Transforming rainfed agriculture in the Arab region

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Key messages

The food gap in the Arab region has grown from **$20 billion** in the early 2000s to over **$75 billion** today, with a **cereal import dependency ratio** of about **65 per cent.**

Rainfed systems occupy more than **70 per cent** of the **cultivated land** in the Arab region, with the largest areas found in Algeria, Iraq, Morocco, the Sudan, the Syrian Arab Republic and Tunisia.

Three types of rainfed mixed systems are present in the Arab region, including a highland system in the mountains, the most common rainfed system where **rainfall exceeds 400 mm**, and the dryland system where rainfall is below **400 mm.**

Challenges facing **rainfed systems** include low yields, limited land, rainfall variability and poor and fast-degrading soils.

The **transformation path** for regional **rainfed systems** include enhancing (i) water availability through supplemental irrigation, (ii) crop water use, e.g., through genetic improvement, (iii) rainwater productivity, e.g., through agronomic practices, and (iv) climate-smart practices such as rainwater harvesting.

Six key policy areas for transforming **rainfed systems** were identified, including encouraging investments, fostering an enabling environment, revamping the institutional setup, engaging women and young people, supporting farmers, and collecting and disseminating data and information.

In the Arab region **internal food production** covers less than **50%** of the region's **food needs**

1. Introduction

Although global food production exceeds food demand, many world regions face a growing food deficit, including the Arab region where internal food production covers less than 50 per cent of the region's food needs.

The food gap in the Arab region has grown over the years from less than $20 billion in the early 2000s to more than $75 billion today, with cereal import dependency at nearly 65 per cent (FAOSTAT, 2023). This is a cause for concern, especially in light of the successive crises within the region and at the global level, including the 2008 food price hike or the more recent COVID-19 pandemic and the food crisis caused by the war around the Black Sea region.

Arab countries are looking for ways to enhance food production to improve self-sufficiency and reduce rural poverty. Most efforts, however, are geared towards irrigated agriculture, though productivity in existing irrigated systems is reaching a plateau, with further expansion expected to be onerous. Options for expanding irrigated agriculture exist in certain countries that have sufficient land and water resources, but these countries lack adequate financial resources.

The Arab region is water-stressed, with a per capita annual availability well below the scarcity threshold of 1000 m^3 and 13 countries well below the absolute water scarcity level of 500 m^3 per capita per year. As climate change sets in and upstream abstraction on transboundary waters increases, water scarcity will worsen, meaning there is limited potential for expanding irrigated agriculture (Abu Zeid and others, 2019). Thus, rainfed agriculture can be viewed as the last frontier for increasing Arab food production in the near future.

Globally, rainfed agriculture produces most of the consumed food, particularly in developing countries. In the Arab region, rainfed systems occupy about 70 per cent of the cultivated land, and most countries rely on them for their food production. Improving rainfed systems' productivity and sustainability is therefore a necessity.

However, investments in agriculture, in general, remain low in relation to the needed transformation. On average, the agriculture sector in most Arab countries receives fewer public investments compared to its contribution to national economies. Moreover, these agricultural investments are usually geared towards irrigated systems, cash crops, fruits and vegetables, livestock and the food supply chain, while rainfed production systems receive a tiny portion.

2. Rainfed systems in Arab countries

The availability of natural resources, particularly sufficient water resources, underpins agricultural production. While the presence of surface and aquifer water resources define irrigated systems, rainfed systems are determined by the amount of rainfall.

The Arab region has close to 70 million hectares of cropland, of which slightly more than 70 per cent are exploited through rainfed systems. Six countries, namely Algeria, Iraq, Morocco, the Sudan, the Syrian Arab Republic and Tunisia, hold most of the rainfed areas. Although there are less rainfed lands in the remaining countries, they still represent a large share of the cultivated land therein and contribute significantly to livelihoods in rural areas (table below).

