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Editorial

Roberto Capone*, Yasmine Seghirate*, Giulio Malorgio**, Teodoro Miano*

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Multiple global crises have highlighted the fragility and the volatility of global food systems, particularly evident during shocking and extreme weather events, combined with the remnants of the COVID-19 pandemic and the current exacerbation of the conflicts around the Mediterranean area.

Food production, smallholder farmers, fishing communities and other businesses/producers at local and national level are increasingly vulnerable and are the first to suffer the negative effects of climate change (water stress, salinization, desertification…), environmental pollutions, unsustainable practises and rising costs of inputs (energy, fertilizers and improved seeds…); at the same time, global food systems contribute up to a third of greenhouse gas emissions, induce up to 80% of biodiversity loss and utilize up to 70% of the available freshwater resources. Nowadays the majority of the vertebrate animal population on our planet represent farmed animals. These farms contribute to GHG emissions, use several hundred liters of drinking water to produce one kilogram of meat and can contribute to deforestation.

The global commitment of the international community for a shift towards more sustainable food systems has increased significantly over recent years, with numerous UN and Ministerial Declarations, international reports and scientific articles supporting this transformational change. Nowadays, it's clear that more sustainable food systems will be vital for all populations of the world. Moreover, the Mediterranean region is facing unprecedented and interdependent environmental, economic, and social challenges that affect food security, health, nutrition, and sustainability, and thus the livelihoods of all Mediterranean people.

Mediterranean countries exhibit significant diversity in demographic, cultural, and governance aspects. The region also experiences pronounced disparities in economic growth and development, both between nations and within individual countries, particularly between rural and urban areas.

Population growth, unequal demographic changes, urbanization phenomena, and globalization trends are all driving increased food demand and affecting food choices, resulting in profound changes in the food production/transformation processes, as well as in the food consumption patterns and lifestyles. In the region, the birthplace of the Mediterranean diet, diet-related illnesses are rising to alarming levels, particularly among young people. Obesity, diabetes, and hypertension are spreading rapidly, imposing a growing burden on public health systems. Simultaneously, in certain areas, the specter of hunger and famine is re-emerging due to devastating conflicts. Finally, the agriculture and fishing sectors are increasingly struggling to attract new talent and inspire vocations. The lack of appeal is

attributed to the demanding nature of the work and the low social status often associated with these professions. Consequently, many young people are turning away from these fields in search of careers perceived as more rewarding or prestigious. Addressing this issue is crucial to ensuring the sustainability of these essential industries and fostering a new generation of skilled professionals.

To accelerate more sustainable development in the Mediterranean region, fostered by the 2030 Agenda, transformative changes in food systems are imperative.

Urgent action is requested to face escalating water scarcity, degradation of land and marine resources, impacts of climate change, and progressive nutrition unbalances. Additionally, challenges such as youth and women unemployment, demographic shifts towards urbanization, vulnerability of rural livelihoods, political conflicts, and distress migration underscore, also in this region, the necessity for immediate intervention. It's essential to address these issues while acknowledging the diverse cultural dimensions across the region. In order to move towards more sustainable food systems, it is essential to foster innovative multi-stakeholder strategies and transdisciplinary knowledge by means of combined actions among the countries of the Mediterranean. On this purpose, a heightened emphasis on scientific research and data collection for impact assessment is necessary, alongside capacity building and innovation efforts encompassing technological, institutional, and social dimensions.

In this context CIHEAM following the previous declarations of the meetings of Food, Agriculture and Fisheries Ministers of the CIHEAM Member countries, the Matera G20 statement and the independent dialogues of the Summit 2021 of UN on Food Systems interprets the transition towards Mediterranean Sustainable Food Systems as a whole, a conceptual model but also a functional product of innumerous real actions in which the production of food moves towards human consumption in respect of the environment, durable management of natural resources, social and economic considerations, rural and urban community dynamics, trade practices, food distribution, access, and ultimately, human wellbeing.

In a synthetic way, we strongly believe that food systems connect two large biological entities. From one side Nature, which includes land and water, soils, biodiversity and climate: on the other side Human beings in variable frameworks of socio-economic and cultural drivers. A very simple equation links the production and the consumption of food. The relationship though is extremely complex either because the production of food is related to intricate systems of different domains or because the consumption is not simply an individual act but involves aspects and conditions.

The focus towards sustainable and resilient food systems also reflects a cultural and social change on the demand side of food goods to allow a greater sustainability of the Mediterranean food system, and at the same time, to improve human health.

But to change the demand for food, it is necessary to act on that part of the food system where the consumer makes his choices to buy, prepare, consume food, i.e. the so-called "food environment", which also includes nutritional, cultural and social actions. Only by creating a new sustainable food demand will it be possible to transmit those necessary signals to influence the way of production, thus creating newer supply and value chains.

Thus, the concept of sustainability is combined diet patterns in which solutions are explored to face the problems of malnutrition in its various forms, while addressing the loss of biodiversity and the erosion of indigenous and traditional food cultures.

A sustainable diet can help reduce the use of water and minimize CO_2 emissions, promote food biodiversity and enhance traditional and local foods thanks to their numerous varieties, which are also nutritionally rich.

In the process of transformation and adaptation of the agri-food system of the south-eastern Mediterranean countries, also the organization of the supply chain takes on particular importance. It is estimated that only a small part of the food expenditure incurred by consumers contributes to remunerating farmers, when they represent a very high part, on average 25%, of the employed population. This discourages farmers from investing in innovations and increasing commitment to the productivity, quality and sustainability of agricultural production. Therefore, this requires greater attention from public decision makers in allowing a fair and profitable distribution of value among actors along the supply chain.

Multiple innovations technological, social and organizational, will be needed to achieve the most suitable conditions for guaranteeing food security in the Mediterranean region. Science and innovation will play a fundamental role in this process.

