss. Integrating sectoral solutions offers a unified model for sustainable land, water, forest and aquatic resource management that addresses multiple aspects of food security, climate resilience and environmental sustainability. To cite just a few examples of such approaches, integrated plant production and forestry enhance soil health and restore degraded landscapes, both of which are essential to ensure long-term land productivity and adaptation to climate change. In rainfed agriculture, a focus on organic amendments, crop diversification and conservation tillage directly supports forest restoration by fostering soil conditions that stabilize and enrich surrounding landscapes. Agroforestry systems, known for their resilience and high biodiversity, complement these practices by providing long-term soil benefits, such as increased soil moisture retention and carbon sequestration. Integrating agroforestry practices within pasturelands can provide shade, improve forage quality and enhance soil health, while rotational grazing maintains productive grasslands that prevent soil erosion and loss of biodiversity. By encouraging the strategic inclusion of trees in grasslands, these complementary practices promote resilience to climate extremes, help to manage erosion and enhance carbon sequestration within pasture ecosystems.

For water resources – a critical factor in any strategy for increased agricultural production – there is a strong case for adopting a joint management approach to support both agriculture and fisheries, maximizing food production while conserving water. Designing and managing water for multiple uses (e.g. agriculture, drinking water, industries, livestock and fisheries) can raise the social and economic productivity of water in water management systems. Multifunctional farm ponds can store water for irrigation and domestic purposes and simultaneously be used to raise fish as a source of food and revenue for local communities. Integrating agriculture with aquaculture provides a means of recycling water and nutrients and increasing income. Rice–fish farming systems are a prime example of how this synergistic approach can contribute to both household nutrition and finances, while simultaneously using water more efficiently.

Enhancing the productivity of water in irrigation can be achieved through modernization, including fish-friendly irrigation infrastructures that can enhance both aquatic biodiversity and food security without compromising agricultural productivity. For the long-term success of modernized irrigation systems, a benchmarking approach that encompasses technical, institutional, socioeconomic and environmental factors is essential.

Combining improved water management and grazing practices – by selecting drought-tolerant and water-efficient pasture species (including grasses and woody species), integrating forage and legumes in pastures, and introducing precision livestock farming technologies – can make a significant contribution to better land and water management for pasture and feed production.

Regarding food production for the world's increasingly city-based populations, the report examines the potential of urban and peri-urban agriculture, with a focus on hydroponics, and vertical and rooftop farming – techniques that have proved to be effective around the world. In addition to sustainable and integrated practices on site, other innovative tools such as early warning systems and climate forecasting play an increasingly important role in supporting agricultural production in all its forms.

In every sector and setting, the adoption of technical solutions requires community engagement, data-driven solutions and adaptive practices that consider both the environmental and the social dimensions of resource management. Provided that all these prerequisites can be put in place, the complementary strategies outlined here have strong scope for transforming agrifood systems in line with FAO's overall objective of achieving better production, better nutrition, a better environment and a better life, leaving no one behind.

AN ENABLING ENVIRONMENT FOR BETTER LAND, SOIL AND WATER RESOURCES MANAGEMENT

Ensuring an enabling environment is the final – but critical – piece in the puzzle designed to scale up sustainable land, soil and water resources management, through effective and conducive legal, policy and organizational frameworks. First and foremost, sustainable and integrated solutions are required to address food, climate, land, soil, water and biodiversity crises. The need for such solutions has gained recognition in recent years through various international processes, calls for action, targets and commitments.

Integrated land-use planning, integrated landscape management, integrated water resources management (IWRM), the Water–Energy–Food–Ecosystems (WEFE) nexus, agroecology and the agrifood systems approach are essential sustainable and integrated approaches to address these challenges.

An evidence-based integrated planning process is essential to incorporate the needs and views of different sectors and stakeholders, considering emerging opportunities to enhance production in a sustainable manner and avert planning decisions that could have unintended or unjust consequences. Integrated land-use planning is one such approach, and its benefits are examined in this report, in terms of addressing challenges and competing demands. Modern approaches to ILUP are based on the principles of decentralization and participation, acknowledging that farmers, herders, fisherfolk and forest dwellers have a legitimate stake in the planning process, together with actors who may have separate and at times competing interests in the use of land and water resources, such as for housing, energy, industry, mineral extraction, recreation or tourism.

In tandem and in close cooperation with ILUP, IWRM is advocated as a tool for optimizing the spatial and temporal allocation of water resources for different needs and among different users. Institutional arrangements at local, national, regional and international levels are essential to manage trade-offs and conflicting demands, especially given the agriculture sector's massive consumption levels of global freshwater resources.