Rainfed agriculture is possible when annual rainfall is sufficient for economic cropping. The Arab region's rainfed systems are located along the North African coastal strip from Morocco to Tunisia, as well as in West Asia's fertile crescent along the seaboard of the Mediterranean Sea extending in the north of the Syrian Arab Republic and Iraq along the Euphrates and Tigris Rivers and into the Mesopotamian valley and, finally, the southern part of the Sudan and Somalia, in

Arab land use, 2021

	Rainfed Area (1 000 ha)	Cropland as % of land area	Rainfed land as % of cropland
Algeria	7,746.9	3.6	84.0
Bahrain	-	5.9	18.9
Comoros	131.0	62.3	99.9
Djibouti	-	0.1	50
Egypt	810.3	4.0	1.1
Iraq	4 774.2	12.1	32.9
Jordan	339.9	3.2	62.7
Kuwait	-	0.8	-
Lebanon	675.0	26.4	66.6
Libya	880.8	1.2	80.5
Mauritania	258.1	0.4	89.1
Morocco	10,047.7	21.0	79.3
Oman	25.1	0.3	-
State of Palestine	325.9	27.9	19.0
Qatar	-	2.1	-
Saudi Arabia	362.0	1.7	8.8
Somalia	1.6	1.8	82.2
Sudan	6 303.2	11.4	91.3
Syrian Arab Republic	3,573.9	31.2	77.1
Tunisia	2 753.4	32.1	90.1
United Arab Emirates	-	1.3	-
Yemen	709.6	2.8	53.2
Arab region	**39 718.7**	**5.2**	**71.5**

Source: Computed from FAOSTAT data (accessed on March 2023).

a strip along the Red Sea in the southern part of the Arabian peninsula and along the Senegal river in southern Mauritania (figure 1).

These rainfed systems are either temperate, like those found in North Africa and West Asia, or subtropical, like those found in Mauritania, Somalia, the Sudan and Yemen.