The mechanisms and strategies of the EU agricultural policy were deliberately not taken into consideration in this special issue of *New Medit*, as they are well known and debated between the first pillar of direct aid and the second pillar of rural development.

The aim was to focus attention on the agri-environmental and rural development policies of the South-East Mediterranean countries in order to increase the knowledge and strategic orientations of the individual countries and undertake a coherent and effective Euro-Mediterranean cooperation activity.

This can be achieved by focusing on promoting human development, strengthening regional integration South-South and supporting sustainability, creating synergies and promoting projects that stimulate social and inclusive development, thus integrating migration into regional development and integration. In this context, we ask ourselves what role Europe will play in building a renewed Mediterranean cooperation? The establishment of the new European Commission has given positive signals in this regard with the promise of a new separate portfolio dedicated to the Mediterranean that bodes well for a new perspective of cooperation.

In this context, CIHEAM, in its institutional mission, has promoted this special issue in order to provide an analytical framework of knowledge of the conditions of the agri-food system and the relative forms of intervention of the policies applied in the various countries of the Mediterranean region.

The 5 Times of the Biosphere. Risks for the Mediterranean civilisation and sea biodiversity

Robin Degron*

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Abstract

Geology, Palaeontology and History can be brought together under the auspices of biogeography, the "frontier" disciplines, to guide us in the explanation of the orders and disorders of a World in perpetual movement through the theory of the "5 Times of the Biosphere". The subject of Fernand Braudel's geo-historical work, the Mediterranean sea and the Mediterranean region are like the cradle of a renewed reflection on Time and its rhythms in the light of climate change and rising salt water levels, which are accelerating at an alarming rate. This calls into question the biogeographical characteristics of the Grande Bleue or Big Blue and its shores. Global warming is thus likely to seriously weaken civilisations whose sustainability depends to a large extent, and even essentially, on the availability of water and an atmosphere that is simply breathable and physiologically bearable.

Keywords*: Climate Change, History, Adaptation, Mediterranean.*

Introduction

Life and Earth Sciences and Human and Social Sciences can be brought together under the umbrella of biogeography to guide us in explaining the order and disorder of a world in perpetual motion. We are currently experiencing accelerating climate change, which is calling into question the foundations of many civilisations. The subject of Fernand Braudel's pioneering geo-historical work, the Mediterranean sea and the Mediterranean region offer a concrete space for renewed reflection on Time and its rhythms. Extending the Braudelian concept of the "3 Times" of History, our reflection opens onto the "5 Times" of the Biosphere, a concept born of bio-geohistorical reflection committed to responding to the major challenges of climate disruption and the upheavals of the Earth, which overdetermine the life of living communities, of which humanity is a part.

Indeed, the acceleration of climate change calls for a fresh look at natural history and the rhythms of life on Earth. An effort to synthesise the visions of geologists, palaeontologists and historians would appear to be useful, confirming biogeography as a "bridge" between the natural sciences and the humanities. This approach also serves the purpose of futurists in their attempt to mark out the paths of the future by relying on a "science of temporalities" nourished by History but also by the ability to invent possible futures

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according to the oscillations of the "Clockwork of the Earth" (Degron, 2024 online[1]).

Understanding the cycles that over-determine the evolution of the biosphere requires an effort of abstraction in order to move away from a linear perception of Time and gain a better grasp of development cycles and their disruptions, as well as their implications in terms of public policy. The foresight approach helps us to do this (Degron, 2022). It is also a matter of better understanding the divisions between the components of a society whose components do not experience events according to the same rhythms: not being able to manage "one's end of the month", the socio-economic constraint, makes one less receptive to the "end of the World", the environmental constraint, as we pointed out at the time of the "yellow waistcoats" crisis, when working at *France Stratégie* (Degron, 2018). Even if the former can be considered "flexible", pushing living beings and singularly humans to adapt to the latter, perceived as hard, physically unsurpassable, we should not underestimate the strength of social movements hostile to an ecological transition deemed unjust, especially in a democracy where the opinion of the greatest number can take precedence over scientific rationality and where the political game has its own rationality, sometimes complex[2].

Analysing the timescale of the Biosphere requires the mobilisation of a variety of knowledges (geology, ecology, biology, history, economics, sociology, political science). We need to transcend the barriers between disciplines and encourage dialogue between them. By virtue of its in-between position, geography, which touches on the first world through biogeography and on the second through human or economic geography, can serve as a "bridge" for the construction of global knowledge. Alfred Wegener (1928) deals with time as much as Valérie Masson-Delmotte (2012), Claude Lévi-Strauss (1993) or Georges Duby (1996), but they do not understand it on the same "scale", or rather according to the same "time step": Wegener reasons about continental drift in terms of millions of years; using glaciology, Masson-Delmotte reconstructs climates from a few hundred thousand years ago; Lévi-Strauss's "sad tropics", the civilisations that have disappeared, will only have lived for a few thousand years; Duby deciphers medieval life from a secular perspective only.

To understand the phenomena affecting the Mediterranean world and appreciate the fragility of a thousand-year-old civilisation and its biodiversity, which are being permanently disrupted by global warming, we need to connect the many facets of the human and life sciences.

1. The theory of the three stages of history

Fernand Braudel, historian and geographer, developed the theory of the three stages of history without considering the evolution of geological substrata, or that of soils or climates, which he regarded as quasi-invariant (Braudel, 1949). Considered to be the founder of geohistory (Ribeiro, 2012), his pioneering thinking was anchored in his state thesis on the *Mediterranean and the Mediterranean world in the time of Philip II* (1949). In formal terms, the three phases he developed there correspond to the three parts of his work. In terms of content, these periods are characterised by a metric, ranging from a few thousand years to just a few years.

