Food and Agriculture Organization of the United Nations

Globally Important AGRICULTURAL HERITAGE Systems

HAND IN HAND WITH NATURE

NATURE-BASED SOLUTIONS FOR TRANSFORMATIVE AGRICULTURE

A REVISION OF NATURE-BASED SOLUTION FOR THE EUROPE AND CENTRAL ASIA REGION, SUPPORTED BY GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (GIAHS) EXAMPLES

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A REVISION OF NBS FOR THE EUROPE AND CENTRAL ASIA REGION, SUPPORTED BY GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (GIAHS) EXAMPLES

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CONTENTS

FOREWORD

This publication offers an overview of Nature-based Solutions approach and specific examples of these solution applied to agriculture, for the countries in the Europe and Central Asia (ECA) region. Agri-food systems in the region face many social, economic, and environmental challenges. Therefore, there is an urgent need for a transition toward more sustainable and resilient food systems capable of facing these challenges. Nature-based Solutions in agriculture can play a key role in this transformation, drawing a path built hand in hand with nature.

Nature in food systems entails natural resources, agroecosystem services and biodiversity for food and agriculture, so-called natural capital. Food production is sustained in vital agro-ecosystems, that depend on natural capital to carry out their functions. The ability of food systems to provide us with food and ensure its sustainability over time has depended on our ingenuity to observe, understand, and foresee the events taking place in a changing environment. This is how we have been able to spread all over the world, developing a colossal range of food systems; diversity is a fundamental part of our society and our survival.

The slow but constant and tireless march of human beings around the planet has been witness to their chameleonic capacity to understand and adapt to the specific environments in which they settle. The most extreme conditions have not been an impediment for humans when it comes to adapting and creating favourable environments for their societies. Observation of the environment, of changes and repetitions in orography and climate, and of interactions among the elements and living beings have been the foundations of smart agricultural technology, improved and transformed based on trial and error.

However, in the last decade intensive agro-industrial food systems have gone beyond the functioning of nature and its rhythms, with the increasing distance between food systems and nature taking its toll and leading to environmental, economic, social and health crises.

For this reason, eyes are now turning towards a way of producing food that considers Nature-based Solutions to solve current societal challenges such as climate change, water and soil conservation, and biodiversity loss.

Those challenges are badly hitting the Europe and Central Asia agri-food systems. However, the region's farmers, fishers, herders and foresters have stewarded nature-based technologies adapted to local conditions for centuries and even millennia. This richness is a treasure trove to be discovered and employ together with science and innovation, to bring us closer to the transformative agriculture that our time demands.

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Vladimir Rakhmanin

Assistant Director-General and Regional Representative for Europe and Central Asia

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ACRONYMS AND ABBREVIATIONS

CEB	United Nations System Chief Executives Board for Coordination
COP25	Twenty-fifth Conference of the Parties to the United Nations Framework Convention on Climate Change
COVID-19	coronavirus Disease 2019
ECA	Europe and Central Asia
EC	European Commission
EbA	ecosystem-based adaptation
FFS	farmer field schools
GHG	greenhouse gas
GIAHS	Globally Important Agricultural Heritage Systems
GMO	genetically modified organism
IUCN	International Union for Conservation of Nature
KJWA	Koronivia Joint Work on Agriculture
NaCl	sodium chloride
NbS	nature-based solutions
NCS	natural climate solutions
NDC	nationally determined contributions
SDGs	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
UN	United Nations
UV	ultraviolet

INTRODUCTION


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Nature-based Solutions (NbS) are being mainstreamed as an opportunity to guide the current development into a more sustainable path, with eco-friendly technology in line with nature. In agriculture, these solutions are an opportunity to walk through the better management of agroecosystems and landscapes – enhancing and maintaining productivity, food security and economic viability – while ensuring the sustainable management of natural resources, biodiversity, and resilience to crises, disasters and climate change.

Nowadays, we are witnessing the existence of an extremely polarized agricultural system: at one extreme is intensive agriculture focused on high-yield production, and at the other extreme are locally diversified smallholder agricultural systems. The first has taken for granted the ecosystem services that provide it, favouring the simplification of the system with one or a few varieties and the use of techniques and agrochemicals that reduce the ability of agroecosystems to absorb and recover from disturbances and maintain sustainability over time. The second, though embedded in techniques and practices that favour ecosystem services, is severely threatened due to its inability to offer sustainable and sufficient income for the people who depend on it, being affected by the serious processes of rural migration and population ageing and by strong competition from capital-intensive agro-industry.

A wide variety of agroecosystems lay between both extremes, and calls increasingly are being made for the necessary integration of both parts into a transformative agriculture. This transformation calls for the application of strategies that collaborate with nature but are capable of facing current social challenges by making use of scientific and technological advances. For this reason, Nature-based Solutions in agriculture must act on the two extremes of the agrifood system, reducing the gap that separates them.

NbS is a new concept, but its essence is not new at all. Other disciplines and approaches in agriculture have been expressing widely the fundaments of these concepts, such as agroecology, smart agriculture, conservation agriculture, permaculture, land and forest sustainable management, the ecosystem-based approach, etc. These solutions, understood as *actions supported by nature designed to face societal challenges and ensure human well-being*, have been deployed for food production by farmers, herders, fishers and forest people for hundreds and thousands of years. These people have created ingenious techniques, technologies and practices whose footprints can be observed worldwide in outstanding agricultural landscapes. However, these systems have been neglected and are extremely threatened, as are the NbS that lay within them. ➤

On the other hand, colossal work is taking place to build new agricultural practices for the better management of landscapes.

Landscapes, as perceived by humans, are the result of the evolving interactions among nature and human factors in a specific area. The evolution of these interactions over time is printed in the landscape, and as such it acts as a footprint of the degree of harmony between human interactions and nature. Landscapes are an expression of biocultural diversity, going beyond aesthetic value. Indeed, managing agroecosystems at a landscape scale allows an extension of the degree of observation, integrating social, economic and environmental objectives.

Therefore, landscape degradation is also an indicator of the degree of imbalance between nature and human beings. For this reason, NbS are being mainstreamed as a complete approach for developing resilient landscapes (Lafortezza *et al.*, 2018). Innovation in this regard could enhance ecosystem services in landscapes that have been degraded or even destroyed by unsustainable agricultural practices and policies.

Both are complementary pieces of the same puzzle. However, they do not walk hand in hand. Therefore, it is urgent to establish synergies between both streams, saving huge sums of energy and money while avoiding the loss of our irreplaceable agricultural heritage.

This report aims to provide the countries in the Europe and Central Asia (ECA) region with an overview of Nature-based Solutions applied to agriculture. In this manner, we aim to build the first bases to establish a link between modern technological innovation for sustainable agriculture and the practices and techniques that have, thanks to the ingenuity and perseverance of local communities imitating nature's processes, remained in the region for centuries.

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PART 1: NATURE-BASED SOLUTIONS FOR A TRANSFORMATIVE AGRICULTURE

1.1. NATURE-BASED SOLUTIONS: CONCEPT, PRINCIPLES, OPERATIONAL FRAMEWORK

The Nature-based Solutions (NbS) approach was initially mentioned in relation to its capacity to reduce biodiversity loss and climatic changes (MacKinnon, Sobrevila and Hickey, 2008). Afterwards, the International Union for Conservation of Nature (IUCN) promoted the concept in its position paper on the United Nations Framework Convention on Climate Change (UNFCCC) COP15 (IUCN, 2009). Later, the European Commission (EC) embraced the concept, defining it and proposing operational frameworks based on experts' assessment, to ensure the effective upscaling of this concept in practice (EC, 2015; Raymond *et al.*, 2017). This way, the EC (2020) defines NbS as:

> Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.

The EC has established an EU Research and Innovation (R&I) policy agenda on "Nature-based Solutions and Re-Naturing Cities" with an objective to "position Europe as the world leader, both in R&I on Nature-based Solutions and in the global market for Nature-based Solutions" (EC, 2015). The R&I policy agenda is implemented through Horizon 2020, the EU Framework Programme for Research and Innovation. The EU recognizes NbS to support major EU policy priorities, in particular the European Green Deal, the EU Biodiversity Strategy and the EU Adaptation Strategy, which promote NbS as a way to foster biodiversity and make Europe more climate-resilient. NbS must therefore benefit biodiversity and support the delivery of a range of ecosystem services.

In a short time from its conceptualization, the term "Nature-based Solutions" is being embraced by governments, academia, international organizations and civil society. This term has been broadly mainstreamed for communications targeting policymakers, and for a few years now an emerging range of scientific publications has been developed. This is, therefore, an opportunity for the successful scaling of NbS for policies to be supported by scientific evidence and an efficient operational and evaluation framework. ➤

NbS brings together actions that operate in a wide range, acting like an umbrella to many approaches, including the ecosystem approach, ecosystem-based adaptation and mitigation, and green and blue infrastructure. They cover a wide range of interventions: green roofs for climate adaptation; urban agriculture for liveable and edible cities; stormwater drainage across watersheds, avoiding flooding and soil erosion; coastal resilience through mangrove conservation and restoration; UV radiation to treat algae-polluted water; green spaces and horticulture therapy for improving mental health, etc. (Artmann and Sartison, 2018; Cohen-Shacham *et al.*, 2016; Lafortezza *et al.*, 2018; Sonneveld *et al.*, 2018; Rodrigo-Comino *et al.*, 2018) and vary in the amount and diversity of ecosystem services they target and in stakeholder engagement. Despite the breadth of the term and the possibilities offered by its versatility, the risk posed by the lack of limits in its applicability requires the creation of an operational framework. Intending to adapt the solutions provided for agriculture within the current operational and conceptual framework of the NbS, it is compiled the typologies proposed by Eggermont *et al.* (2015) and later adjusted by the IUCN (Cohen-Shacham *et al.*, 2016), as follows:

PRESERVATION:
Actions that imply the maintenance or protection of active and functional ecosystems, avoiding degradation with minimal intervention for the delivery of ecosystem services.