Rainfed yields are low in the Arab region, standing at about

1.0 t/ha

compared to

3.0 t/ha

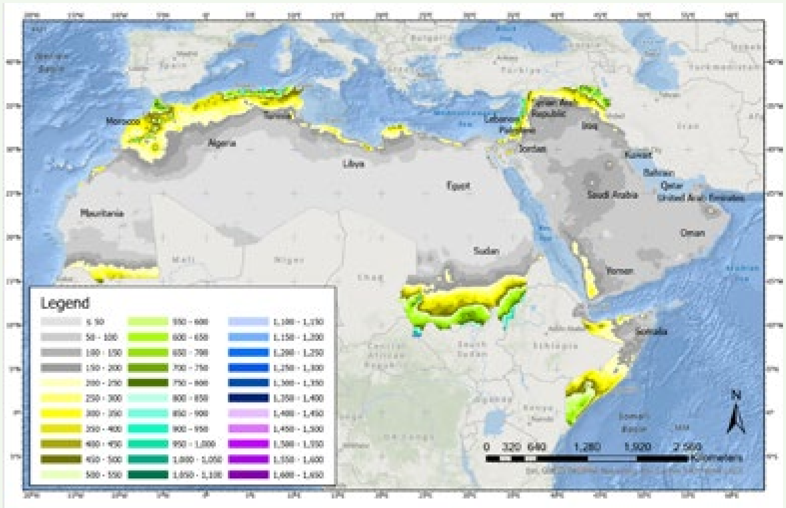
for irrigated yield

Suitable land for **rainfed crop production** in the Arab region makes up

5.2%

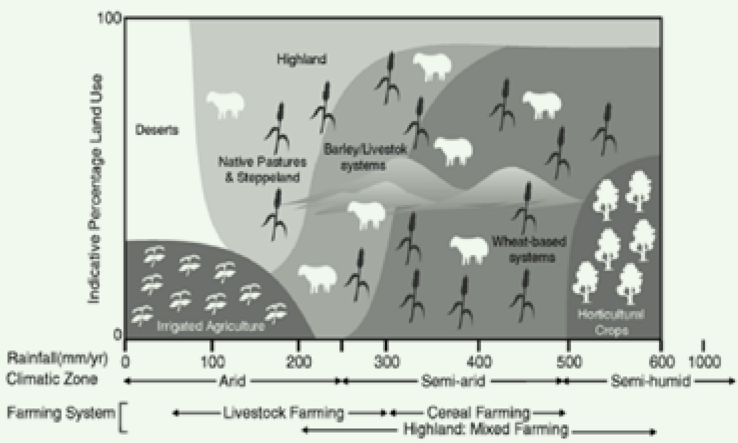
of total land

Figure 1. Isohyets of mean annual rainfall in the Arab region for the period 1981–2020



Source: Funk and others, 2015.

Figure 2. Farming systems across rainfall transect dry areas



Source: Ryan (2011).

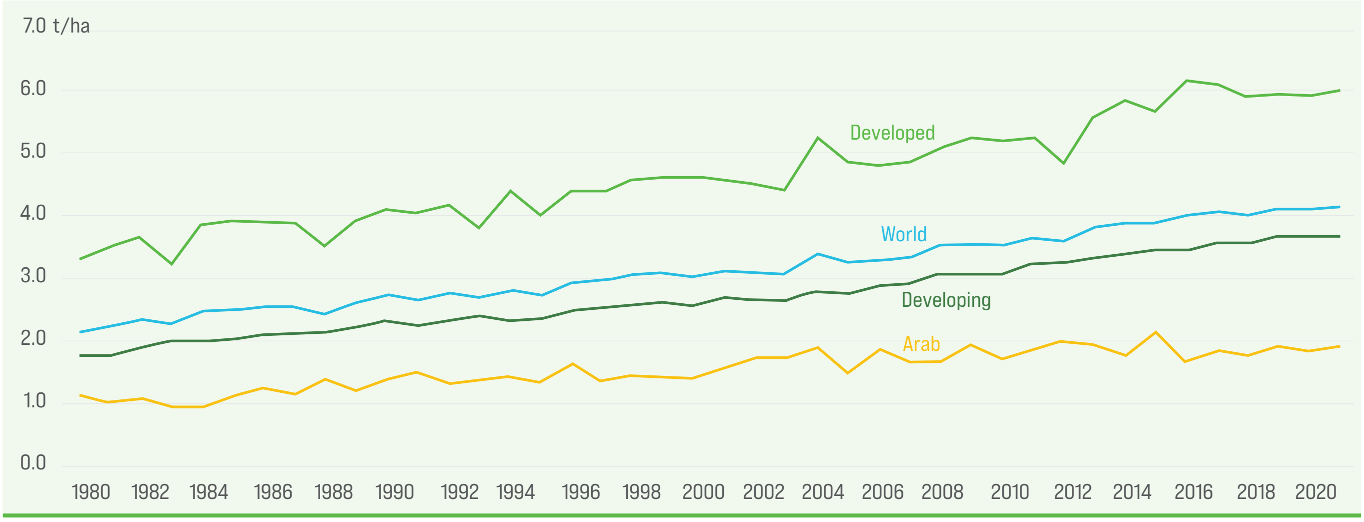
Three principal agroecosystems are identified: irrigated, rainfed and agropastoral (figure 2) (Ryan, 2011).

- **Irrigated systems** are found where sufficient surface or underground water resources are available, such as in the Nile valley, the Euphrates and Tigris basin and other select areas.

- **Agropastoral systems** are found where annual rainfall is below 300–400 mm and are dominated by livestock rearing, though drought-tolerant crops such as barley are also cultivated.

- **Rainfed cropping systems** are usually found in areas where annual rainfall is above 300 mm in temperate climates or above 400 mm in tropical environments, and where rainfall meets crop requirements.

Figure 3. Cereal yields across regions



Source: Based on FAOSTAT (accessed on March 2023).