The first stage of history, that of civilisation, of the "long haul", is on a millennial scale. It brings with it religions, arts and mentalities, materialising in the architecture, painting, literature, music and art of living of the peoples of the Mediterranean basin. The second period perceived by Braudel is social. In line with the École des *Annales*, founded by Marc Bloch and Lucien Febvre, and the Marxist conception of history (Thuillier and Tulard, 1990), this time oscillates with the secular movements of the economy,

[1] https://www.futuribles.com/en/et-si-en-2050-lhorlogerie-de-la-biosphere-se-dereglait/.

[2] Robin Degron, 6 November 2023, Opinion column published in Acteurs Publics «*Finances publiques et Environnement : Acceptability, beware of the dangers*». https://acteurspublics.fr/articles/robin-degron-finances-publiques-et-environnement-acceptabilite-attention-dangers.

modes of production and trade: slavery, serfdom, wage-labour, the advent of industrial and then financial capitalism largely dictate the daily life of human communities and, more broadly, of all living communities. The historian's third and final phase is "the time of the individual", as Braudel puts it, the time of everyday life.

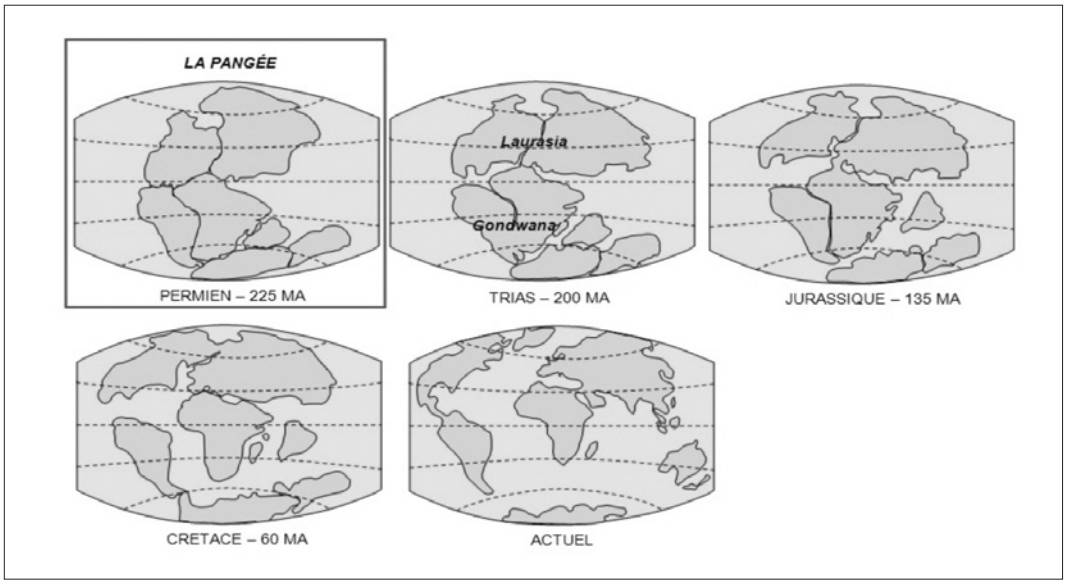
The Braudelian theory of the three times has enjoyed great success, but it has also been the subject of criticism, or at least debate. Other authors have attempted to analyse time through the prism of the human and social sciences, in particular the sociologist Georges Gurvitch, founder of the *Cahiers internationaux de sociologie*. In opposition to Braudel, whom he considered to be an "imperialist" theorist of history, Gurvitch acknowledged the importance of historical time, but relativised its explanatory value, considering it to be the result of social time (Maillard, 2005). He advocated a scale of *eight temporalities*: 1) time of long duration and slow motion, 2) "trompe l'œil" or "surprise time", 3) time of irregular beats between the appearance and disappearance of rhythms, 4) time lagging behind itself, 5) time alternating between delay and advance, 7) time in advance of itself, 8) the explosive time of creation. Fernand Braudel responded by noting the overly qualitative nature of the times proposed by Gurvitch. According to the historian, in this sociologist's division of time, time is difficult to measure: "*the time of sociologists cannot be ours* [...]. *Our time is measured, like that of economists. When a sociologist tells us that a structure constantly destroys itself in order to reconstitute itself, we readily accept the explanation, which historical observation confirms. But we would like, in line with our usual demands, to know the precise duration of these movements, whether positive or negative*" (Braudel, 1958).

With regard to Braudel's second "socio-economic" phase, we could introduce another criticism of a systemic nature, which this time resonates with the current situation of a World in which the Living is no longer limited to the Human in our awareness of it. In our view, it is worth highlighting the anthropocentrism of Braudel's original thinking, a logical prism for a post-war author who was confronted with the reality of a bipolar ideological opposition, but who was not yet at the height of environmental issues and the risks that the emerging consumer society would bring to bear on all living communities. It was not until the 1970s that the world turned the corner, notably with the first Earth Summit in Stockholm (1972). Industrial and then financial capitalism effectively dictated the lives not only of human communities but, more broadly, of all living communities. Biodiversity as a whole is being squeezed by the over-exploitation of resources, the artificialisation of land and the accumulating pollution (Lévêque and Mounolou, 2008; Degron, 2012; Lévêque, 2021).

By the same token, the third and final period of history, "the time of individuals" in Braudel's phrase, the time of our daily lives, has a major impact on living organisms as a whole and on their diversity. As a biogeographer, today we would prefer the term "the time of living organisms", "biological time" in short. With the exception of human beings, animal and plant biocenoses are caught up in the short time of their existence and appear fragile in relation to the time of the civilisations and societies that overhang and enslave them. If we were to associate this third time with a unit of measurement, we would obviously have to take a few precautions. A human life can be measured in decades, according to demographic data on life expectancy, which varies considerably from one region of the world to another, from one social class to another and, to some extent, from one gender to another. For other living organisms, the spectrum is wider: a butterfly lives only a few days; a flowering plant lasts only a few weeks; an oak, olive or sequoia tree can last several hundred years. All the same, for the sake of clarity, let's use the year or ten years as a yardstick for measuring our precarious lives. We will leave aside here the supra-individual reflection that encompasses the being in the *continuum* of a phylogenesis that is not a *priori* aware of itself. We are talking here about individuals, beings in their materiality and their sensitivity. We are taking an "augmented humanist" approach *to Homo sapiens sapiens*, part of a Biosphere in motion (Morin, 2021).

