Food and Agriculture Organization of the United Nations

Photos: ©FAO/Marco Longari, ©FAO/Giulio Napolitano (2 & 4), ©FAO/Sergey Kozmin

Coping with water scarcity in agriculture
a global framework for action in a changing climate

1 Why a global framework for action on water scarcity in agriculture is needed

The world is thirsty, because it is hungry

Water is essential for agricultural[1] production and food security. It is the lifeblood of ecosystems, including forests, lakes and wetlands, on which the food and nutritional security of present and future generations depends. Water of appropriate quality and quantity is essential for drinking and sanitary purposes and for food production (fisheries, crops and livestock), processing and preparation. Water is also important for the energy, industry and other economic sectors. Water streams and bodies are often key means of transport (including of inputs, food and feed). Overall, water supports economic growth and income generation and, therefore, economic access to food.

Nevertheless, significant parts of the world are struggling with water scarcity (Figure 1). From California to China's eastern provinces, from Jordan to the southern tip of Africa, an estimated two-thirds of the global population – over 4 billion people – live with severe water shortages for at least one month each year. Although, overall, there will be sufficient water in a changing climate to satisfy the demand for food at the global level, a growing number of regions will face increasing water scarcity.

Growing demand...

As the global population heads for more than 9 billion people by 2050, demand for food is expected to surge by more than 50 percent. The world is rapidly becoming wealthier and more urbanized, and

[1] "Agriculture" comprises crops, livestock, fisheries, aquaculture and forestry.

Photos: ©FAO/Ado Youssouf, ©FAO/Asim Hafeez, ©FAO/Sarah Elliott

food preferences are changing to reflect this: the consumption of staple carbohydrates is on a declining trend while demand for high-value products such as milk, meat, fruits and vegetables – which, in many parts of the world, have much higher water footprints – is increasing. At the same time, competition for increasingly scarce land, water and energy resources is intensifying, further aggravated by the existential threat of climate change.

...and a declining resource base...

Agriculture is both a cause and a victim of water scarcity. The excessive use and degradation of water resources is threatening the sustainability of livelihoods dependent on water and agriculture. Inefficient and uncoordinated water use depletes aquifers, reduces river flows and degrades wildlife habitats, and it has caused salinization on 20 percent of the global irrigated land area. The inappropriate use of fertilizers and pesticides translate into water pollution, affecting rivers, lakes and coastal areas. The bulk of production in capture fisheries comes from coastal waters, where both the productivity and quality of fish stocks are severely affected by pollution, a great part of which comes from agricultural crop production, aquaculture and livestock.

Achieving the required levels of production from an already seriously depleted natural resource base requires profound changes in our food and agriculture systems, ensuring global food security, providing economic and social opportunities, and protecting the ecosystem services on which agriculture depends.

> "Water is a precious resource, crucial to realizing the Sustainable Development Goals, which at their heart aim to eradicate poverty"
>
> UN Secretary-General
> Ban Ki-moon

As water becomes scarcer, it is fundamentally important to tackle the issue head-on. The adoption of Sustainable Development Goal (SDG) 6 creates an opportunity to systematically engage with key water-scarce countries and to inform and orient national policies towards effective, sustainable models of water management and governance. Target 6.4 of SDG 6 – "increasing water-use efficiency across all sectors and ensuring sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reducing the number of people suffering from water scarcity" – is especially relevant here.