Three rainfed production systems can be identified (Oweis, 2017):

- **Highland farming systems** are found in high-altitude areas in Algeria, Lebanon, Morocco or Yemen. Dominant crops include cereals and legumes mixed with tree crops such as olives, vines, qat or coffee, and sheep and goats raised under a transhumant system.

- **Rainfed farming systems** are the most commonly encountered type of rainfed production systems and are found in areas with mean annual rainfall above 300–400 mm. They are dominated by cereal-based systems mixed with tree crops such as olives and vines, and sheep and cattle.

- **Dryland farming systems** are found in areas with less than 300 mm of annual rainfall, low population and larger farm sizes. Main crops are barley and millet mixed with small ruminants.

3. Challenges to rainfed systems

Rainfed systems face many challenges, some of which are common to the agriculture sector in general, such as underinvestment. Rainfed systems are often characterized by declining productivity and rising environmental degradation or depletion of resources, meaning that they are unable to support producers in most cases. Some of the main challenges include:

Low yields

Rainfed yields are low in the Arab region, standing at about 1.0 tonnes per hectare (t/ha) compared to 3.0 t/ha for irrigated yields (Arab Organization for Agricultural Development, Khartoum, 2020). Cereal yields in the Arab region are at an average of 1.9 t/ha compared to 3.7 t/ha in other developing countries and a world average of 4.2 t/ha (FAOSTAT, 2023) (figure 3). Rainfed tree crop yields are also lower in the Arab region, e.g., olive tree yields average 1.0 t/ha, while they are above 2.0 t/ha in Greece, Spain or Türkiye (Global Yield Gap Atlas, 2021).

Land availability

Suitable land for rainfed crop production in the Arab region makes up 5.2 per cent of total land, with few opportunities for further expansion. Up to the late 1990s, cultivated areas grew faster than the world average, but they have since stopped except in a few places where opportunities still exist. With climate change, rainfed lands are expected to shrink rather than expand as areas currently at the margins of the rainfed zones (300–400 mm annual rainfall) are likely to lose their production potential.

Rainfall variability

The temporal and spatial variability of rainfall is a critical constraint to rainfed agriculture. Insufficient rainfall or drought spells lead to crop water stress in later parts of the growing season. These are becoming common and are expected to increase in frequency and duration with climate change. In subtropical zones, extreme precipitation variability characterized by high rainfall intensities, few rain events and poor spatial and temporal distribution constitute another challenge (Oweis, 2017).

Poor soil structure

The Arab region's soils have low water storage capacity due to insufficient soil depth. Areas with higher soil depth are limited and found in deep clayey soils where yields could reach up to 3–4 t/ha with good rainfall (Oweis, 2017). The soil water storage capacity is a function of its texture and depth, though aspects such as soil structure and degradation processes also influence it. These affect rainfall infiltration rates and the amount of water available for the crop and its sensitivity to drought spells.

Land degradation

Rainfed lands are subject to land degradation due to the loss of organic matter, physical soil degradation, nutrients depletion and chemical degradation. Nutrient depletion limits crop production and is a major limiting factor in rainfed systems. Due to land degradation, the region's soils are deficient in nitrogen. Deficiency in potash and phosphorous is also apparent in some soils, together with deficiencies in micronutrients such as zinc, boron and sulfur, all of which may affect yields.

The United Nations Economic and Social Commission for Western Asia (ESCWA), in cooperation with the Food and Agriculture Organization (FAO) and the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), assessed the impact of changing water availability due to climate change on agricultural production in a select number of Arab countries. The assessments relied on the AquaCrop simulation programme and examined the impact of projected climate change on selected crop productivity, including wheat. The programme used the climate-variable projections of the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) and showed that deficit irrigation, also known as supplemental irrigation, at critical times improved yields of wheat by up to 10 per cent in Iraq, 28 per cent in Jordan, 13 per cent in the State of Palestine and 14 per cent in Yemen.

Source: Economic and Social Commission for Western Asia (ESCWA), Climate resilient agriculture: translating data to policy actions, 2019.