By adopting Braudel's ideas as our own, and

Map 1 - Evolution of the Earth's surface from the primary era to the present day (in Millions of years, MA)



Source: Banque de Schéma Supérieur, Académie de Dijon, Alain Gallien (2005)

building on his achievements to develop them further in the light of our "long emergency" climate, we are seeking to organise the times of the Earth and its living communities in a way that bridges the gap between History and the Life and Earth Sciences.

2. Geological time and natural weather patterns

When it comes to understanding the world, geography is not just about living communities, social pressures or human buildings. The history of the Biosphere must also include the temporality of biotopes and the environment. The Earth and the diversity of its landscapes are a dynamic geological and climatic construction, but this dynamic is slow enough for us not to perceive, in general, the driving forces at work over a very long time.

Geological time

Alfred Wegener's theory of continental drift (1928), extended by the theory of plate tectonics, provides an almost imperceptible image of the Earth's surface. Wegener, who trained as an astronomer, did not initially measure the dynamics of the Earth's crust. He began by observing the astonishing geometric interlocking of the African and American coasts and the proximity of plant communities on either side of the South Atlantic. From this he deduced how far apart they have become over millions of years. Occasionally, and often tragically, volcanism or earthquakes remind us of the power of tectonics: just think of the African plate gaining on the European plate, to the great displeasure of Italian Alpine communities[3] or, just recently, Moroccan populations in the Atlas mountains[4]; nor should we forget the French Overseas Territories where the work of the magma depths unexpectedly ris-

[3] Among the many earthquakes that have affected northern Italy, the most recent was the one that hit the town of Bonate Sotto in December 2021, and whose tremors shook Milan, fortunately without causing any casualties. In 2016, the Amatrice earthquake killed almost 300 people.

[4] The earthquake of 8 September 2023, which took a heavy toll on the Marrakech and High Atlas regions, recently reminded us that the African plate was also at play to the south of the Mediterranean along the subduction zone of the African plate beneath the European plate.

es to the surface and can engulf villages or entire towns[5]. If it is relatively discreet, so much the better, because when it is agitated, locally, it crushes everything.

In our analysis of time, geological time therefore holds a special place. Because of its power and slow pace, it could be considered virtually absent from the History of Mankind. And yet, with its spasms that are difficult to anticipate, it produces fearsome jolts that do not, in themselves, call into question civilisations that have extended far and wide, despite their punctual and territorial violence. At the limit of our reasoning on the Earth's timescale, we are also leaving aside, as a first approximation, non-geological phenomena of a planetary nature (e.g. meteorite impacts, solar eruptions) which can obviously eradicate all forms of life on the Blue Planet. Implicitly, we are isolating the Biosphere from its cosmic environment in order to better address the point of our fragility, as components of Living Things, from the effects alone of the geophysics of the Globe and the atmosphere induced by industrial activities.

So, alongside the cataclysmic events, the structural changes brought about over geological time become apparent as we look back over millions of years (see Map 1).

Natural weather patterns

Climate time is normally shorter in scale, but long enough to suggest the immutability of the biomes and soil and climate factors that structure our geography. Based on research by glaciologists in Antarctica, Valérie Masson-Delmotte (2012) points out that past climate variations over the last 800,000 years bear the imprint of the Earth's orbit around the Sun, with a cyclicity of around 100,000 years, to which is added a variability linked to the Earth's obliquity with a periodicity of around 40,000 years and another linked to the precession of the equinoxes with a time step of around 20,000 years. The glaciological analysis carried out at Vostok (Antarctica) of changes in carbon dioxide and methane concentrations and insolation over the last 420,000 years illustrates the natural climate cycle (see Figure 1 from Petit *et al.*, 1999).

This fundamental, long-term work is confirmed by the work of climate historians, in particular the remarkable work of the late Emmanuel Leroy-Ladurie (2007), who died last year. His work made it possible to detail the changes in climate over the course of medieval history, modern times and the contemporary period, without however calling into question the dynamics at work in global warming, which has been accelerating since the start of the 21st century: "*because of climate variability, we have experienced waves of hot, even scorching summers in the past, particularly in the 17th century. But from the point of view of the effect on humans, these episodes were quite different from those we "experienced" recently (notably in August 2003 and July 2006). In the twentieth century, there were heatwaves in 1911, 1921 (less severe), 1947, 1959, 1976 and 1995; as for 2003, it was the summer with the highest average temperature in the history of Western European weather for centuries*".