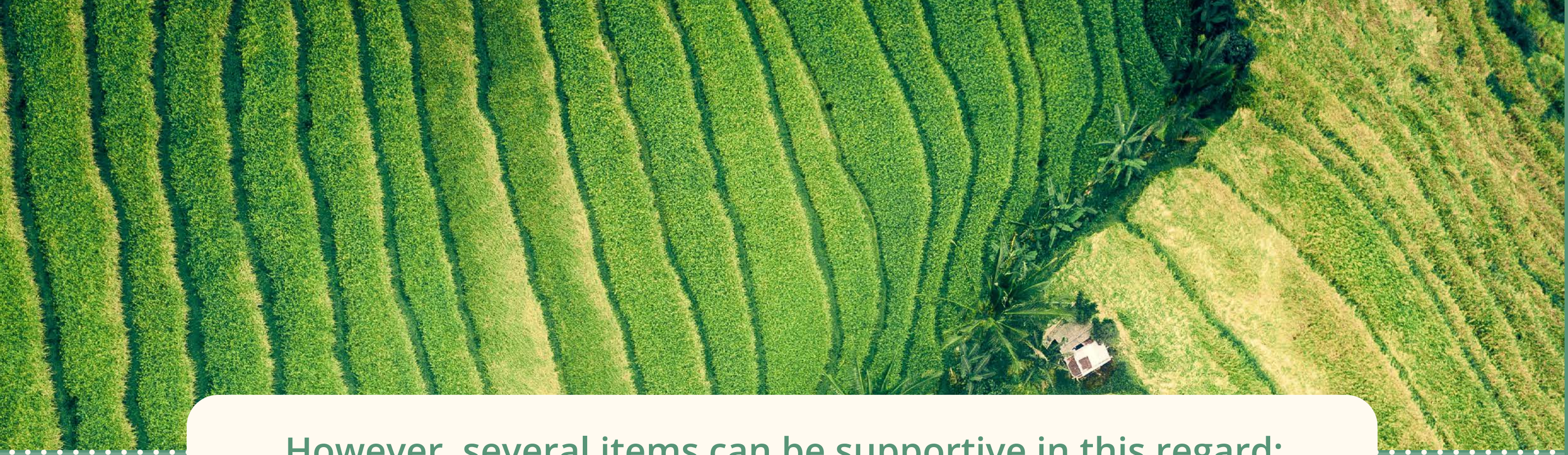
BETTER MANAGEMENT:
Solutions that imply better interventions in already managed landscapes and ecosystems, improving the delivery of selected ecosystem services with sustainable protocols, measures, practices and techniques.

RESTORATION:
Actions that imply the partial or total restoration of degraded ecosystems.

Recently, a global standard for NbS has been developed by the IUCN (2020) for the establishment of a common framework, with clear parameters. This standard provides eight criteria and a set of 28 indicators. The extent to which this standard can be applied for NbS in agriculture is still to be assessed. However, understanding the principles that have served as the basis for its construction can be helpful in this task:

1 • NbS embrace nature conservation norms and principles.
2 • NbS can be implemented alone or in an integrated manner with other solutions to societal challenges.
3 • NbS are determined by site-specific natural and cultural contexts (including traditional, local and scientific knowledge).
4 • NbS produce societal benefits in a fair and equitable way, in a manner that promotes transparency and broad participation.
5 • NbS maintain biological and cultural diversity and the ability of ecosystems to evolve over time.
6 • NbS are applied at a landscape scale.
7 • NbS recognise and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services.
8 • NbS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge.

Principles 2, 6 and 8 establish benchmarks that work as a good start for NbS to be applied to the wide range of agroecosystems in the world. On the other hand, the same cannot be said for the other five principles, which in many cases require a major paradigm shift for NbS applicability in agriculture. ➤



However, several items can be supportive in this regard:

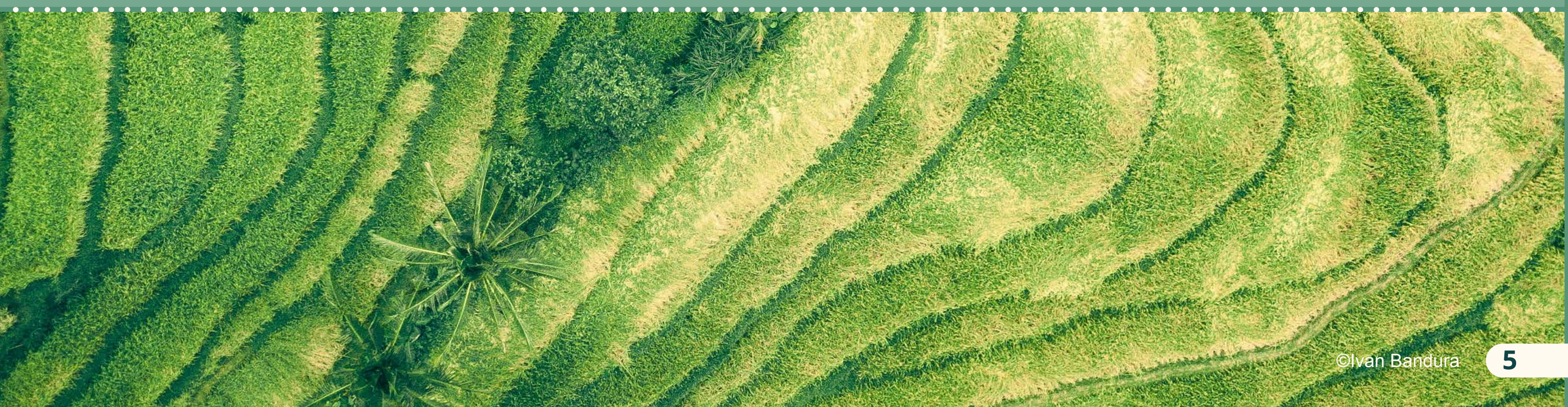
• Food production is sustained in vital agro-ecosystems in which its components – natural resources and biodiversity – interact, creating the operating networks through which ecosystem services are provided for the realization of agriculture. These networks are unique and highly context-specific, as are the diversity of ecosystems and climate factors.

• A lack of knowledge, the over-exploitation of resources, and the application of inputs that affect natural resources and biodiversity put at risk this natural capital on which the world's food and livelihoods depend.

• Such negative impacts are part of the trade-offs and could be minimized by creating synergies (FAO, 2014).

• Context-specific, local and traditional knowledge in agriculture has been neglected and is disappearing at an alarming rate. Policy commitments and the raising of awareness are required to preserve this knowledge, without which NbS will be hardly applicable.

• Awareness-raising – through social participation, scientific evidence, innovative technologies and multidisciplinary interventions – encourages joint action for good governance and the scaling up of NbS.



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1.2. SOCIETAL CHALLENGES IN AGRICULTURE AND FOOD SYSTEMS

1.2.1. TOWARDS A TRANSFORMATIVE AGRICULTURE

The 2030 Agenda for Sustainable Development and its Sustainable Development Goals face many challenges in achieving sustainable development in the next decade: degradation and depletion of natural resources; a growing population; migration of rural communities to cities, with the consequent abandonment of rural areas; the drastic consequences of climatic changes; the loss of biodiversity; and natural disasters and conflicts.

In the midst of all these, global agricultural and food systems are at a crossroads and are currently not meeting the world's expectations for sustainability.

FAO recognizes the existence of a world food crisis; since 2014, hunger has slowly been rising. Moreover, the COVID-19 pandemic could increase the ranks of the undernourished by 83 million to 132 million people. Although there is currently enough food to feed the entire world population, more than 1.5 billion people cannot afford a diet that meets the required levels of essential nutrients, and more than 3 billion people cannot even afford the cheapest healthy diet. The unsustainable ways of consuming and producing food are causing hidden costs in climate and health that could amount to USD 3 trillion per year by 2030 (Food Security Information Network, 2020). Managing natural resources sustainably is critical for reducing these hidden costs and preventing future crises like the one we are currently experiencing worldwide due to the COVID-19 pandemic.

Despite the current crisis, challenges are being stressed as opportunities to analyse and build up new ways to walk together through sustainable development. This is the case of the One Health vision, which recognizes the connections among humans, animals, plants and their shared environments, applying integrated actions to reduce disease threats and ensure a safe food supply through the effective and responsible management of natural resources (FAO, 2011).

The necessity of a transformation of agri-food systems also has been highlighted in the Convention on Biological Diversity through the Aichi Biodiversity Targets –especially Target 7, urging for reconciliation between agriculture and the conservation of biodiversity, and Target 18, asking for the respect of traditional knowledge.

In this regard, FAO has been challenging and supporting for decades Member Nations in improving agricultural production while reducing the impacts on nature of their activities. FAO has been calling for sustainable agricultural development, which it defines (FAO, 1988) as:

> the management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Sustainable agriculture conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable.

FAO's new Strategic Framework 2022-2031 promptes a transformation to more efficiente, inclusive, resilient and sustainable agri-food systems. This transformation aligns with FAO's high commitment to achieving the SDGs, and the cornerstone of the Agenda 2030: *a healthy planet that allows our agri-food systems to provide a healthy diet for all in a sustainable manner.*

This is a conceptual approach that must be properly brought ashore with policies and practices adapted to the situation of each Member Nation. It is in this commissioning where NbS in agriculture can greatly pave the way.

NbS have the potential to contribute towards the achievement of the SDGs by supporting the delivery of ecosystem services that generate a variety of socio-economic and environmental co-benefits (Martín et al., 2020). NbS directly facilitate conservation and restoration of ecosystems thereby contributing to the achievement of SDGs 13 (Climate action), 14 (Life below water) and 15 (Life on land). However, they are designed to ensure not only environmental sustainability but also the social and economic dimension and thus addressing the realization of the SDGs 11 (Sustainable cities and communities) and 12 (Responsible consumption and production). In agri-food systems, NbS implies the promotion and implementation of practices, techniques and technology that preserves natural resources and biodiversity for food and livelihoods security (SDG 2: Zero hunger), provisioning clean water and air (SDG 6: Clean water and sanitation). It also recognises the value of traditional and local practices thereby dignifying the work of smallholder farmers and reducing inequalities along the agri-food system (SDGs 5: Gender Equality and 10: Reduced Inequalities) and poverty (SDG 1: No poverty). Additionally, the importance of NbS in ensuring a steady supply of diversified and balanced diets, which is crucial for achieving SDG 3 (good health and well-being) cannot be overstated. Furthermore, NbS principles apply at the landscape level, implying that enhanced local community partnerships, as outlined in SDG 17 (Partnerships for Goals), are required for successful implementation.

FAO Director-General QU Dongyu, in his speech during the 2019 UN Climate Change Conference COP25 in Spain, highlighted the key role of agriculture in offering Nature-based Solutions to address climate change. Afterwards, the United Nations System Chief Executives Board for Coordination (CEB), during a virtual meeting held during the COVID-19 pandemic, committed to developing a common approach to integrating biodiversity and NbS for sustainable development into the planning and delivery of United Nations policies and programmes. The roles of soil biodiversity and the ecosystem-based approach in NbS in agriculture already have been stressed by FAO, along with actions for water management, sustainable soil management, and food security (Abdelmagied and Mpheshea, 2020; FAO, 2017b; FAO and Global Soil Partnership, 2020; Sonneveld et al., 2018).

The potential contribution of NbS to nationally determined contributions (NDCs) also is a promising field. FAO supports the Koronivia Joint Work on Agriculture (KJWA), through which the Organization has been supporting countries in implementing and enhancing the agricultural components of their nationally determined contributions, including analyses that have identified a substantial number of NbS within both mitigation and adaptation climate commitments.

Last but not least, NbS can support nature-positive production, which is embodied in the third action track of the UN Food Systems Summit (FSS), which will be held later this year. Nature-positive production lays a strong emphasis on addressing synergies and potential trade-offs in scaling agri-food production within the limits of the planetary boundaries (Hodson et al. 2021). Furthermore, it recognizes that biodiversity underlies the delivery of all ecosystem services on which mankind depends (WWF, 2021) and that these functions are crucial to attaining the SDGs, Paris Agreement, and the Convention on Biological Diversity. The incorporation of NbS into the FSS dialogue can aid in the mapping of pathways for utilizing ecosystems' services to minimize GHG emissions while also assisting us in adjusting to the negative repercussions of climate change and limiting biodiversity loss. In this context, the adoption of NbS practices, techniques, and technologies that protect natural resources and biodiversity can aid in the transformation of present agri-food systems into nature-positive production systems.