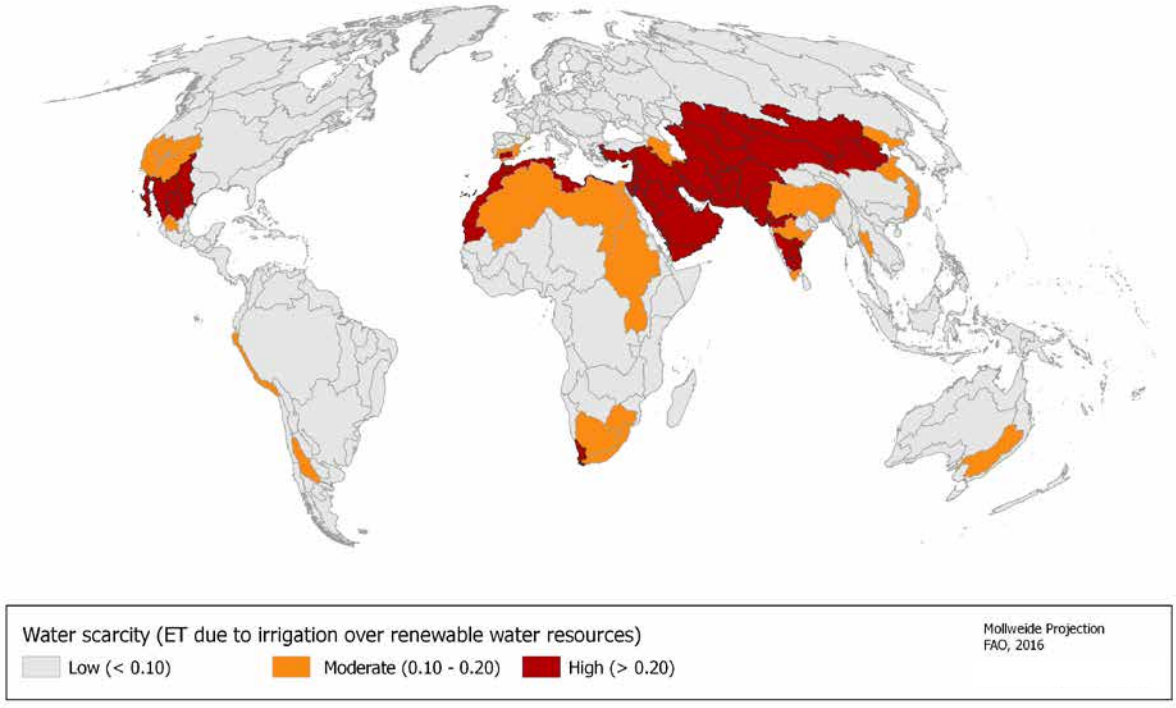
... in a changing climate

Climate change will have significant impacts on agriculture by increasing water demand, limiting crop productivity and reducing water availability in areas where irrigation is most needed or has a comparative advantage. Projections show a general reduction in precipitation in semiarid areas, an increase in precipitation in temperate zones, higher variability in rainfall distribution, an increase in the frequency of extreme events, and an increase in temperature. A severe reduction in river runoff and aquifer recharge is expected in the Mediterranean Basin and in semiarid areas in southern Africa, Australia and the Americas, affecting the availability of water for all uses.

Reduced river base flows, increased flooding and rising sea levels are predicted to affect highly productive irrigated systems dependent on glacier melt (e.g. in the Punjab region, and Colorado) and lowland deltas (e.g. those of the Indus, Nile and Brahmaputra–Ganges–Meghna). In the semiarid

Photos: ©FAO/Olivier Asselin, ©FAO/Giulio Napolitano (2 &3)

FIGURE 1. GLOBAL MAP OF PHYSICAL WATER SCARCITY BY MAJOR RIVER BASIN



Source: Hoogeveen et al, 2014

tropics, where droughts and floods are expected to increase in frequency and severity, climate change is likely to especially affect the rural poor by reducing crop and livestock yields.

2 Mobilizing political will to act

Addressing water scarcity in the agriculture sector directly contributes to the achievement of the 2030 Agenda for Sustainable Development and its SDGs (see box), and the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC).

> "Freshwater-related risks of climate change increase significantly with increasing greenhouse gas concentrations (robust evidence, high agreement). The fraction of global population experiencing water scarcity and the fraction affected by major river floods increase with the level of warming in the 21st century"
>
> IPCC, 2014

The Paris Agreement

The Paris Agreement – an outcome of the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change – provides opportunities for adaptation and mitigation actions in agriculture. Among other things, it establishes the global goal of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response[2].