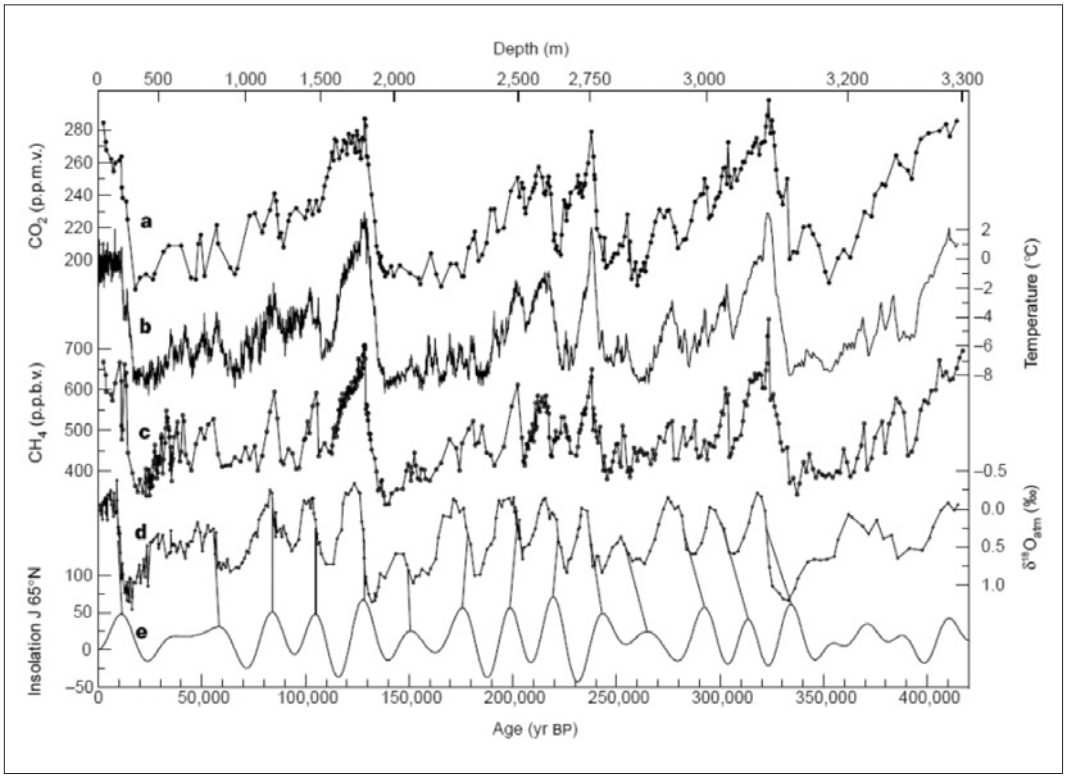
The IPCC's reports, in particular the 6ème report published in 2021, demonstrate the rapid warming caused by man-made emissions of greenhouse gases (carbon dioxide, but also methane and nitrous oxide), which have increased the Earth's average temperature by 1.1°C between 1850 and 2020. For 2023, in line with COP28 held in Dubai, it is worth highlighting the acceleration of the phenomenon: whereas in Paris, in 2015, COP21 of the Climate Convention (UNFCCC) aimed to limit the rise in average temperature to +1.5°C between 1850 and 2100, we have already reached +1.48°C in 2023. That's the bad news for early 2024. The international community's proactive approach seems to have been lost on a global scale.

At this rate, the IPCC experts consider that a rise of +3 to +4°C by the end of the century has become likely. To give an idea of the biogeographical consequences of such a temperature

[5] In 1976, the Soufrière volcano erupted, forcing the entire population of the town of Saint Claude in Guadeloupe to move.

Figure 1 - Changes in concentrations of carbon dioxide (CO2), methane (CH4) and insolation over the last 420,000 years, based on analysis of Vostok ice.

N.B.: The times closest to us are on the left of the graph. The scale at the top of the graph is expressed in terms of ice depth (in metres) and the scale at the bottom in terms of age (in years since present day).



Source: Petit et al., 1999

change, 100,000 years ago, the Earth's average temperature was around 5°C lower than it is today. Northern Europe was then covered by a glacier, France was covered by tundra and sea levels were 100 metres lower. Today, we are witnessing major climate disturbances that are disrupting the clockwork of the biosphere and its communities.

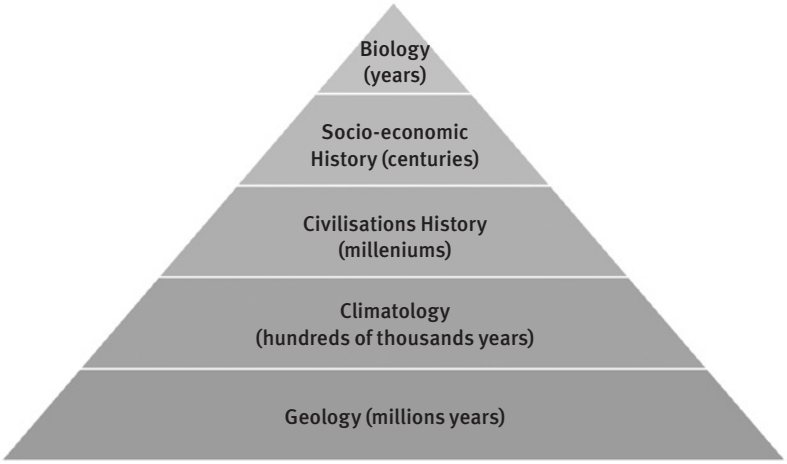
The very long time component of Biogeography is beginning to interact with the long time component of History, colliding with it and accelerating it. In fact, this "clash of temporalities" is forcing us to adopt a unified vision of the "5 Times of the Biosphere", in order to give a better account of the solidarity between living beings, and humanity in particular, and the planet that supports them.

3. Towards a unified and structured approach to Time

In the end, five timeframes are superimposed and articulated to give rhythm to the life of our planet and its living processions: geological time, pedoclimatic time, the time of civilisations, socio-economic time and biological time.