1.2.2. THE CASE OF EUROPE AND CENTRAL ASIA

The aforementioned food system trends align with the challenges facing the Europe and Central Asia region. The Thirty-second Session of the FAO Regional Conference for Europe stressed the negative implications of the COVID-19 pandemic crisis for the whole food system, affecting smallholders in particular. The crisis has, unavoidably, led to decreases in incomes and increases in unemployment and poverty (FAO, 2020c).

Agriculture in Europe and Central Asia is highly diverse; however, farm structures are mostly based on smallholders and family farms. The region's food systems also vary significantly, from high-income European Union countries to low-income countries in Central Asia. Land fragmentation and non-inclusive value chains are severe challenges for smallholder farmers and other rural entrepreneurs in the Caucasus, Central Asia, Eastern Europe and Western Balkan countries (FAO, 2020d). The demographic trends of rural areas, characterized by an ageing population and intensive outmigration from rural to urban areas and abroad, affects the whole region (FAO, 2020e). ➤

Agriculture and natural resources in the region are seriously exposed to climate change due to weather extremes and warm temperatures. Since the early 1990s, the average temperature has increased 0.5 °C in the south of the region and 1.6 °C in the north (FAO, 2018). Intensification in the frequency of extreme weather events is expected to cause significant losses in crop and animal production, with some areas geographically prone to severe flooding (the Western Balkans) or droughts (Central Asia, the Republic of Moldova and Ukraine). This already has happened with the melting of glaciers in the mountains of Central Asia, which has caused an increase in river flows.

The loss of biodiversity also is a challenge for the agricultural sustainability of the region, which has suffered a drastic reduction during recent decades. Agricultural species in fields and farms have decreased due to the practices of selection of a few genetically uniform staple crops and animal breeds. Agricultural intensification practices and chemical inputs also have led to losses of associate and wild biodiversity, undermining the environmental and economic resilience of farming systems (FAO, 2018).

The jeopardization of natural resources in the region is no different from global trends. Unsustainable farm practices put under pressure the efficient use of land and water resources – particularly in Central Asia, due to water scarcity, salinization and pesticide contamination. Furthermore, land degradation is a growing threat to agricultural productivity and ecosystem services in Europe and Central Asia (FAO, 2018).

PART 2: EXAMPLES AROUND THE WORLD: NATURE-BASED SOLUTIONS IN AGRICULTURE TO FACE SOCIETAL CHALLENGES

The post-COVID-19 era must be a time during which we make peace with nature. This means including natural capital in activities planning and recognizing that many of the challenges we face come precisely because we have removed nature from the equation (UNDP, 2020). Climate change, soil and water conservation and biodiversity loss are societal challenges strictly linked to natural capital that threaten the whole agrifood system.

This chapter sets out several tested and successful examples of NbS in agriculture, organized according to these three main challenges that they help to target. However, as will be seen in each case, time-tested NbS in agriculture implies a systems-thinking approach that tackles many ecosystem services (Seddon *et al.*, 2020). This reflects that human performance and nature are intricately linked, and thus the challenges they address are not easy to differentiate. The planning and design of NbS must be done keeping this in mind.

The case presentation has made use of the extensive repertoire of NbS in agriculture offered by designated Globally Important Agricultural Heritage Systems (GIAHS).

2.1. GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (GIAHS): RESERVOIRS OF NBS

GIAHS are highly evolved agricultural landscapes, rich in biodiversity and modelled by traditional and adaptive knowledge and practices that are promoted and maintained thanks to organized and committed social organizations. These systems are living examples of the careful and methodical observation that farmers, herders, fishers and forest people have carried out to ensure food security without taking nature for granted.

However, these landscapes are under severe threat due to inappropriate policies and legal and incentive frameworks; accelerated processes of urbanization and land grabbing; difficulties in competing with the price and production trends of the global market; the neglect of diversified systems and traditional local knowledge; low community involvement in decision-making; rural migration; etc. ➤

For this reason, in 2002 FAO launched the Globally Important Agricultural Heritage System (GIAHS) initiative to preserve and promote this heritage of humanity. It became an official FAO programme in 2015. Nowadays, 62 sites from 22 countries have received the GIAHS designation, and they build upon the strategies agreed by the multi-stakeholder dialogue of the action plan for their dynamic conservation.

These systems have been developed mainly in adverse climate conditions where it was essential to observe and study the functioning of nature and its components to ensure the survival of the community. In such circumstances, human beings have adapted and learned how to manage natural resources in ingenious ways, maximizing their resilience capacities. Generation through generation, knowledge and techniques have been improved upon and adapted to the changing conditions of each ecosystem, surviving social, economic, health and environmental crises.

Nature-based Solutions in GIAHS are designed with a specific target: to provide livelihoods and food security to communities. The means through which they have reached that goal are the changes that have allowed them to solve other challenges, such as soil and water scarcity and natural disasters, hand in hand with nature.

Therefore, the identification of NbS in GIAHS on a scientific basis is an opportunity to provide ingenious, time-tested agricultural techniques that have led to community food and livelihood security, the conservation of natural resources, and biodiversity. Nevertheless, a great commitment to technology innovation needs to be carried out in order to promote its adaptation to current development trends and to adapt them to already degraded or even destroyed landscapes.

Moreover, the features and criteria that define GIAHS, according to FAO, are aligned with the principles defined by the NbS operational framework mentioned above: they are applied at the landscape scale, in an integrated manner, based on site-specific natural and cultural contexts and maintained thanks to local social organizations committed to the system. The practices and techniques are transmitted by local and traditional knowledge, and their preservation is part of the strategies of an action plan for the dynamic conservation of the site.

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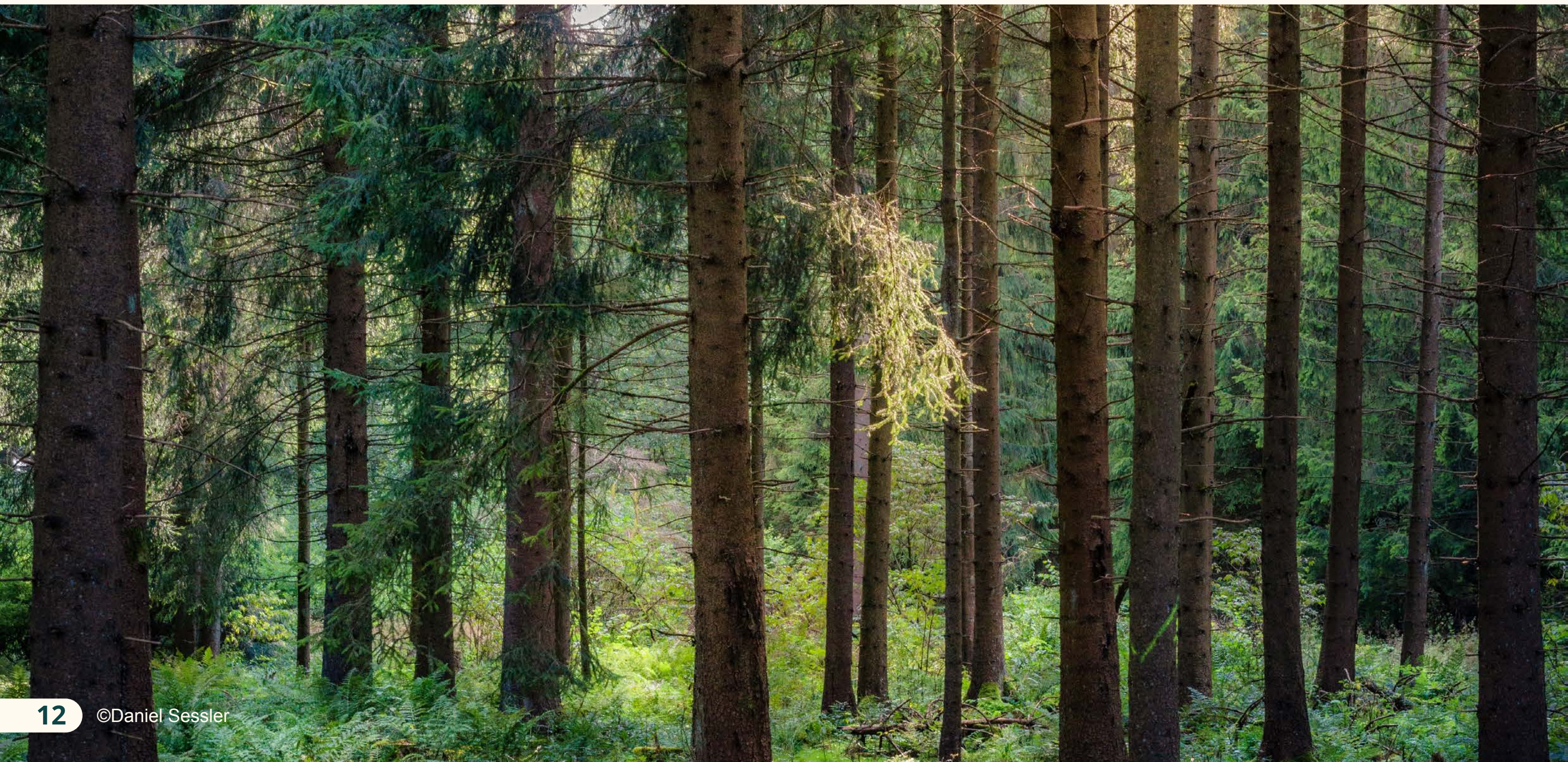
2.2. CLIMATE CHANGE ADAPTATION AND MITIGATION

Agri-food systems activities have carried out an important role in the carbon cycle, which is widely known to affect global climate change. Land dedicated to agriculture activities occupies more than a third of the world's land surface – 4.8 billion ha by 2018 (FAO, 2020a) – and this terrestrial surface stores more than double the carbon that the atmosphere does. For this reason, good agricultural management requires promoting and incorporating techniques that positively affect carbon flow, avoiding carbon emissions and enhancing carbon sinks.

Nature climate solutions (NCS), a subset of NbS aiming to reduce greenhouse gas emissions, act on both fronts equally. Following the NbS actions categorization given above, 40 percent of the NCS for emissions reductions come from protecting existing ecosystems (not land-extensive), while 40 percent come from better management of existing lands and 20 percent come from restoring ecosystems (Girardin, 2020). Therefore, most emissions reductions come from the protection and better management of already existing lands.

Although a lot of effort for the reduction of greenhouse gas emissions has focused on reforestation, soil carbon comprises 9 percent of the mitigation potential of forests, 72 percent for wetlands and 47 percent for agriculture and grasslands. For this reason, NCS are more efficient if they focus on preserving current ecosystems and improving land management techniques in agriculture, grazing, forests, etc. Afforestation and reforestation are attractive measures; however, other techniques such as agroforestry reduce competition for land, do not invade other natural ecosystems – which are soil carbon sinks – and do not compromise food production.