[2] Intergovernmental Panel on Climate Change. 2014. Summary for policymakers. In: Climate change 2014: impacts, adaptation, and vulnerability.

Photos: ©FAO/H. Null, ©FAO/Franco Mattioli, ©FAO/Giulio Napolitano

The 2030 Agenda for Sustainable Development

Food and agriculture lie at the heart of the 2030 Agenda and its goals of ending poverty and hunger, responding to climate change and sustaining natural resources. Food – the way it is grown, processed, traded, transported, stored, marketed and consumed, and the role it plays in cultural life – presents a fundamental link between people, the planet and the path to inclusive and sustainable development.

Rapid progress in reducing and eliminating hunger and malnutrition will help in achieving all the SDGs. Likewise, progress in all the SDGs will pave the way for ending hunger and extreme poverty. In particular, SDG 1, which is to "end poverty in all its forms everywhere", includes targets on social protection, land rights and resilience. SDG 2 is dedicated to ending hunger, improving food security and nutrition, and promoting sustainable agriculture. The link between food security and natural resources features prominently in SDG 6 on water, SDG 14 on oceans and marine resources, SDG 15 on ecosystems, biodiversity, forests and land (which provide the foundation of all food and agricultural systems), and in the SDGs on energy, gender, climate, and consumption and production.

The Paris Agreement recognizes the fundamental goal of ensuring food security and ending hunger, as well as the vulnerability of food production systems to climate change. Adapting agriculture to climate change is closely linked to water management: adaptation measures that build on existing good land, water and agricultural management practices enhance both resilience and water security. Innovative and sustainable water-management technologies derived from applied research, combined with appropriate policies and strategies, will help in the mitigation of, and adaptation to, climate change.

3 Calling for immediate and concerted effort: the Global Framework for Action to Cope with Water Scarcity in Agriculture in the Context of Climate Change

Water scarcity presents an immediate threat to people, the planet and the path to inclusive and sustainable development. As the largest water user globally and a major source of water pollution, agriculture will play a key role in tackling the looming water crises.

What can agriculture do to address water scarcity in the context of climate change, while ensuring food and nutrition security? What responses can the agriculture and food sectors offer to alleviate the impacts – and reduce the risks – of water scarcity?

To respond to these challenges in a coordinated and effective manner, FAO and a broad range of partners has developed the *Global Framework for Action to Cope with Water Scarcity in Agriculture in the Context of Climate Change* (abbreviated below to "the Global Framework for Action" and "the Global Framework"). It calls for urgent action to cope with water scarcity in agriculture in the context of climate change and growing competition for water resources.

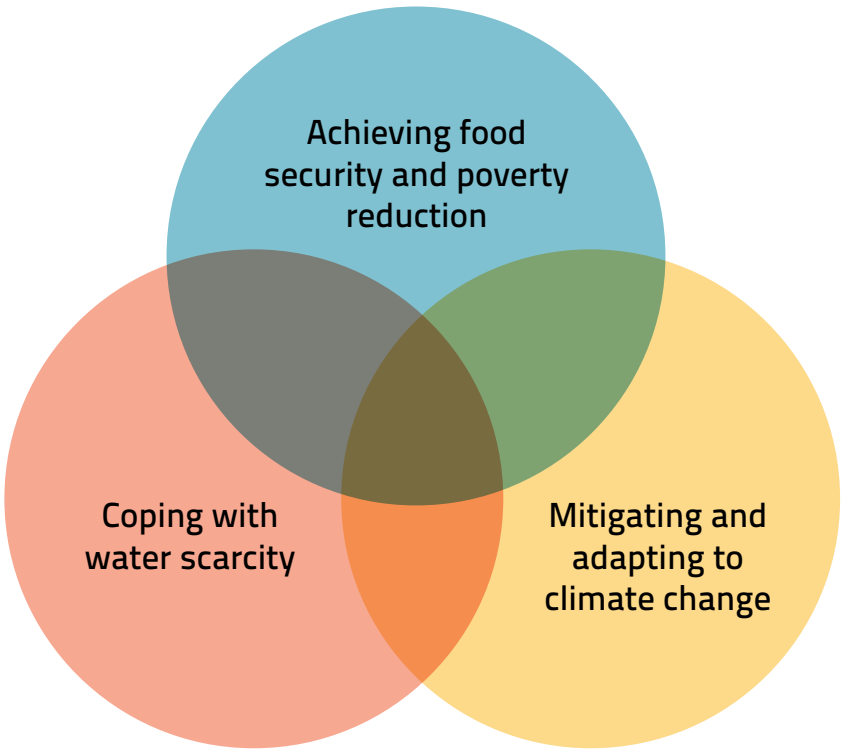
Photos: ©FAO/Florita Botts, ©FAO/Alberto Conti, ©FAO/Ivo Balderi