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4. Rainfed system transformation paths

Improving rainfed agriculture production calls for action at several levels. This includes minimizing the impact of rainfall shortage on the crop, adopting agronomic practices that maximize the ability of the crop to utilize the available water and nutrients, enhancing rainwater productivity, and adopting climate-smart practices to sustain food production in the face of climate change.

Enhancing water availability

what?

The availability of sufficient water in the soil during growing periods is essential for crop production. There is always some water stress during one or more stages of crop growth, particularly in arid environments. Water stress could be limited by increasing water availability in the soil through improved water and crop management as well as supplemental irrigation.

how?

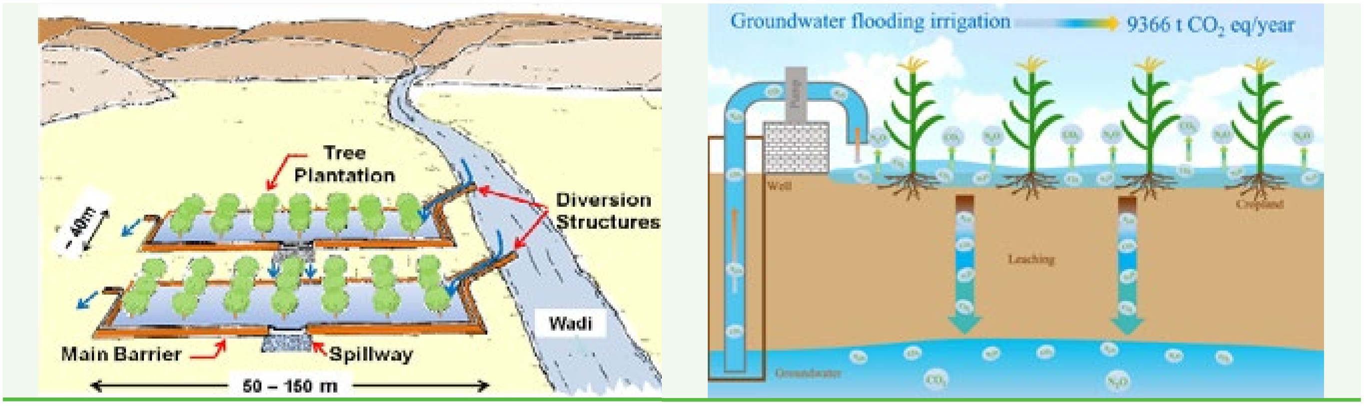
Supplemental irrigation alleviates the negative impact of low or variable rainfall and drought spells on crop productivity. It involves applying small amounts of water by irrigation using surface water, groundwater or harvested rainwater at critical times of the growing season when rainfall fails to cover crop water requirements. In farmer fields, yields could be doubled or tripled when small amounts of water are applied at critical times (figure 4).

Enhancing crop water use

what?

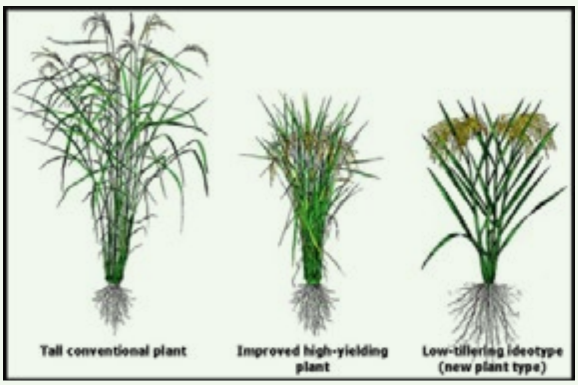
To maximize the ability of the crop to utilize the available water, the plant needs to be able to uptake the water from the soil and to transform it into transpiration and food. In water-stressed

Figure 4. Supplemental irrigation systems



Source: ESCWA/Oweis, 2021; Huo and others, 2022.

Figure 5. Rice plants cultivars



Source: Breseghello and Coelho (2013).