Case examples of Nature-based Solutions for climate change adaptation and mitigation are displayed hereafter, present in already designated Globally Important Agricultural Heritage Systems (GIAHS).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2.2.1. SAWTOOTH OAK FORESTS FOR SHIITAKE PRODUCTION IN THE KUNISAKI PENINSULA USA, JAPAN

The communities of the Kunisaki Peninsula Usa, Japan, have designed a system in which forestry and agricultural production are made possible and are sustained by the connected system of sawtooth oak forests and multiple interlinked irrigation ponds. The Kunisaki Peninsula was created in a near-circular shape around Mount Futago due to volcanic activities millions of years ago. Above the volcanic soil, the agroforestry system of sawtooth oak (*Quercus acutissima* Carr.) and shiitake production takes place.

Local communities in the region have been planting sawtooth oak widely in the *satoyama* (rural areas) because they are an important resource of log wood for shiitake cultivation, charcoal, firewood and water. The log wood of these trees is used as beds to grow the shiitake mushrooms. Sawtooth oaks are cut down every 15 years, the moment at which they are suitable for being used as the base for the inoculation of the mushroom spores. However, the sawtooth oak has the characteristic of shooting from the stump and regrowing. This excellent property of circulating lumber has been used by the local communities to ensure the sustainable management of sawtooth oak and shiitake production.

In this way, the sustainable management of the forest is ensured with 15-year cycles of regeneration, maintaining the common pool resource function of the ecosystem, preserving forest carbon sinks, and reducing the impact of carbon emissions that come from deforestation.

Apart from the ecosystem services provided to balance the carbon cycle, the sawtooth oak forest management facilitates the maintenance of biodiversity and ensures a continuous water supply. The broadleaf sawtooth oak forests strengthen the water retention capacity of the groundwater, already low due to the highly porous volcanic soil. In addition, the forest water charge joins the 1 200 small-scale irrigation ponds built by the communities in its role supplying the paddy and Shichitoui crops. Otherwise, these fields could not be irrigated by the short and steep rivers that spread out radially from the Futago mountain system. This way, the forest also supports the water ponds, alleviating the risks of drought as well as of floods during rainy and typhoon seasons.

2.2.2. LANDSCAPE RESILIENCE IN THE HANI RICE TERRACES SYSTEM, CHINA

The Hani rice terraces in the southeastern part of the Yunnan Province, in China, conform to the agricultural landscape that has been built and maintained for 1 300 years, together with the forest, the villages on the mountainside, and the river. The Hani people and other ethnic groups perform their activities with technologies that manage the ecosystem services of the environment and the orographic conditions ingeniously and sustainably. This way, all elements of the system play key roles in the resilience of the landscape in a region where episodes of harsh droughts recur. Moreover, these interactions allow the existence of a continuous water supply despite the lack of groundwater reservoirs. ➤

Photo courtesy of GIAHS Rice Terraces in Southern Mountainous and Hilly areas, China

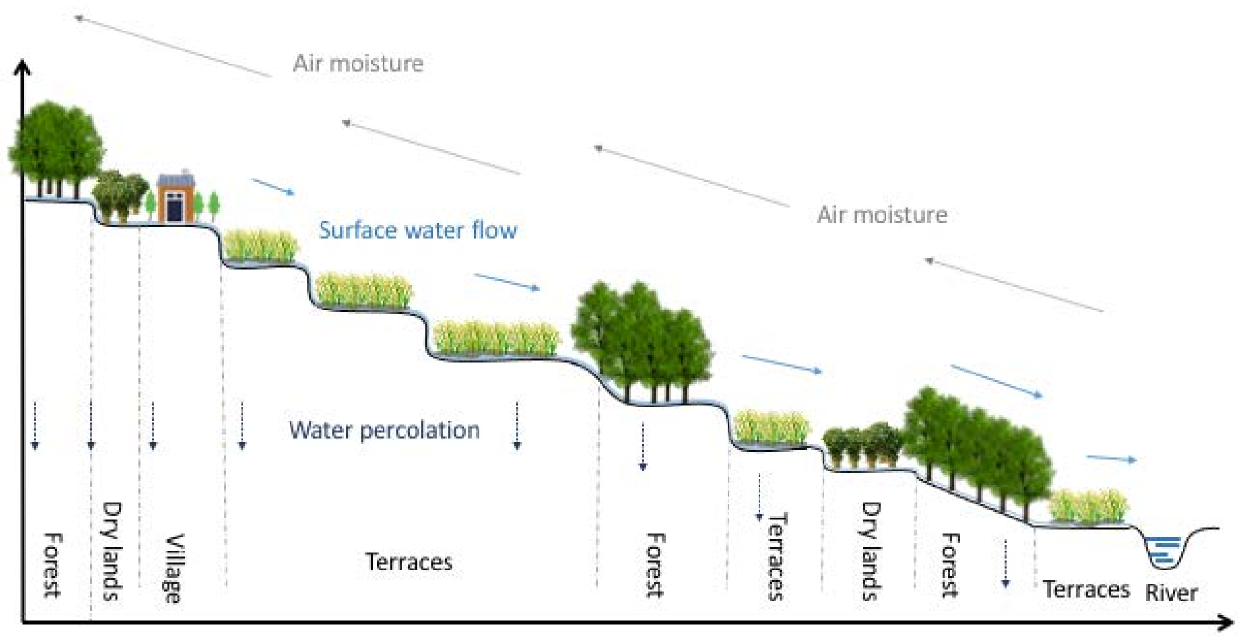
The forest in the upper part acts as a spring, collecting rainwater and fog through its adapted biodiversity. The water drains into the ground and through the surface towards the town and the field crops, taking advantage of the topographic conditions. From the terraces, the water flow reaches the river valley. Water evaporation from the terrace and valley aids in the creation of clouds at the hilltops due to monsoons and topographic conditions.

To take advantage of the water that falls from the forest, the people from the village use water allocation tools (*muke* or *shike*) to direct the swags and creeks into the channels and ditches that act as irrigation networks aimed at supplying the rice terraces.

In addition, water provides fertilizer for the paddy fields, as the flowing water carries nutrients from the forest litter. To improve the fertilization of the rice paddies, the community uses the traditional method of hydropower. This method consists of digging communal or individual manure ponds in which oxen and horse livestock manure is accumulated. This way, water coming downhill washes the ponds and ploughs nutrients into the substrate, engendering long-lasting soil fertility.

The management of the ditches not only plays an important role in terraced field irrigation but also avoids run-off soil erosion and increases the water retention capacity of the terraces by regulating sediment deposition.

The spatial structure of the Hani terrace performs various ecological functions, including soil and water conservation, control of soil erosion, protection of village safety, maintenance of system stability, self-purification capacity and others.



Source: GIAHS Secretariat, 2020

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2.2.3. ANCIENT OLIVE GROVES AS CARBON SINKS: THE CASE OF TAULA DEL SÉNIA, SPAIN

Ancient olive groves represent agricultural systems that act as carbon sinks if integrated with energy efficiency methods in all production stages. The region of Taula del Sénia, in Spain, hosts almost 5 000 specimens of millenary olive trees that have remained in the area since Roman times.

Most of these ancient olive groves (96 percent) proceed from plantations in which wild olive trees already growing in the territory were grafted by the local communities with the variety Farga. Therefore, these specimens are totally adapted to the characteristics of the area, with incredible longevity.

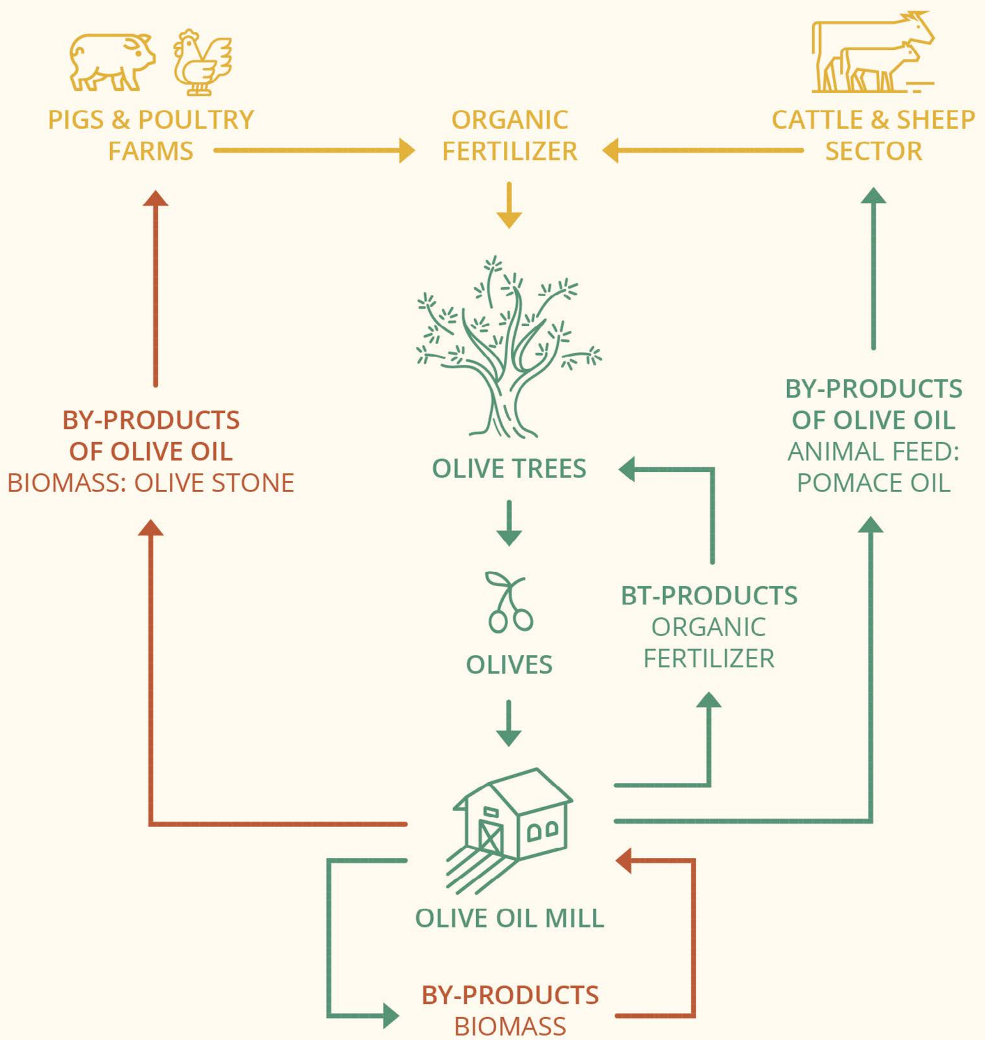

©Mancomunidad Taula del Sénia

The useful life of traditional olive groves is limitless, as evidenced by the specimens of monumental olive trees that already exist in Taula del Sénia. Only when an ancient olive tree dies is it replaced by young trees. This implies a progressive renewal of the property, enabling the sustainable maintenance of carbon soil sinks. Other production models, in which olive trees have short useful lives, imply the frequent total replacement of olive trees. This imposes economic and environmental implications, increasing carbon emissions and reducing carbon sequestration and carbon sinks. Indeed, productivity rises considerably in irrigated and young crops, but other ecological costs (erosion, salinization, pollution, overexploitation of aquifers) imply long-term costs derived from these productive models, making them unsustainable for the future. ➤

Apart from the implications in terms of climate change, the maintenance of these ancient groves supports water storage and energy conservation as well. Ninety-nine percent of the olive groves in Taula del Sénia – 33 520 ha – are traditionally rain-fed crops, while there are 275 ha of irrigated crops, less than the 1 percent of the total area. Varieties such as Farga, Morruda and Sevillenca can be found only in this region, and they are adapted to local climate conditions that entail long summer periods and scarce annual rainfall. Due to their size and strength, these trees are more resistant to drought and can survive without irrigation.