The Global Framework for Action recognizes the intricate links between climate change, water scarcity, sustainable agriculture and food security – and the importance of addressing these holistically. Its objective is to strengthen the capacities of vulnerable countries to adapt agriculture to the impacts of climate change and water scarcity and thereby to reduce water-related constraints to achieving the food security and sustainable development goals of those countries.

The Global Framework for Action is based on the premise that a sustainable pathway to food security in the context of water scarcity lies in maximizing benefits that cut across multiple dimensions of the food–water–climate nexus, enabling sustainable agricultural production while reducing vulnerability to increasing water scarcity and optimizing the climate change adaptation and mitigation benefits (Figure 2).

"For the third consecutive year, the World Economic Forum's Global Risks Report lists water crises as one of the top-five risks in terms of impact. It states that 'the longer-term concerns are more related to underlying physical and societal trends, such as the failure of climate change mitigation and adaptation, water crises and food crises"

FIGURE 2. THE FOCUS OF THE GLOBAL FRAMEWORK FOR ACTION IN A NUTSHELL



Photos: ©FAO/Ivo Balderi, ©FAO/Jon Spaull (2 & 3)

4 Agriculture holds the key to tackling water scarcity in a changing climate

Agriculture is not only the largest water user globally, it is also a major source of water pollution; the sector will be crucial, therefore, in addressing water scarcity in the context of climate change. Agriculture must adapt to the impacts of climate change and improve the resilience of food production systems in order to feed a growing population with less water. Climate change will bring greater variation in weather events, more frequent weather extremes, and new challenges requiring the sector to take mitigation and adaptation actions.

Securing access to water: dimensions of water scarcity

Securing access to water is crucial for achieving food security and improving rural and peri-urban livelihoods. Access can be limited by physical water scarcity – an excess of water demand over available supply; economic water scarcity – the lack of adequate infrastructure due to financial, technical or other constraints; or institutional water scarcity – the lack of an appropriate institutional framework or capacities for ensuring the reliable, secure and equitable supply of water.

Symptoms of physical water scarcity are environmental degradation, declining groundwater levels, and water allocations that favour some groups over others, thereby causing conflicts (frequently among farmers and pastoralists). Physical water scarcity can be exacerbated by human activities that cause pollution and adversely affect ecosystem services.

Symptoms of economic water scarcity include a lack of adequate and equitable access to water for agriculture and domestic use. Much of sub-Saharan Africa is characterized by economic scarcity, and the development of water infrastructure there could help in reducing poverty, especially in the arid and semiarid lands of the Horn of Africa and the Sahel, where food security is highly dependent on livestock production. Institutional water scarcity may arise when governments lack accountability to their constituencies, service providers are unaccountable to their users, or institutions are unable to address the management of supply and demand or deal with gender roles, relations and inequalities.