Among the various models discussed in *The State of the World's Land and Water Resources for Food and Agriculture 2025*, the WEFE nexus is highlighted for its potential to improve resilience, maximize synergies, promote the participation of stakeholders, and enhance the sustainability of agrifood systems. Adopting the WEFE nexus approach acknowledges the interconnectedness between water, energy and agrifood systems and their impact on ecosystems. For example, water is essential for the production of energy such as hydropower and the cooling of coal-fired or nuclear power stations; energy is critical for accessing and distributing water; and both water and energy are important in agrifood systems, from production, transformation and marketing through to consumption. Agrifood systems also have an impact on both water and energy, so taking account of and planning for their different interactions is essential.

In order for such integrated land, soil and water resources management solutions to be implemented coherently at scale, the following seven enablers must be set in place: i) policy coherence across sectors; ii) governance of natural resources; iii) data, information and technology; iv) risk management systems including early warning and adaptation and resilience strategies; v) sustainable financing and investment; vi) innovation; and vii) institutionalized capacity development.

Better coherence between sectoral policies is needed to maximize the gains associated with land and water management and address overlaps and trade-offs between conflicting objectives. This requires adapting and strengthening institutions and regulatory environments.

Stronger policies to promote sustainable land, soil and water management should include clear land and water rights, incentives for sustainable practices, and disincentives for unsustainable ones. Regulatory frameworks can create a more conducive environment for public and private sector investments. Securing access to resources for smallholders and vulnerable groups offers the potential to enhance productivity, protect resources and contribute to inclusive rural development.

Data and information are key to ensuring the sustainable and productive management of land and water. The rapid development of information and communication technologies, including remote sensing, offers new opportunities for support to land and water management. Efforts should be made to ensure that the right type of information reaches the different decision-makers at all levels.

Understanding and addressing interconnected, systemic risks and their underlying drivers is essential for building resilient and sustainable agrifood systems that can support long-term food security and nutrition and human well-being for a growing population. Tackling these complex, overlapping challenges requires integrated, cross-sectoral solutions aligned with the objectives of the three Rio Conventions, and incorporating disaster risk reduction strategies alongside humanitarian policies to ensure that no one is left behind.

Public and private investment instruments that increase agricultural productivity, contribute to inclusive development and preserve natural resources need to be developed and put into practice. Sustainable investments require coordinated collaboration between the public sector and the financial and private sectors.

Farmers, especially in developing regions, often lack access to the necessary technologies, information and skills required to implement sustainable practices, which hinders the adoption of innovative and sustainable land

and water management techniques. Farmer-centred training programmes should use modern communication technologies to promote the adoption of sustainable practices that strengthen resilience while ensuring the overall improvement of farmers' socioeconomic status.

In areas where land and water resources are scarce, satisfying competing societal objectives (agriculture, industry, urban development, energy, biodiversity conservation) often implies trade-offs and difficult choices in resource allocation. Integrated land and water resource planning provides tools to manage the competition for resources and optimize resource use.

The need for integrated solutions to address food, climate, land, soil, water and biodiversity challenges is emerging from several international processes. The three so-called Rio conventions – the Convention on Biological Diversity, the United Nations Convention to Combat Desertification and the United Nations Framework Convention on Climate Change – were among the first instruments to recognize the inextricably linked nature of the challenges facing the planet and humanity and to highlight the role of agrifood systems in tackling the interconnected triple challenges. They offer a framework for countries to enhance their efforts towards addressing these intertwined objectives in an integrated manner. ■

THE STATE OF THE WORLD

2025 THE STATE OF THE WORLD'S LAND AND WATER RESOURCES FOR FOOD AND AGRICULTURE

THE POTENTIAL TO PRODUCE MORE AND BETTER

Land, soil and water resources are the foundations for agricultural production and global food security. Meeting the increasing demand for food will place additional pressure on resources that are already under severe strain: over 60 percent of human-induced land degradation occurs on agricultural lands (including cropland and pastureland), and agriculture accounts for more than 70 percent of global freshwater withdrawal.

The 2025 edition of *The State of the World's Land and Water Resources for Food and Agriculture* underscores the urgent challenges of human-induced land degradation, water scarcity, and climate change, and their impact on agricultural productivity and ecosystems; it examines the hidden and untapped potential of land and water resources to enhance sustainable agricultural production by safeguarding these finite resources.

While the report looks at land, soil and water in an integrated way, considering different production systems (crops, rangeland, forests, fisheries and aquaculture), particular attention is paid to crops drawing from a thorough analysis of main crop production potential based on data and information derived from the updated version of the Global Agro-Ecological Zoning (GAEZ) assessment. The report further explores sustainable solutions and integrated approaches for sustainable land, soil and water use and management, illustrated with examples, and identifies the key enablers required to scale them up for lasting and sustained impact.

The choices we make today for the management of land, soil and water will determine how we meet current and future demands while protecting the world's precious resources for generations to come.

The State of the World's Land and Water Resources for Food and Agriculture 2025 (full text)

ISBN 978-92-5-140290-0

9 789251 402900

CD7598EN/1/12.25