With atmospheric temperatures expected to rise by around 3 to 4°C by the end of the 21st century compared with the pre-industrial period (1850-1900), the soil and climate factors that characterise biomes are changing. Qualitatively, the main types of climate will remain broadly the same, but quantitatively, crossing record temperature thresholds will doom entire species, whose ecological amplitude is conditioned by a

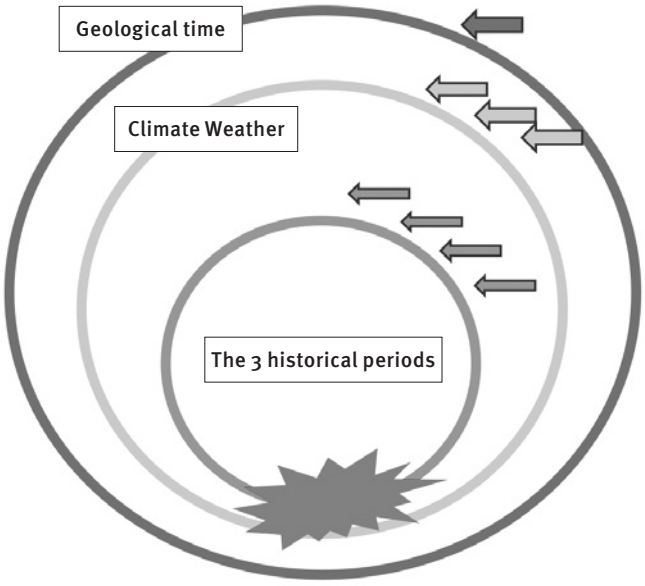
Figure 2 - The 5 times of the Earth and its living communities.



genetic capital that cannot mutate and adapt as quickly as the rise in temperatures. Climate disruption calls for an integrated vision of the Earth and its living communities (see Figure 2).

By speeding up natural climatic time (Figure 3), humankind, and in particular its unbridled industrial activity, which has been a corollary of the hyper-consumption society since around

Figure 3 - The 5-stage wheel of the accelerating Biosphere.



The acceleration of climate change, particularly in the Mediterranean, and the clash of timeframes in the Biosphere

1950, is disrupting the time clock of the biosphere and impacting on the times of History, starting with the times of our own times but going backwards to economic times and even, from now on, the times of civilisations.

The acceleration of climate change, particularly in the Mediterranean, and the clash of timeframes in the Biosphere.

4. The Mediterranean sea and the Mediterranean region at risk from climate change: leading indicators of the collapse of Mediterranean civilisations

a) The Mediterranean, a hotspot for global warming and plate tectonics

The Mediterranean region (see Map 2) has always been sensitive to the interactions between climate and mankind: Plato, in his last philosophical tale, Critias, noted that Attica had become a stony land due to alternating hot summers and abundant autumn rainfall, which washed out the soil, combined with overexploitation of forest resources that are difficult to regenerate in these soil and climate conditions (Degron, 2018). The Mediterranean area is a biogeographically degraded region, with low shrub formations of the scrubland or maquis type from which emerge a procession of pubescent or holm oak groves with pine plantations punctuated by relict climatic woodlands (e.g. culminating beech grove) like those depicted by Cézanne on the Sainte Beaume. Today's climate is therefore similar to that of yesteryear, but with the unprecedented intensity of worsening summer droughts and autumn rains caused by evaporation from an inland sea overheated in summer.

According to MedECC, the group of environmental and climate change experts specifically dedicated to the Mediterranean (UPM-UNEP/Plan Bleu, 2020), the average annual temperature on land and sea in the basin is already 1.5°C higher than in pre-industrial times. By 2100, it is set to rise by +0.5 to +2.0°C compared with the rest of the world, reaching 3.8 to 6.5°C depending on the scenario used to combat climate change (the optimistic RCP2.6 scenario, which aims to stabilise the average annual global temperature at +2°C by 2100*, compared with* the more pessimistic RCP8.5 scenario, which targets a global average of +4°C). Whatever scenario is adopted, the rise in atmospheric temperature in the Mediterranean is well above the global trend. This is particularly worrying given the sensitivity of southern environments.

Map 2 - The Mediterranean basin.

Source: Wikimedia Commons, sous licence d'utilisation libre, Idarvol (2005)

The Mediterranean region also has a remarkable geological feature that plays a role in the accelerated warming of sea water. Straddling the Eurasian and African tectonic plates, which form an East-West boundary, the Mediterranean Sea is subject to a subsidence phenomenon that makes its coastlines more sensitive to rising sea levels, in addition to the well-known factor of fluid dilatation caused by rising air temperatures.

Three researchers from the Italian National Institute of Geophysics and Volcanology in Bologna and Rome and the Dutch University of Radboud (Vecchio *et al.*, 2023) have established the facts about subsidence. Broadly speaking, the land sinks and the seabed rises, pushing up the water level on the coastline. In detail, the researchers demonstrate that the projections in the IPCC's 6ème report (2021) underestimate future sea levels along the Mediterranean coast because the effects of tectonics and certain other local factors have not been properly taken into account. Their revised projections of sea level in 2100, compared with those of the IPCC, show maximum and minimum differences of 1094 ± 103 mm and -773 ± 106 mm, respectively, with a mean value that is about 80 mm higher than that of the IPCC in its reference scenarios and at different levels of global warming.

The study even predicts that as a result of the global rise in the coastline (a rise of both climatic and geological origin), more than 38,500 square kilometres of coastline could be flooded by 2100-2150. According to this study and the projections made, France would be the third country most exposed to risk factors (3,681 km^2, mainly on the Rhône delta), after Egypt (12,879 km^2, on the Nile delta) and Italy (10,060 km^2, on the Po delta). Emblematic cities of Mediterranean civilisation such as Venice, Istanbul and Alexandria would be directly threatened. On the other hand, the Galilee coast in Israel and the Phlegrean Fields in Italy would experience a relatively slow rise in sea level thanks to the uplift of the land as a result of tectonics and volcanism, which are particularly prevalent in these regions: on the Galilee coast and the Phlegrean Fields, the variation in sea level in 2150 compared with 2020 would be around 0.5 and -0.7 m respectively.