Farmers worldwide hold tested solutions to water scarcity, but they need to be supported with appropriate policies, the right mix of public and private investments, and access to knowledge and resources for producing more and better with less water. Various adaptation measures that deal with climate variability and build on improved land and water management practices have the potential to create resilience to climate change and address water scarcity. The sustainable intensification of food production with more efficient water management systems adapted to climate variability and local circumstances can help increase water productivity and raise on-farm incomes. Countries in water-scarce regions will increasingly need to devise food security strategies that explicitly consider structural food supply deficits and trade arrangements that will provide protection from food price volatility.

Photos: ©FAO/Rosetta Messori (1 & 2), ©FAO/Olivier Thuillier

Innovative and effective governance mechanisms and investments in water technologies and infrastructure are needed to address growing water shortages and to ensure that water is allocated in ways that ensure its efficient use, protect the natural resource base, and secure access to water for household use and agricultural production.

Key areas for collaborative action on water scarcity in agriculture in a changing climate

There is a clear need for actions and strategies that holistically address the interlinkages between water scarcity, agricultural production, food security and climate change. Appropriate responses to water scarcity will be found not only in the water domain but also in all the agriculture and food sectors – crop production, livestock, fisheries, aquaculture and forestry. Most water is withdrawn at the production stage, but water scarcity can also be addressed along food value chains and by consumers.

The Global Framework for Action to Cope with Water Scarcity in Agriculture in the Context of Climate Change will focus on the following main areas of collaborative action to address issues of water scarcity in the agriculture sector.

- **Improving agricultural water productivity sustainably.** This cuts across all agricultural subsectors, from irrigated agriculture to livestock production, aquaculture and agroforestry. Agricultural productivity should not only be looked at in terms of land, but in terms of water productivity, maximizing the return on water from a diverse range of activities. Crop water productivity can be improved by increasing yields (production per unit of land) through good agricultural practices, based on soil and water management (e.g. precision irrigation), fertility and pest control and improved genetic materials, keeping in mind the environmental impacts this may have. Crop water productivity can also be improved through deficit irrigation – that is, by applying water to crops in only the most drought-sensitive periods and avoiding irrigating in other periods. Water productivity in agroforestry can be improved by looking at context-appropriate combinations of trees and crops to exploit spatial and temporal complementarities in resource use. Livestock water productivity is closely linked to improved feed management and animal husbandry, reduced animal mortality, appropriate livestock watering and sustainable grazing management. In aquaculture systems, most water is depleted indirectly for feed production and through polluted water discharge, and efforts to improve water productivity should be directed at minimizing those losses.

- **Improving and climate-proofing irrigation services ("soft" measures) and infrastructure ("hard" measures).** Water losses and adverse environmental impacts, like salinization, can be reduced productivity and cost-effectiveness improved by rehabilitating, modernizing and improving irrigation infrastructure. Climate projections and potential impacts on water resources need to be taken into account in both adaptation and mitigation (e.g. low-carbon solar irrigation) efforts. Shifting towards more service-oriented and participatory approaches can improve access to, and the management and maintenance of, infrastructure and thereby increase water-use efficiency. So doing would increase women's rights and access to irrigation and their participation in management structures.

Photos: ©FAO/Roberto Faidutti, ©FAO/Ami Vitale, ©FAO/Giulio Napolitano

- **Preventing and controlling water pollution.** Particularly problematic in situations of water scarcity, pollution reduces the volume of water available for safe use, and increases the cost of water treatment. The cost of not addressing pollution is high, and some impacts may be irreversible (e.g. contamination of groundwater drinking water, and ecosystem losses) and have severe consequences for human health. Water pollution from agricultural crop production can be reduced at both point and non-point sources through integrated pest and plant nutrition management, and pollution control (e.g. stringent regulation and enforcement, and payments for ecosystem services). Water pollution stemming from intensive aquaculture and livestock production requires good management practices (e.g. grass buffer strips near surface water; manure management; and reduced pharmaceutical inputs).

- **Planning, designing and managing for multiple uses of water resources.** Multiple benefits can be derived from the synergetic use of water resources, resulting in greater water-use efficiency and more services for all. Water storage (e.g. reservoirs and ponds) and water-supply infrastructure (e.g. multipurpose dams, canals and green infrastructure) can be designed and managed in ways that more effectively serve the needs of water users for irrigation, livestock watering, homestead gardens, habitats for fish and other aquatic resources, transport, hydroelectric power generation and the environment.