Figure 6. Agronomic practices

Source: www.mydreamgarden.in.

environments, it is essential to provide farmers with crops that maximize water and nutrient use efficiency or that are highly water responsive for optimal production under water stress.

how?

Crop water use can be enhanced through good agronomic practices such as crop rotation and interspersing, but superior results are obtained through breeding and genetic improvement that target specific characteristics to improve crop yield and quality under varying environments. Nowadays, it is possible to find plants with traits such as tolerance to drought, heat, cold, pests and diseases as a result of breeding and genetic improvement (figure 5).

Improving rainwater productivity

what?

Agricultural productivity is usually measured through biophysical returns, quantity of product, or economic returns such as income per unit of water. It can also be measured through nutritional value, such as protein and dietary energy content; environmental benefits such as carbon sequestration; or social benefits such as employment to further highlight the importance of water on key issues. Rainwater productivity could be improved using technical options that include cropping patterns, agronomic practices or genetic improvement.

how?

Agronomic practices play an important role in increasing rainfed crop productivity, with different returns obtained using differing practices, e.g., cropping patterns, crop rotation, input use or supplemental irrigation. Productivity could be enhanced using several methods, including nutrient management by enhancing soil organic carbon content and maintaining soil fertility and health; conservation agriculture through minimal soil disturbance, permanent soil cover or intercropping; and use of improved varieties (figure 6).

ESCWA identified a few best practices, innovations and technologies to inform climate action for resilient and sustainable agriculture systems in the Arab region, which face challenges such as limited water and natural resources and a high susceptibility to climate change-related outcomes. The way forward is to adopt technologies in water, land and livestock management that can help mitigate and adapt to climate change impacts. Enhancing water management could be achieved through the adoption of digital water solutions that could help address prevailing water scarcity while boosting resilience to climate impacts. Enhancing land management includes maintaining or growing soil organic carbon stocks, which offer synergies for tackling desertification, land degradation and drought, in addition to mitigating and adapting to climate change by enhancing soil health and fertility and increasing water and nutrient retention. Enhancing livestock productivity through climate-smart solutions requires diversifying livestock animals (within species), using different crop varieties for animal feed, and transitioning to mixed crop-livestock systems as they are among the most promising adaptation measures.

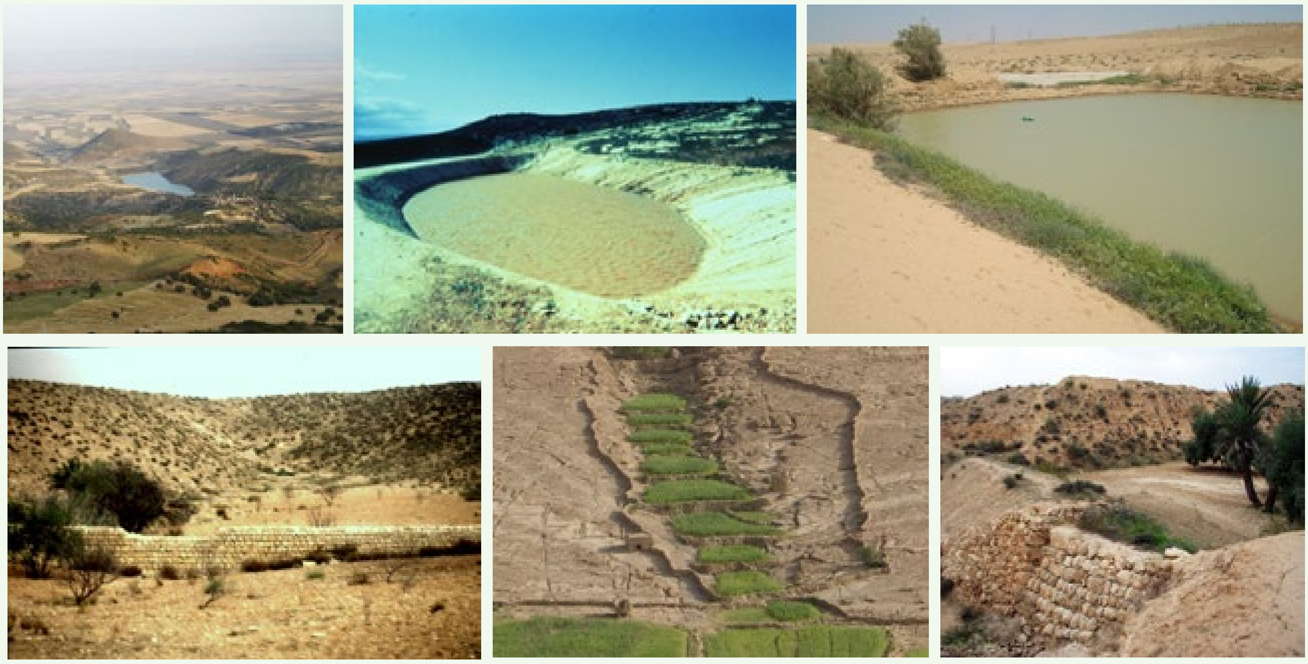
Source: ESCWA, Climate resilient agriculture: translating data to policy actions, 2019.