The traditional systems of rain-fed groves in this area are plantations with low densities in which pruning takes into account the size of the trees and the weather in the area to improve resilience to harsh and changing climatic conditions. Other practices also support them in this regard, such as the construction of dry-stone margins and furrows (called *valonas*) to protect the trunks of these trees against the wind and make more effective use of rainfall. Moreover, the diversity of olive trees within the properties is promoted, so flower pollination and olives are improved.

Furthermore, ancient olive trees in Taula del Sénia are part of a wider circulatory system in which efficiency in biomass and energy is assured. The groves are integrated with pig and poultry farms, as well as with the cattle and sheep sector, which supply organic fertilizers to olive groves. The olives are transported to oil mills to produce olive oil, which creates subproducts that are reused, in the majority of cases, avoiding economic and environmental impact.



2.3. SOIL AND WATER CONSERVATION

Although natural resources are the foundation of vital agroecosystems worldwide, soil and water are the resources par excellence whose limitation puts the entire system at risk if it is not well-managed and solved.

Agriculture industrialization focused primarily on high-yield production has jeopardized soil and water resources. The negative consequences include soil and water pollution, soil acidification, salinization and nutrient depletion. The destruction of hedges to create open fields and the use of ploughing machines have transformed surfaces, modified the hydrology of watersheds and accelerated erosion while limiting groundwater recharge.

Currently, more than 30 percent of agricultural land globally is already degraded, and around 70 percent of water withdrawals from surface- and groundwater sources are aimed at agricultural activities.

The role that NbS can play in strengthening agriculture productivity from a lens of water resources management has already been evaluated through case study analysis by FAO (2018). Conclusions point out that NbS in water management interventions involves a bipartite goal focused on how to better serve the well-being of humanity while minimizing impacts on the functioning of ecosystems.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2.3.1. THE GUETTAYAS: RAMLI AGRICULTURAL SYSTEM IN THE LAGOONS OF GHAR EL MELH, TUNISIA

In the north of Tunisia, in the area of Ghar El Melh, the local community has adopted an ingenious agricultural system, brought by migrants from Andalusia, to deal with the scarcity of arable land and fresh water (surface- and groundwater) in the region enclosed between the mountain of Jbel Ennadhour, the Mediterranean Sea and the lagoon of Ghar El Melh and the Sebkha of Sidi Ali el Mekki. ➤

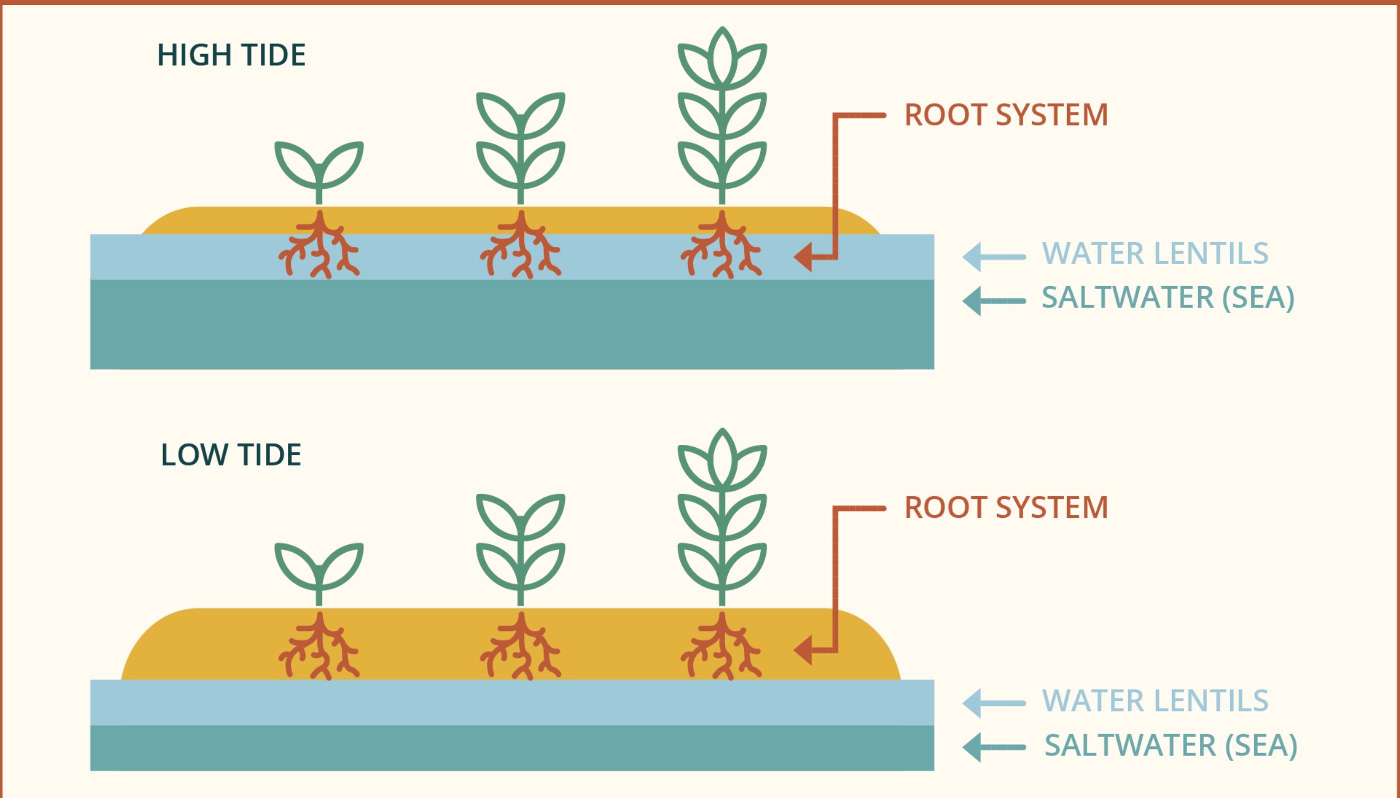
Intending to gain arable land, the local farmers of Ghar El Melh designed islands of rain-fed crops within the lagoon. These islands, commonly called *guettayas*, are the result of methodical traditional engineering built upon the observation of the movement of tides and other natural factors. In this manner, the *guettayas* can maintain diverse and organic agricultural products by utilizing the rainwater stored and floating over the seawater.

The *guettayas* are part of a system of agricultural practices and techniques called the *ramli* (etymologically "on sand"), which consists of growing crops on sandy substrates.

Effectively, these islands are made up of a layer of soil about 30 cm high, brought from the foothills of mountains and backfilled with sand from the banks of the lagoon. This substrate is mixed with manure inputs. Thus, the sandy texture evolves into a soil favourable for arboriculture and for the cultivation of beans and vegetables, including potatoes.

The principles of this cultivation practice are the development of arboriculture and vegetable crops on a soil whose level allows the plants to meet their water needs by contact. In the guettayas, the rainwater stored in the bottom creates a thin lens of fresh water floating on salt water. This lens, or blade, rises and falls about 10 cm twice a day, at high tide and low tide. It is reconstituted each year thanks to rainfall, allowing the same two cycles of culture per year. The particularity lies in maintaining the soil at the right level between the lens of water and the crops' root system. Thanks to traditional knowledge transmitted from generation to generation, the local farmers are experts on maintaining the soil at the exact height needed to ensure that the roots receive enough fresh water but do not come into contact with salt water. This soil regulation work is done by regular contributions of sand and animal manure. For the purpose of reducing the effects of drying winds and of sea spray, screens of reeds are positioned to protect the crops and guarantee the microclimate necessary for the growing of the plants.

The knowledge and experience of the farmers allow them to maintain the lagoon plots through the precise application of sand and organic matter, allowing the roots to be irrigated by a fine freshwater lens and not to be affected by salt water.



2.3.2. PASTORALISM AS AN ACTIVE FORCE OF LANDSCAPE MAINTENANCE: THE CASE OF THE MAASAI COMMUNITIES IN KENYA AND THE UNITED REPUBLIC OF TANZANIA

The Maasai people of East Africa carry out traditional practices of sustainable pastoralism. The pastures they manage occupy a large area that implies a transboundary pastoralism system between Kenya and the United Republic of Tanzania. It involves the regions of Oldonyonokie/Olkeri in Kenya and Engaresero in the United Republic of Tanzania. This is a territory of extreme conditions, where water and grassland are scarce. However, the Maasai people have adapted to these extreme conditions to secure their food and livelihoods.

With the aim of managing the land and other natural resources in a sustainable manner, they have developed various strategies. These strategies are based on a deep knowledge of the ecosystem, integrated into an intricate social organization. The movement of livestock herds is performed based on, among other pastoral strategies: i) rotational movement patterns to avoid overgrazing and predators; ii) saving forage through delayed entry during dry seasons; iii) ensuring livestock and human health though intra- and inter-annual movements that avoid disease-prevalent areas; and iv) livestock movements that ensure access to needed minerals (salt licks), forage and shade. Furthermore, social organization land tenure systems imply the avoidance of areas recently vacated by others, the maintenance of appropriate distances from other groups, and the avoidance of areas that are in use.

©Paola Blaskovic

The social structure is highly organized in such a way that all members are involved in tasks related to the movement of livestock, the research of grazing land, the management of water, and others. The most strategic tasks are carried out by the elders and the so-called warriors. The former guide the latter in the search for water and forage plans, and they plan the grazing routes. Warriors lead the pastoralist movements, supervise the livestock techniques and monitor the herds' behaviour. This social structure has enabled a sustainable and cost-effective productivity system.

In addition, herds (sheep, goats, camels and cattle such as buffalo) are differentiated by groups, depending on age, compatibility and the economic function of the household. This diversification favours the enhancement of degraded lands and reduces bush encroachment.