- **Using alternative sources of water while ensuring food safety.** This refers to the reuse of treated wastewater for food and non-food production. Wastewater has the advantage of being readily available, regardless of the weather. Food safety standards and guidelines are needed to ensure that crop, agroforestry and fish production using wastewater streams meet human health standards. Another alternative – but expensive – source is desalinized water. The implications for food safety of the intensification of agriculture for crop and fish production should be considered.

- **Promoting territorial/landscape/ecosystem-based management approaches.** Ecosystem services and functions should no longer be treated as residual water uses. Integrated landscape or ecosystem-based approaches can support multiple benefits – for example food, feed, fibre, building materials, energy, rural livelihoods and well-being, medicines, ecosystem services and biodiversity – making the best use of limited resources. If managed strategically, typical upstream–downstream trade-offs can be avoided and benefits for various agriculture subsectors can be enhanced. Forests, for example, might serve as carbon storage and also play crucial roles in regulating rainfall and other climate patterns and influencing water yields, sediment levels and water quality (e.g. buffer zones, erosion control and water retention).

- **Ensuring more efficient use of water along food value chains.** Food manufacturing – including storing, processing and transporting – requires a significant amount of water. There is good potential for optimizing processes for efficiency gains in water use and for reducing water pollution along food value chains. Water savings can also be achieved by producing better-quality food products (e.g. water is introduced into some cheaper meat products to enhance their appearance and add "bulk").

- **Reducing food losses and waste to alleviate pressure on natural resources.** Food losses and waste represent an unnecessary use of environmental resources and contribution to climate

Photos: ©FAO/Ami Vitale, ©FAO/Giulio Napolitano, ©FAO/Johan Spanner

change. FAO estimates that, each year, approximately one-third of all food produced for human consumption in the world is lost or wasted. Without accounting for greenhouse gas emissions from land-use change, this is equivalent to an estimated carbon footprint of 3.3 gigatonnes of carbon dioxide and an estimated blue-water footprint of about 250 km^3 (the annual water discharge of the Volga River). Actions to prevent, reduce, reuse and recycle food losses and waste are part of the solution to using water resources more effectively.

- **Diversifying production systems and income opportunities for smallholders.** It is important to explore options for less water-intensive and more climate-resilient production (e.g. different cropping patterns, climate-resilient crops and the production of salt-tolerant fish species in degraded waters); synergetic resource use in integrated systems (e.g. integrated food–energy systems that use agricultural residues or algae for biofuel production); and income generation other than food production (e.g. non-timber forest products and ecotourism). Incentives (e.g. subsidies, payments for ecosystem services and the provision of extension services) or disincentives (e.g. quotas, fines and pricing) should be applied to support the most productive and sustainable allocation of resources.

- **Using agricultural trade.** In many countries, food security will increasingly depend on food trade. The highly political and complex international issue of agricultural trade needs urgent attention for its crucial linkages with water security. This would require a collective effort at international level to address the trade–food–water nexus and to draw benefits from virtual water.

5 Bringing actions to the ground – how can the Global Framework for Action help?

No single stakeholder can solve the complex issues facing the agriculture sector today. Partnerships among stakeholders in the water, agriculture and climate-related sectors are necessary to tackle the challenges of food security under climate change and growing water scarcity.

The *Global Framework for Action to Cope with Water Scarcity in Agriculture in the Context of Climate Change* aims to catalyse international cooperation for action that should mostly take place at the national level. Progress towards water and food security lies primarily with governments, subnational administrations and local communities, and they are the primary beneficiaries of the proposed support. The Global Framework for Action will assist countries in implementing their intended nationally determined contributions and nationally determined contributions (INDCs/NDCs) related to agriculture and water; in achieving the food security and water-related targets of the 2030 Agenda for Sustainable Development; and in striving towards other objectives, mainly SDG 2, SDG 12, SDG 13 and SDG 15.