Over the past few decades, **investments for rainfed systems** remained at less than

15%

of those of **irrigated systems**

Figure 7. Water harvesting and cultivation systems



Source: ESCWA/Oweis, 2021; Huo and others, 2022.

Adopting climate-smart practices

what?

The impact of climate change on the productivity of rainfed systems is substantial and growing. It comes in the form of temperature and rainfall variability, shifting agroecosystem boundaries, pests and extreme weather events that lead to reduced yields and productivity and lowered nutritional quality, among others. Offsetting these negative impacts could be achieved through adapted agronomic practices, new crop varieties and supplemental irrigation.

how?

Climate-smart agriculture builds on existing knowledge, practices, technologies and principles of sustainable agriculture. One of these is rainwater harvesting, which has been used for thousands of years and consists of redirecting rainwater to a suitable storage system so that it could be utilized later when needed to support agricultural production. Rainwater harvesting structures are used to slow down runoff to allow for enough infiltration opportunities or to redirect it to surface or underground reservoirs or aquifers (figure 7).

The adoption and wide reliance on the above strategies require strategic changes to support their implementation. This necessitates the creation of an enabling environment and the provision of adequate support. A prerequisite would be to allocate a greater share of public financing to rainfed systems, revamping the institutional setup and supporting small farmers.

5. Transforming rainfed systems

There are enough technologies and management packages available to allow farmers to bridge the yield gap. The problem is that most farmers are not adopting these technologies because of a lack of awareness, knowledge or financial capacity. To develop rain-fed systems, farmers need to be supported and transformative changes introduced to incite more interest in this crucial sector.

Encouraging investments

Rainfed farmers are generally poor and consistently lag in applying improved technologies, adopting advanced practices and managing resources more effectively and efficiently. This is partly due to the high risk associated with rainfed agriculture. Investments from both private and public sectors are limited as priorities are geared towards other economic sectors with better returns, and within the agricultural sector towards irrigated systems and cash crops.

Over the past few decades, investments for rainfed systems remained at less than 15 per cent of those of irrigated systems even though returns to investments in irrigated agriculture have generally plateaued (Oweis, 2017). It is worth noting that investments in rainfed agriculture provide better returns if risks associated with unfavourable rainfall characteristics are addressed. Supplemental irrigation has provided excellent returns in the Syrian Arab Republic and Tunisia, and similar outputs to irrigated systems were achieved using a fraction of the water. During drought spells, applying smalls amounts of water more than doubles yields and water productivity as it leads to better responses to other inputs such as fertilizers and improved crops. (Oweis, 2017).