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2.3.3. QANAT IRRIGATED AGRICULTURAL HERITAGE SYSTEMS, ISLAMIC REPUBLIC OF IRAN

Qanat Irrigate Agricultural Heritage System In Kashan

©GIAHS

Qanats are underground tunnels following aquifers in surrounding mountain areas where water is collected from different layers of earth by relying only on gravity. They first appeared in the mountains of Kurdistan in western Iran, eastern Turkey and northern Iraq more than 2 500 years ago. To the west, qanats were constructed from Mesopotamia to the shores of the Mediterranean as well as southward into parts of Egypt and Arabia. ➤

Qanat-based Saffron Farming System in Gonabad

©GIAHS

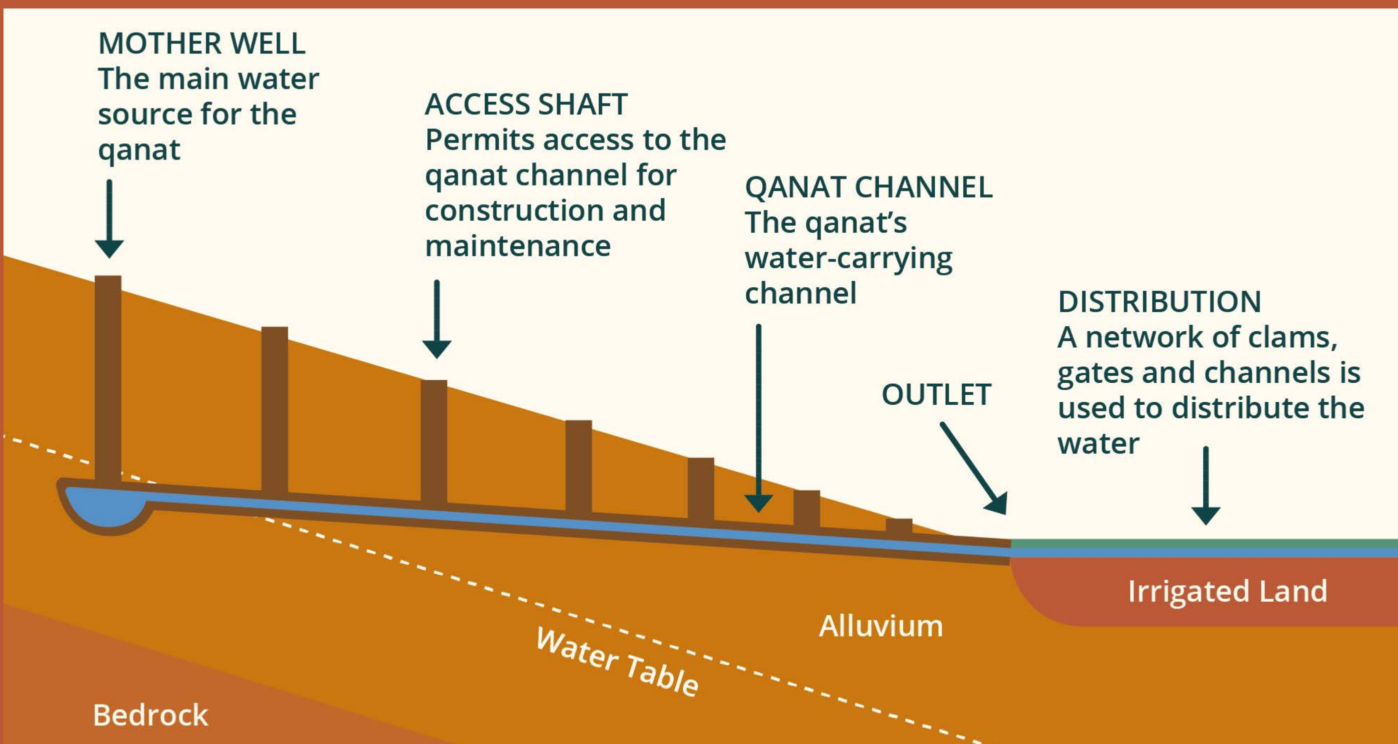
Qanats have sustained food security and livelihoods over millennia by providing a reliable source of water to traditional family farms in most dry areas where agriculture would be impossible otherwise. In the absence of adequate rainfall and reliable permanent rivers and surface waters, these structures were the only means of water supply for several centuries, acting as a source of food security and livelihoods for the local communities.

The basic structure of a qanat consists of a horizontal tunnel (called *kooreh*) running through an incline with many chains of vertical wells (millehs). However, they differ greatly depending on the conditions surrounding the system. For example, if annual rainfall is scarce, the lengths of the qanats and the depth of the mother well increase. On the other hand, if average annual rainfall is heavy, the lengths of the qanats are shorter and the depth of the mother well is less. For this reason, depths and lengths in mountain regions are less than in the plains.

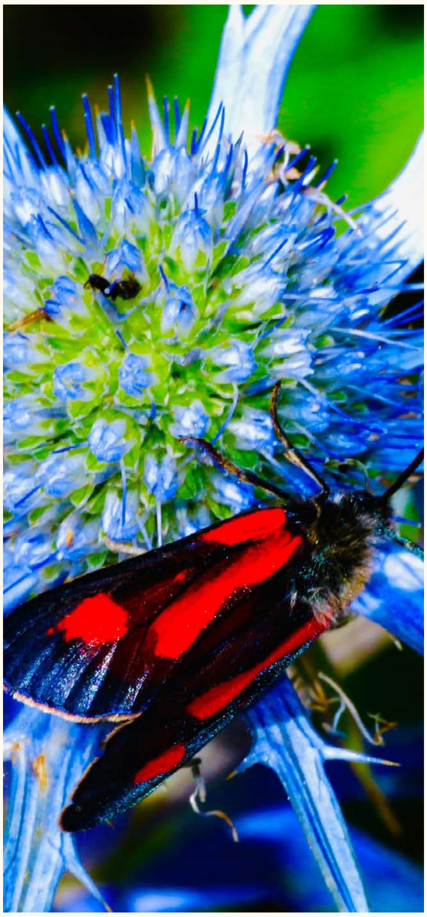
In the Islamic Republic of Iran, until 40 years ago, most of the water supplying the human settlements around the central desert of Iran came from the qanats. Moreover, they have contributed to the forming of civilizations, such as the Persian agricultural civilization, in these harsh climatic conditions.

About 14 percent of Iranian agricultural production still relies on the water supplied from qanats, and about 800 000 ha of farmlands are irrigated from the qanat irrigation system. The most important agricultural systems of Iran, such as pomegranate, pistachio and saffron farming systems, depend on this irrigation system. Rich biodiversity and genetic resources have been widely maintained and cultivated thanks to qanat technology, such as cereals, pulses, vegetables, fruits, vines, olive trees, fruit trees, forage crops and sale crops, such as cotton, tobacco and others. Therefore, qanat technology mastered by local communities has made possible the development of a diversified landscape in a region of soil and water scarcity.

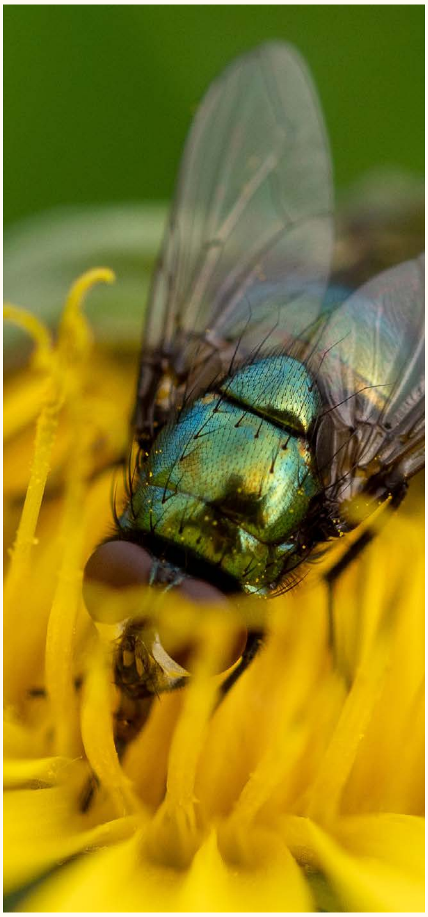
These systems also provide other essential ecosystem services, such as water purification, due to the gradual sedimentation of suspended matter as a result of the long distances that water must flow through the qanats. Qanats play an important role in soil conservation, balancing the salinity of water and protecting agricultural lands downstream. Qanats also act as groundwater drainage systems, preventing increases in groundwater levels during flash floods, a phenomenon specific to arid zones.



2.4. BIODIVERSITY PRESERVATION



©James Wainscoat



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Agricultural expansion is a major driver of biodiversity loss, having favoured a few selected and domesticated species to the detriment of those without directly useful purposes for humans. However, wild species and associated biodiversity such as pollinators, soil organisms and pests' natural enemies provide the essential ecosystem services to maintain the proper functioning of agroecosystems. Their disappearance implies vulnerable agricultural systems, with a consequent loss of resilience and with low long-term productivity.

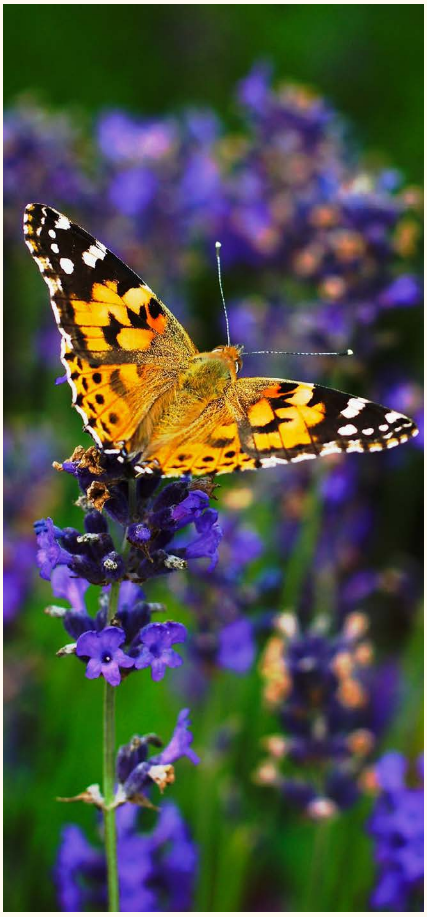
The FAO Commission on Genetic Resources for Food and Agriculture highlights that biodiversity for food and agriculture is requisite to food security, the resilience of production systems, the sustainable intensification of food production and the supply of multiple ecosystem services. Therefore, calls are made to step up sustainable practices in which genetic resources, species and ecosystems are managed in an integrated way in the context of production systems and their surroundings.

The State of the World's Biodiversity for Food and Agriculture (2019) reports a worldwide decline in biodiversity for food and agriculture and the ecosystem services it provides, often – at least in part – because of the impact of management practices and land-use changes associated with food and agriculture.➤

Among the 382 000 species of vascular plants that exist, 6 000 have been cultivated for food, but only nine (maize, rice, wheat, potatoes, soybeans, oil palm fruit, sugar beet and cassava) account for more than 66 percent of all crop production by weight. The proportion of livestock breeds at risk of extinction is increasing. From the 7 745 local breeds of livestock still in existence, just 7 percent are not at risk. In the field of aquaculture, nearly a third of fish stocks and a third of freshwater fish species are considered threatened.