The two primary processes of the Biosphere, that of Geology and that of Climatology, are therefore combining to harden living conditions in the Mediterranean basin. Natural history and history are working together on the Mediterranean. The concrete consequences are already palpable, and even threaten the fundamental equilibrium of terroirs and territories.

b) Worrying signs of the disappearance of Mediterranean civilisation

Agronomic issues

Over and above the fires that are perceived to be recurrent in the Mediterranean area (Clément, 2005), in order to measure the extent of the phenomenon of the disappearance of Mediterranean civilisation, we need to characterise the agronomic character of this civilisation and follow the evolution of a few key indicators that reflect, over time, the reality of a rapid decline. We have now reached a point that raises questions about the very survival of Mediterranean civilisations: their agriculture is dying out all over the Basin. To take a step back, let's return to Fernand Braudel (1949) and his attempt to characterise the singularities of the Mediterranean. According to Braudel, three emblematic products form the basis for the development of community life in this vast region: wheat, wine and olive oil. A number of indicators point to yield losses and the subsequent worsening of environmental conditions.

In the case of wheat, which is the staple food in the south of France (e.g. bread, pasta, semolina), it is clear that productivity is being eroded, despite the fact that Mediterranean soils are already not very fertile: in France, the yield differential between the country as a whole and the Provence-Alpes-Côte d'Azur region is around 50%. Even more worrying is the long-term trend in productivity in the region, once the effect of genetic seed improvement has been neutralised: since the end of the 1990s, durum wheat yields have fallen by around 10 quintals/ha, or almost 25% of average annual productivity, according to the PACA consular chambers. In the Eastern Mediterranean, there is a lack of solid statistical data, but the problem is illustrated by the inabil-

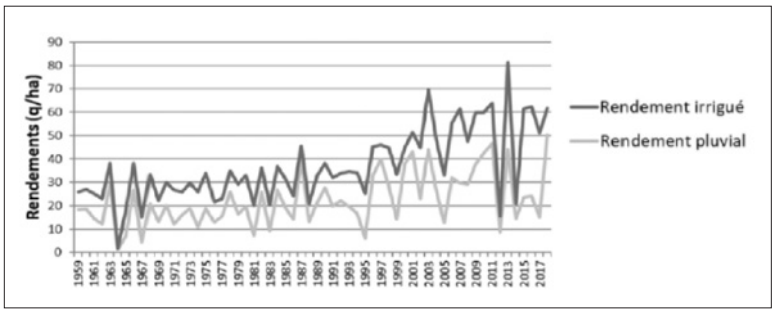


Figure 4 - Yield trends in olive groves in the province of Jaén (Andalusia, Spain) from 1959 to 2018.
Source: Arfaoui et al., 2021

ity of the Mashreq countries to feed their own populations. Current geopolitical events remind us that Egypt is obliged to ask Russia for help to ensure the security of its soft wheat imports and to produce the semolina that is the staple food in the Nile Valley[6].

Wine production is also struggling, despite the widespread use of drip irrigation systems, particularly in the Languedoc region, since the early 2000s. A study carried out by the Hérault Chamber of Agriculture, which is at the forefront of winegrowing issues, reveals and measures the impact of climate change on vines. Despite considerable inter-annual variability, a clear trend towards lower yields is emerging. Several trajectories, both linear and parabolic, can be used to explain the decline: with productivity of around 65 to 70 Hectolitres/ha in the 1990s, yields from Languedoc vines fell to around 55 Hl/ha in 2012. The latest figures for 2021 are 35 Hl/ha: the most rapid reduction curve seems to best reflect the downturn.

In Italy, the world's leading wine-producing country, the case of the vineyards of Umbria and the testimony of a traditional winegrower, Francesco Paolo Valentini, give a literary but very human and synthetic tone to the effects of climate change[7]: "*The climate is changing too fast. At this rate, we won't soon be able to make wine in Italy.* [...] *Agriculture is an outpost of changes in the natural cycle. Something very serious is happening.* [...] *Those who, like me, produce artisanal wines are the first to notice, but sooner or later everyone will see the effects. At this rate, prosecco will be made in Oslo while we grow bananas and pineapples.*"

The olive tree is the third characteristic cultural feature of Mediterranean agrarian civilisation, both to the north and south of the Basin. Thanks to its resistance to high summer temperatures, it is the "last line of defence" against global warming. It floods the Peloponnese from Corinth to Nafplio. It is becoming established in the south of Spain. The case of the province of Jaén in Andalusia – Spain's leading olive-growing region and world *leader* in the sector – has recently been the subject of a very detailed monograph showing the yield dynamics at work and the reactions of olive growers to drought (Arfaoui *et al.*, 2021). Since 1996, researchers have observed that yields have stopped increasing and are marked by high interannual variability (see Figure 4). On average, productivity is better under irrigation, with a difference of around 10 quintals/ha between rainfed and irrigated crops over the period 1959-2018, but in some cases with differences of almost 20 quintals/ha over the last fifteen years. In order to maintain their yields, farmers are having to resort to artificial irrigation on a crop that traditionally did without, putting additional pressure on all water users in a region of Spain that is already particularly arid.

[6] Egypt is the world's largest importer of soft wheat, with an average of 12 Mt/year over the period 2017-2022. According to the International Grains Council (IGC), it obtains 61% of its supplies from Russia and 23% from Ukraine.

[7] According to the Italian newspaper *L'Essenziale*, translated by Courrier International, «Quand le vin italien disparaîtra», 3 August 2022.

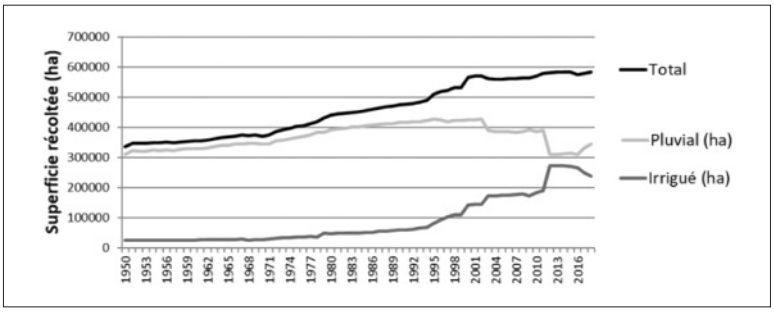


Figure 5 - Change in the area under olive trees in the province of Jaén (Spain) from 1959 to 2018.