Reforms are needed to **empower women** so that they could better plan and **manage agricultural activities**, including in **rural organizations**

Fostering an enabling environment

Farmers cannot work alone on driving the required changes or creating a conducive environment without the existence of enabling policies. Instituting an enabling environment would facilitate the acquisition, adoption and use of appropriate technologies and practices. Enabling policies may include providing incentives, simplifying and supporting access to credits and loans, securing land tenure and property rights, reducing land fragmentation, promoting the adoption of integrated approaches, providing extension services, enhancing access to markets, supporting farmer cooperatives for inputs and outputs, providing necessary infrastructure, or facilitating sustainable natural resource management.

These could be achieved by using well-targeted subsidies and support programmes, which have been proven to drive agriculture development. Unfortunately, they are usually subject to internal politics, which often lead to opposite results and end up depressing producer prices and crowding out local production. Subsidies, incentives and support need to be targeted towards acquiring agriculture machinery, building supplemental irrigation infrastructure, accessing improved seeds and fertilizers or controlling environmental degradation.

Revamping the institutional setup

Organizations supporting farmers and social development need to set proper priorities to focus more on rainfed agriculture systems and their stakeholders through appropriate consultations. Good policies and appropriate legal frameworks are needed for successful interventions, in conjunction with suitable institutional structures, human capacities and adequate financial allocations.

Organizations for farmers and communities in rainfed areas address many issues of concern for their livelihoods. Examples of such organizations include farmers' unions, cooperatives and chambers of agriculture, among others. They facilitate the availability of collective machinery, the marketing of products, the availability of small loans or the management of shared natural resources. However, these organizations are usually weak, riddled with internal conflicts and poorly financed and managed, resulting in low farmer participation. Governments need to empower these organizations and provide adequate assistance to improve their management.

Engaging women and young people

The role of women in rainfed agriculture is substantial. Reforms are needed to empower women so that they could better plan and manage agricultural activities, including in rural organizations. The same applies to young people in rural areas, who are migrating to urban centres for more attractive jobs and improved income. Upgrading the capacities of young and female farmers on new technologies and practices, and on management, finance and leadership is needed to empower them.

Supporting farmers

Technologies and practices to upgrade rainfed agriculture already exist. However, upscaling these solutions is happening at a slow rate. The lack of adoption is either because farmers are unaware of these technologies and practices, or because they are unaffordable. There is a need to know the underlying causes of the low adoption rates to develop programmes and strategies to reverse the trend. Farmers would have to be reached to formulate pathways and facilitate adoption and investment in already available improved technologies and practices. The involvement of stakeholders in research and development for suitable technologies and practices is essential to ensure their suitability and the likelihood of their adoption.

Collecting and disseminating data and information

Arab countries tend to not collect detailed national agricultural data, meaning that the performance of rainfed systems alone is largely unknown. There is an urgent need to collect more detailed data not only on areas, yields and total production but also on spatial and temporal rainfall and variability, evapotranspiration and soil moisture levels. This type of data is important as it enables the assessment of patterns of variability over the years as well as before and after interventions, which could allow the identification of barriers to improved productivity in order to come up with proper remedies.

Conclusion

Rainfed agricultural systems are not performing as well as they should be despite their critical role in providing food and generating livelihoods, especially for poor rural communities of the Arab region. Yields are low owing to unfavourable precipitation and land degradation, as well as to the low efficiency of resource management and use. There is a need to unlock the potential of rainfed systems in the region through a strategic change in the management of risks caused by rising water scarcity. The key is to increase crop water availability and use through improved water management at the field and watershed levels, which would enable a better response from other agricultural inputs and investments. Supplemental irrigation, which could be achieved through rainwater harvesting when other sources of water are not readily available, could also unlock rainfed yield potential. However, a reallocation of water resources, both surface and underground water resources, might be necessary to complement rainfall. Revamping and investing in rainfed systems may prove economically profitable and socially beneficial compared to irrigated agriculture. As such, Governments should be encouraged to consider policies to enhance rainfed systems, in order to provide needed incentives and an enabling environment to encourage investments from farmers and the private sector.

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