It also reports that, in the case of associated biodiversity, many species contribute to vital ecosystem services: pollinators, natural enemies of pests, soil organisms and wild food species. However, they are in decline as a consequence of the destruction and degradation of habitats, due to such factors as over-exploitation, pollution, diseases, invasive species and agriculture intensification. Bee colony losses are on the rise, as well as wild pollinator populations, with 16.5 percent of vertebrate pollinator species threatened with global extinction (rising to 30 percent for island species). Many countries report declines in the population of birds, bats and insects that contribute to pest and disease regulation. Soil biodiversity is under threat in all regions of the world. Indicators point to declines in soil health, and ecosystem services provided by soils are at severe risk.

Sustainable management requires *in situ* or on-farm strategies integrated into the ecosystem or landscape level (FAO, 2019c). This is integrated into the framework of Nature-based Solutions, so it predisposes the application of these solutions in agrifood systems in such a way that they maintain biological and cultural diversity and the ability of ecosystems to evolve over time. All this is based on a robust understanding of their biodiversity and their ecological resilience.



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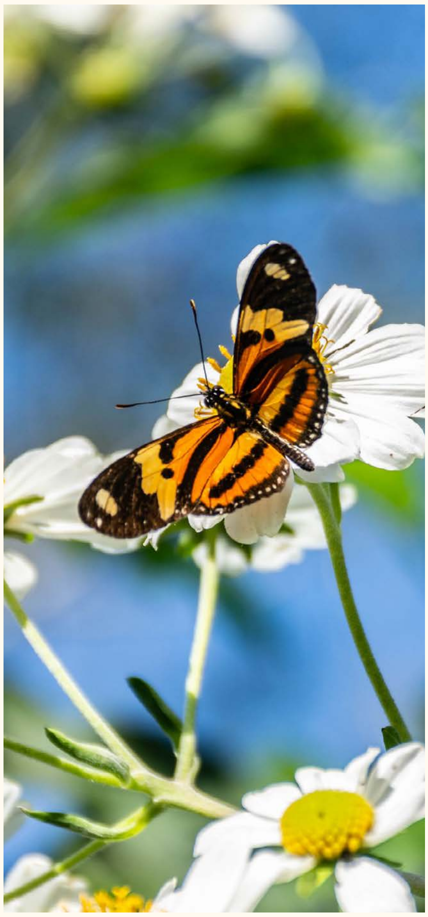

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2.4.1. SHIMBWE JUU KIHAMBA AGROFORESTRY

Humans have continuously inhabited the slopes of Mount Kilimanjaro in the United Republic of Tanzania for the past 2 000 years. Most of the population inhabiting this place are concentrated at an altitude between 1 000 m and 1 800 m, where they practice agroforestry stretching on the climatically most favourable zones of the slopes. The unit system of family labour management is called the Kihamba (or Chagga home garden), of multi-ethnic origin. It is believed that the first Kihamba existed already in the twelfth century, together with the traditional water canals involved in it, being central to the identity and culture of the Chagga tribe.

The Kihamba is a typical agri-silvicultural system characterized by a multi-layered vegetation structure composed of four main vegetation layers – similar to a tropical montane forest – with trees, shrubs, lianas, epiphytes and herbs.

©FAO/Felipe Rodríguez

The uppermost layer is formed by a higher canopy of indigenous or planted multipurpose (medicine, fodder, fruits, firewood and timber) trees, sparsely spaced, which provide shade to the lower crop layer. This layer is characterized by *Albizia schimperiana* var. *amaniensis*, on which epiphytes such as the fern *Drynaria volkensii* and *Telphairia pedate*, a liana with oil-containing seeds, find habitats.

Major agricultural cash crops such as coffee (*Coffea arabica*) and banana (*Musa* sp.) grow below in an intimately intermixed complex arrangement with the upper layer to meet their shade requirements. There also is a middle canopy of fruit and multipurpose trees/shrubs and a lower ground cover of food crops, medicinal plants and annual fodder plants.

The vertical stratification of the home garden provides a gradient in light and relative humidity, which creates different niches for enabling various species groups to exploit them. Shade-tolerant crops constitute the lower stratum, while shade-intolerant trees occupy the top layer, and species with varying degrees of shade tolerance are located in the intermediate strata. ➤

The Chagga home gardens have high biodiversity in an average surface area of around 0.5 acres, with more than 500 used plants – such as coconut, banana, cassava, yams, taros, ginger, turmeric, pineapple, cashew, jackfruit and mango – and 400 that are not cultivated but still preserved in the system.

Most plant species in the home garden are forest species, followed by ruderal species and cultivated species. Indigenous species can contribute up to 70 percent of the species found in the home gardens, and the Kihamba forest species contribute about 17 percent of the forest plants of Kilimanjaro, demonstrating a high conservation value. Forest-related tree species common in the home garden include remnants of the former forest cover, such as *Albizia schimperiana, Rauvolfia caffra, Cordia Africana, Commiphora eminii* and *Margaritaria discoidea*. There are also introduced timber trees such as *Grevellia robusta* and *Cupressus lusitanica* and fruit tree species such as *Persea Americana, Mangifera indica* and *Syzygium cumini.* ➤

©FAO/Felipe Rodríguez

©FAO/Felipe Rodriguez

Besides food supply, different crops and livestock such as sheep, goats, cattle and others from the home garden contribute to improving household nutrition.

In addition to the rich biodiversity this agroforestry system has been able to maintain, many other ecosystem services are derived from it. This is the case of the traditional irrigation system that, complimented with storage ponds (*nduwas*), helps the Kihambas overcome water shortages during the dry season. The home garden irrigation system consists of traditional canals of earthen furrows and ponds, dug by subclans and administered by subclan leadership. These canals trap water from perennial streams and rivers originating from the montane forest. They also trap water run-off.

Selective wood harvesting avoids the complete removal of tree cover, reducing carbon leakage and improving carbon permanence.

2.4.2. BIODIVERSITY CONSERVATION THROUGH TRANSHUMANCE AND OTHER TRADITIONAL TECHNIQUES IN SERRA DO ESPINHAÇO

The sempre-vivas flower gatherers of the Serra do Espinhaço in the central part of Brazil have managed to maintain an agro-silvo-pastoral system in which just one community preserves around 480 species for food and agriculture. Thanks to transhumance, cultural knowledge and traditions, these local communities transport species from one place to another and preserve them as a family legacy favouring adapted local genetic resources. Their profound knowledge of the environment allows them to collect flowers and other wild species in the correct way, favouring regeneration in the next year while spreading seeds in other optimum places during their seasonal transhumance movements among higher pastures and lower valleys.

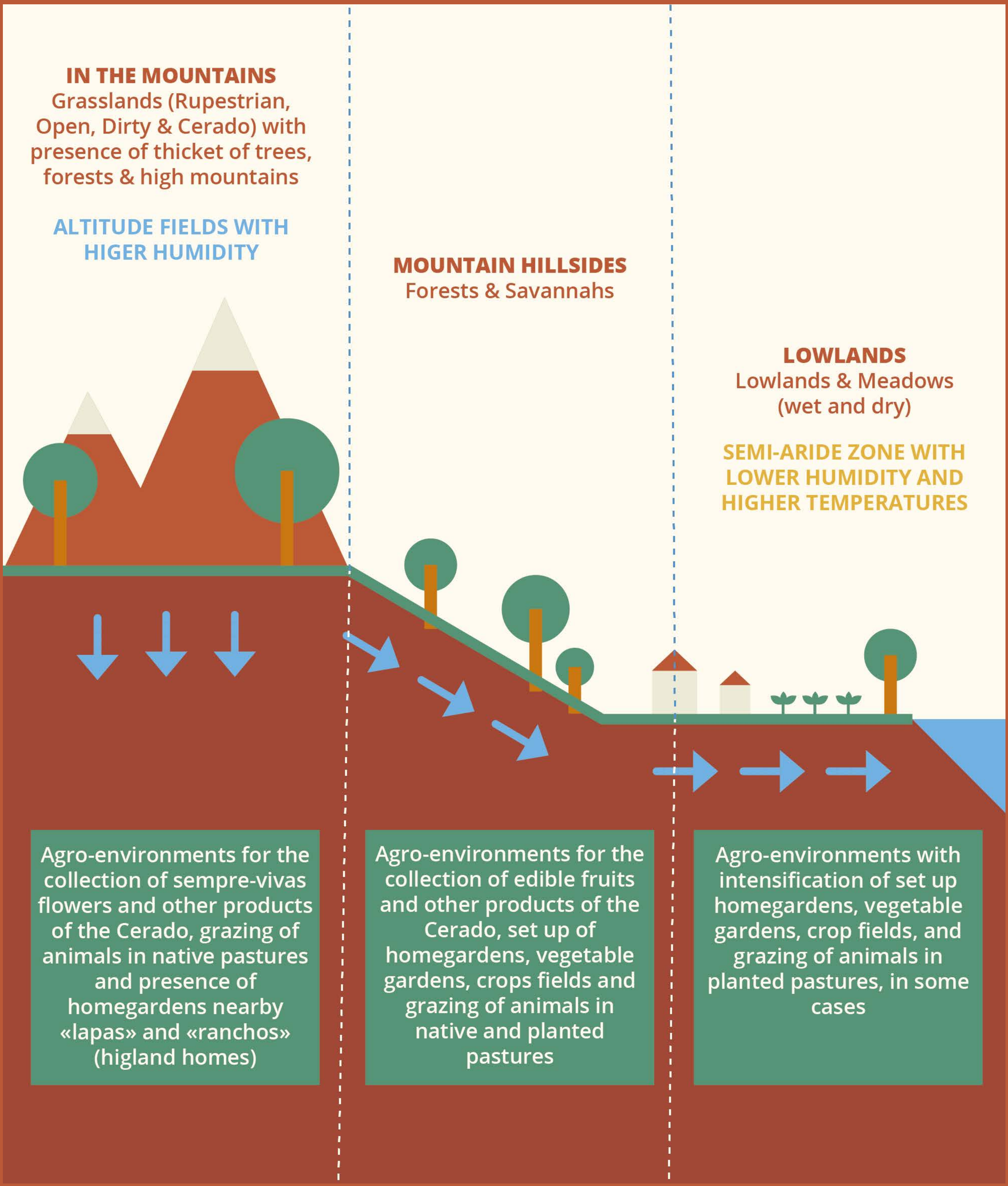
The flowers and buds are managed in their habitat using conservation practices, including: i) respect for the ripening point for collection, in which part of the seeds has already been expelled by the plant, ensuring new individuals; ii) during collection, the leaving of 30 percent of the individual flowers and buds, with this residue being responsible for the conservancy of the population of the species; and iii) the returning to the native fields of the seeds that fall into the flower storage areas, a practice known as "enrichment." These practices aim to maintain and expand the populations of species managed and marketed by families. In all cases, the collection of forest products – timber and non-timber – occurs according to the lunar calendar and vegetative cycle, in order to conserve community forest resources.