FAO and partners will support countries in implementing their INDCs/NDCs, national adaptation plans (NAPs) and other relevant development plans, programmes and projects contributing to adaptation to climate change and water scarcity in agriculture. An early action of the Global Framework will be to support Morocco's *Adaptation for Agriculture in Africa (Triple A) Initiative*, which aims to significantly scale up support for climate change adaptation in African agriculture under water scarcity.

Photos: ©FAO/Giulio Napolitano (1 & 3), ©FAO/Ishara Kodikara

Action-oriented Partnership: knowledge, innovation and investment

Progress towards sustainability is knowledge-intensive; knowledge and innovation are linked to action on the ground through policies and investments. A repository of good development practices and innovative approaches and technologies applicable to water management in agriculture is available for analysis, testing and potential scaling up. Appropriate policies, incentives, regulatory frameworks and institutions are also needed to enable countries to absorb innovation and change. Combined with sound policies and institutional capacities, investments are a main pathway for scaling up the available knowledge and technological and methodological innovations and multiplying their development impact. For this reason, the Global Framework for Action has a twofold approach that combines knowledge and innovation with effective policies and investment in a unified action chain.

Such an approach calls for a broad, action-oriented partnership: governments, public-sector and private-sector organizations at the national and local levels, non-governmental organizations, regional collaborative bodies and mechanisms, academic and research institutions; UN organizations, bilateral development agencies, and international financial institutions are all invited to join the Global Framework for Action to jointly address water scarcity in agriculture in a changing climate (Figure 3).

Facilitating the action

Partners and established alliances will be responsible for undertaking actions under the Global Framework for Action based on the outlined approach. The Global Framework Partnership will support its members by:

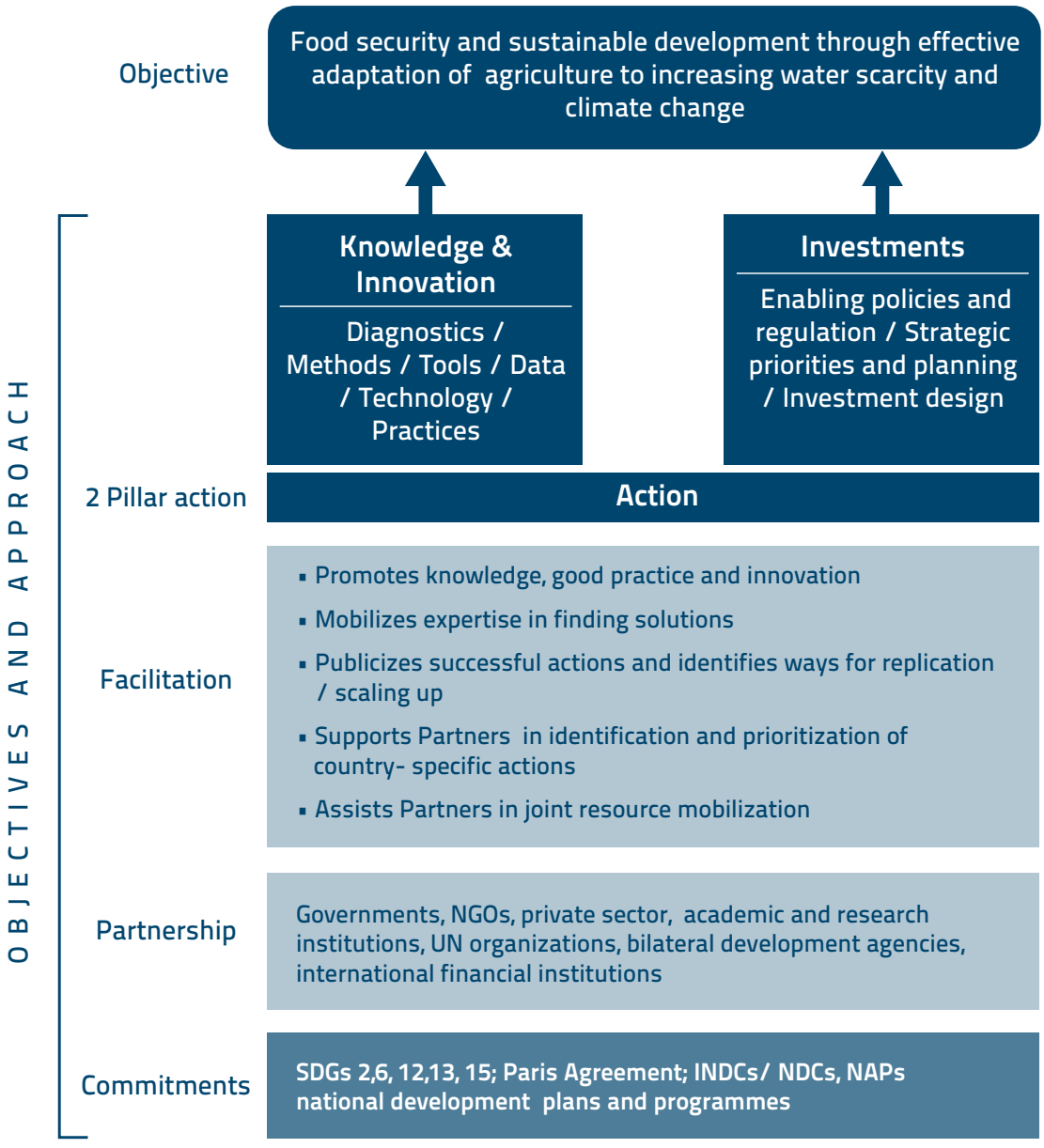
- Providing a forum for analysis, discussion and lesson learning through the exchange of information and knowledge on adaptation of agriculture to water scarcity.
- Promoting knowledge, good practices, available technologies and mechanisms under the two pillars of knowledge & innovation and policy & investment.
- Supporting partners in prioritizing and formulating transformational projects to tackle water scarcity in agriculture (for example by organizing regional and national-level consultations).
- Facilitating collaboration and partner alliances for effective development results.
- Publicizing successful experiences in adapting agriculture to water scarcity and identifying ways in which it can be replicated.
- Assisting partners with fund mobilization, particularly where this leads to a scaling up of action, through the development of joint proposals for projects and programmes on water scarcity in the agriculture sector. Potential sources of funding are the Green Climate Fund and other climate finance mechanisms, the Global Environmental Facility, international financial institutions, and bilateral development assistance, among others.

Operational modalities

FAO will provide the Global Framework for Action to Cope with Water Scarcity in Agriculture in the Context of Climate Change with secretariat services, and a steering committee composed

Photos: ©FAO/Munir Uz Zaman, ©FAO/Noah Seelam, ©FAO/Asim Hafeez

FIGURE 3. THE GLOBAL FRAMEWORK FOR ACTION TO COPE WITH WATER SCARCITY IN AGRICULTURE IN THE CONTEXT OF CLIMATE CHANGE



of representatives of collaborating governments and organizations will oversee and guide implementation. Partners will provide assistance in response to countries' requests through two technical expert platforms: Knowledge/innovation; and Investment. The FAO Water Platform will support the implementation of the Global Framework for Action.

The outgoing and incoming Presidencies of the UNFCCC COP (France and Morocco) have indicated they would like to be included in the initiative, and a number of knowledge organizations, including

Photos: ©FAO/Sia Kambou, ©FAO/Joan Manuel Baliellas, ©FAO/Marco Longari

ICBA, ICID, IFPRI, IWMI, UNESCO-IHE and the World Water Council are among the initial partners. A call has been made to member states through the FAO delegations, as well as to selected potential partner organizations.

For more information, please contact FAO at **Water-Scarcity@fao.org**

I6459EN/1/11.16