©FAO/Valda Nogueira

The system combines various altitudes with different moisture content in a semi-arid climate zone on predominantly acidic, sandy and dystrophic soils. Therefore, the use of high biodiversity adapted to the different edaphoclimatic characteristics is essential and depends on the traditional associated knowledge of its properties and use and on the sustainable management of natural resources, generating different agro-environments. In this sense, transhumance works as a mechanism for overcoming agro-environmental limits and exploiting a great deal of the region's various potentials. ➤

Thus, families use the lowlands (at 600 m of altitude) for cultivation and animal breeding during the rainy season and the highlands (at 1 400 m of altitude) to feed the cattle during the dry season. This way, they keep them moist and guarantee the animals grazing in native fields. In this manner, the system deals with landscape verticalities and horizontalities that confer elasticity and flexibility to local agrifood strategies through cultivation, the collection of native plants and the breeding of animals. This management of resources also is important for biomass cycling, which guarantees the flow of matter and energy for agrifood production by raising the pH and natural fertility levels of the soils and ensures the conservation of natural resources through the soil-plant-water relationship.

The practices used in the region have the potential to boost natural processes and cycles – such as energy, nutrients, organic matter and biotic interactions – and improve the conservation of soil, water, biodiversity and other renewable natural resources. The practices also serve to increase independence from non-renewable natural resources, including fossil fuels, and from such non-natural inputs as pesticides, genetically modified crops and anabolic steroids. ➤



In this system there is a direct relationship between agricultural biodiversity and food culture, with women playing a leading role in conservation and in the intergenerational transmission of knowledge. The community manages genetic resources and water through adaptive techniques, leading to high food security, socio-ecological resilience, the generation of income, unique managed landscapes and the social reproduction of cultural diversity. The agro-environmental (or agroecosystem) products and services that are generated serve not only the local communities but also the global society in terms of the conservation of biodiversity and water resources and the regulation of the climate, not to mention important knowledge about sustainability, conservation and Nature-based Solutions.

PART 3: TOWARDS THE SCALING UP OF NATURE-BASED SOLUTIONS IN AGRICULTURE IN EUROPE AND CENTRAL ASIA

3.1. EUROPE AND CENTRAL ASIA: A TREASURE TROVE OF NATURE-BASED SOLUTIONS IN AGRICULTURE

Europe and Central Asia is among the biggest and most diverse of the FAO regions, with 53 Member Nations and one Member Organization, and a surface area that encompasses more than 25 million sq km, extending from Lisbon to Vladivostok and from the Arctic Circle to the Pamir Mountains of Central Asia.

Considering this, it is not difficult to imagine the huge diversity of landscapes and food systems that it hosts – from the wild walnuts and fruit tree forests of Kyrgyzstan; through the pastoralism practices in the extensive grasslands of Kazakhstan, Uzbekistan and the mountains of Tajikistan; to the inland fishery at the coastline of the Caspian Sea; and to the Mediterranean crops adapted to long seasonal droughts, to mention just a few.

This region has been recognized as among the pioneers in the development of agriculture, which began to spread 11 000 years ago when it arrived from the Caucasus and other areas. Despite the extreme conditions in some parts of the region, the population has spread everywhere, creating a range of agricultural systems. The steppes, mountain ranges, forests, rivers, lakes and saltwater areas have witnessed the ingenuity of the people who inhabit this region.

Nowadays, the countries in the region face many challenges, including environmental and landscape degradation, biodiversity loss, unpredictable weather events and pandemics. However, history reflects that food security and livelihoods have been threatened repeatedly by such external factors as natural disasters, drastic climate changes, social conflicts, transitions and political reforms. Through it all, context-specific traditional knowledge has continued to be transmitted from generation to generation, carrying with it the keys to successful recovery from these negative impacts.

As has been mentioned, smallholders and family farms serve a vulnerable role in the region. Although they represent the vast majority, they fight high interest rates, price volatility, inaccessible value chains and weak support from rural institutions and extension services. However, it is recognized that smallholders and family farms, through knowledge-intensive systems, play a key role in rendering agriculture more environmentally friendly and resilient to shocks (FAO, 2019b). They usually make the most of their scarce land resources by developing diversified systems, often integrating trees, livestock or even aquaculture (HLPE, 2013). ➤

On the other hand, the race to transform their plots into highly productive systems can cause the opposite effect by placing them in situations of unbalanced competition with large-scale farms. This transformation implies the neglect of their local and traditional knowledge, based on nature performance, and requires important investments in synthetic fertilizers and similar inputs that can lead to serious imbalance, both socio-economic (indebtedness, for example) and environmental (such as groundwater pollution) (HLPE, 2013).

Many challenges affect food security and livelihoods in the countries of the region. However, the strengths of the region's agricultural systems are much greater than their weaknesses. The loss of local, specific and traditional knowledge would imply the loss of mechanisms for adapting to the extreme circumstances that these regions have already experienced.

NbS in agriculture speaks loudly about these strengths, encouraging us to change our points of view and to recognize and improve these practices and techniques with scientific evidence and modern technology.

3.2. SCALING UP NBS IN AGRICULTURE

NbS have been put forward as efficient and cost-effective actions to tackle societal challenges, in comparison to other approaches to development. For this reason, the positive financial returns of NbS has the main role to play in the upscaling of these solutions. This implies the measurement of NbS financial returns, including ecosystem services and natural capital monetary assessment. EU Biodiversity Strategy calls for natural capital investment as one of the main fiscal recovery policies (EC, 2020), and for NbS deployment. Investing in NbS in agriculture implies investing in natural capital, and positive financial returns for society along with their environmental benefits (Iseman and Miralles-Willhelm, 2021).

However, it is difficult to set a price for NbS multiple ecosystem services. The very identity of these actions implies that there is a highly specific and ecosystem-dependent integration. A systems-thinking approach can bring light to the identification of the value generated beyond the NbS (Seddon *et al.*, 2019). Furthermore, this quantification should be based on long-term resilience and sustainability in addition to short-term benefits.

In this manner, policymakers can use verified information to make decisions regarding policies that benefit society (Sonneveld *et al.*, 2018). The private sector also has a key role to play in financing and delivering NbS (e.g. NbS financial returns investment), and policy can help by shifting or minimizing perceived risks (Hepburn, 2020).

NbS have been identified in their potential to contribute to nationally determined contributions (NDCs) within both mitigation and adaptation climate commitments (Abdelmagied and Mpheshea, 2020). Specifically, nature climate solutions (see Section 2.1) aim to target the reduction of greenhouse gas emissions. In agriculture, the improvement of existing land use systems is considered highly relevant to contributions to national NDCs via NbS, based on national priorities, circumstances, capabilities and needs.

Examples of NbS in agriculture contributing to NDC commitments already exist in the ECA region, including sustainable forest management in Kazakhstan and pasture improvements through the restoration of degraded and overgrazed land in Tajikistan (Kehayova *et al.*, 2020).

For this reason, this report stresses the importance of the identification (mainly through scientific evidence) of NbS that have significant potential to deliver on NDCs in the region.

FAO studies have revealed that the success of NbS in agriculture interventions is linked to participatory and bottom-up processes. This implies the involvement of all stakeholders from the beginning of the intervention. Especially important is community involvement, enhancing the sense of ownership and responsibility towards long-term and sustainable interventions. A lack of knowledge about the functioning of ecosystems and ecosystem services is among the main causes attributed to failed NbS interventions. Multi-stakeholder dialogue and community involvement increase access to local knowledge through co-creation and sharing. This flow of information favours the exchange of intraspecific knowledge and the arrival of new skills and knowledge that favour agricultural innovation. This has been done for decades in the Farmer Field Schools programme, which is a useful strategy for NbS interventions.

To improve NbS social interventions and further strengthen the scaling up of NbS, Sonneveld *et al.* (2018) propose a five-step roadmap: i) identification of problematic actors involved and their interests; ii) NbS value proposition and alignment to social engagement and needs; iii) identification of NbS interventions and related business models; iv) implementation of NbS, following a management plan; and v) participatory monitoring and evaluation of NbS activities, penalizing abusive interventions.

Therefore, through this review report, several main actions are proposed to scale up NbS in Europe and Central Asia:

I. Capitalization of innovation and good practices in NbS in agriculture

• **Identify and collect already existing Nature-based Solutions** lying within small and medium enterprises and local and traditional agricultural systems (involving livestock, grazing and breeding, cropping, fishery, agroforestry, etc.) and collect data on the technology used and the socio-economic aspects of the NbS in agriculture, including ecosystem services and the value of natural capital.

• **Build a comprehensive framework based on scientific evidence to systematize NbS in agriculture**, allowing for improvements to the efficiency of applying NbS in agriculture to improve agroecosystem management to already degraded landscapes and ecosystems, with the help of digitalization and technology.

• **Conduct economic analysis of identified and applied NbS,** assessing the cost effectiveness of these actions.

II. Co-share knowledge and build capacity through extension services, farmer schools and local universities to valorise know-how and train newcomers interested in these alternative agricultural practices

III. Recognize the social value of NbS through acknowledgements at national and international levels, such as through Globally Important Agricultural Heritage Systems (GIAHS)

IV. Design and implement an advocacy based-results strategy to reach out to decision makers

CONCLUSIONS

The NbS concept has gained strength at a time during which many voices are warning of the profound environmental, social, economic and health problems caused by the development of human societies beyond the limits of nature.

The broad scope of this term has meant that in just a few years since its conceptualization, we have a wide repertoire of NbS case studies, scientific articles and implementation measures for protection, restoration and improvement in the management of ecosystems for the well-being of the human population. The analysis of this work has favoured the creation of operational and assessment frameworks for efficiency improvement in the application of these solutions to societal challenges.

These solutions are an opportunity to translate into practices and policy the five conceptual principles defined by FAO to support Member Nations on the path to sustainable agriculture. In addition, the enormous work that has been carried out within the framework of the NbS paves the way for agrifood systems to efficiently drive the delivery of NbS.

However, the design and application of NbS in general requires a strong understanding of the bioclimatic conditions and ecological resilience of the environment. In addition, NbS in agriculture implies a profound understanding of the techniques and arrangements for using natural resources in such a way that agricultural products and services are generated year-round in a sustainable and sufficient manner. This knowledge is embedded in the culture and know-how of local communities, handed down from generation to generation and usually adapted to the changes that have taken place over time. In this way, knowledge has become more sophisticated, creating a complex network that is difficult to replace.

This document has provided various examples of ingenious and time-tested NbS that local communities and indigenous people have applied for centuries and even thousands of years to overcome external difficulties and provide food and livelihood security. These examples have been collected from systems recognized by FAO as agricultural heritages (GIAHS) for meeting high criteria of agrobiodiversity, local and traditional knowledge systems, social and cultural organization and sustainable landscape management.

In addition, several main actions have been proposed to scale up NbS in Europe and Central Asia. For this purpose, Nature-based Solutions proves to be an approach that can support the transformation towards more sustainable and resilient agri-food systems, generating a climate-smart agriculture, that preserves biodiversity and manages natural resources sustainably. This approach also opens the door to attract natural capital investment in agriculture.

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