Source: Arfaoui et al., 2021

In order to preserve their production, Andalusian farmers are planting more and more land, mechanically increasing the pressure on the water resources they can no longer do without (Figure 5): between 1950 and 2018, the area under olive groves in the province of Jaén practically doubled, rising from around 300,000 to 600,000 ha.

The maritime challenge

Then there's the sea to study: its biodiversity, shellfish, fish and fishing. Here, the seabed and aquatic populations are naturally more difficult to observe and measure. In fact, Braudel took fishing in the Mediterranean "out of the field" of his analysis, a sea that he saw primarily as a place of economic exchange, without paying too much attention to its strictly maritime production. In the light of climate change and advances in oceanography, we can now look at the sea and its products with a new, finer eye than in the past. The warming of the air is partly buffered by the water that absorbs the sun's energy. This affects the life of coral reefs, plankton and fish via the food chain. If fish populations collapse, fishing is threatened. The latest research findings are alarming. For the first time (Ben Lamine *et al*., 2023), French and Monegasque scientists have worked on the scale of the exclusive economic zones of EU countries, on nineteen species of major economic interest for Mediterranean countries. Their projections between now and 2100 compared with the reference period 1990-2017 show that, in the Mediterranean, the projected falls in tonnage (*Maximum Catch Potential*) range from -20 to -75% for catches using surface towed nets (pelagic trawls, seine fishing) to -50 to -75% for set nets or traps. They are over -75% for bottom trawls. We are indeed going to hit rock bottom.

Conclusions

Wheat, grapes, olive oil, fish: the agricultural and marine foundations of the Mediterranean are being inexorably eroded. The cradle of Judeo-Christian and Arab-Berber civilisations is withering away. Because the effects of the accelerating climate are not only affecting the roots of Western civilisation, from the Peloponnese to Catalonia, via Lazio and Provence. From Egypt to Tangiers, via Phoenicia and Carthage, the Arab-Muslim and Berber world is also suffering in the south of the Basin. Often opposed, antagonised since the Crusades, the fall of Constantinople, the battle of Lepanto and the wars of colonial independence, the two shores, the two souls of the Mediterranean are sisters in the face of the power of climate change. The environment unites us and calls for peace, especially in the Eastern Mediterranean (Degron, 2023).

Perhaps every cloud has a silver lining? Doesn't the pre-eminence of climate time put into perspective the permanent rivalries and resentments inherited from the history of simple civilisations? Positing the 5 Times of the Earth and its communities also means prioritising the issues so that we can better come together, identify the essentials and avoid the worst while awaiting the return of the best once we have reduced the stock of greenhouse gases. This is undoubtedly one of Geography's contributions to the edifice of a sacred union in the face of what appears more and more to be a climate collapse, which needs to be backed up as a matter of urgency. Red alert on the Big Blue.

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Agri-food policy trends and state of sustainable food system in Türkiye

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Abstract

Over last two decades, the research and evaluation paradigm in agri-food sector has shifted towards comprehensive perspective called sustainable food system. The heavy pressure on earth bio-capacity and massive environmental externalities, biodiversity loss, climate change impacts on agricultural supply and food security, food safety and health issues, and consumers' cultural concern are major factors induced to change the perspective from agri-food supply chain to sustainable food system. Although the sustainable food system perspective has become important paradigm in researches and impact evaluation studies on agri-food system recently, the studies at this perspective are missing in Türkiye. The aim of this study is to fulfil this gap in literature and provide evidences for policy makers. This study evaluates the food system and agri-food policies in Türkiye consisting of the state of the agri-food sector, historical evaluation of agri-food policy transform, climate change policies and environment, rural development measures, agri-food policy impact studies, and the performance level of sustainable food system indicators. Türkiye initiated the process of transformation of food systems in 2019 with an aim "to create sustainable, resilient and equitable food systems". National Program for Agricultural Support Policy is announced each year as a Presidency Decision. The scope of agricultural support measures and its relative importance in GDP has not considerable changed much for over three decades. Nevertheless, it has been observed a positive development in most of the sustainable food system indicators. However, especially food and nutrition indicators have not considerable improved and it has been even worsened in some subcategories during the last decade. Although national policy agenda and documents cover the transition towards sustainable food system, monitoring-evaluation system and assessment of national agri-food policies considering sustainability dimension data and indicators is lacking.

Keywords*: Food system sustainability, Food system monitoring and evaluation, Sustainability dimension of food system.*

1. Introduction

Over the last 50 years, food systems worldwide have shifted from predominantly rural to industrialized and consolidated systems, with impacts on diets, nutrition and health, livelihoods, and environmental sustainability (Ambikapathi *et al*., 2022). Recently, the focus of agricultural and food policies has shifted from predominantly supply-side to overcome issues of supply chain, and finally to food system ap-

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proach to achieving sustainable development goals. According to FAO (2018), "food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal, and natural environments in which they are embedded". In other words, food systems are defined as the sum of actors, sectors, and interaction along the value chains from pre-farm production (such as R&D and input supply) to post-consumption (waste disposal) stages. The system encompasses massive environmental externalities, climate change, health, enabling policy environments and cultural norms (Fan, 2021). The systems consist of everybody and everything that involves in bringing food from "farm to fork" (Fanzo and Davis, 2021). The food systems are a perspective that consists of numerous interlinked activity areas including the natural, technical, economic, and social aspects. It covers all the supply chain activities, externalities and valorisation from primary production and input use to consumption and waste reduction at each stage of the system and their linkages with each other (EC, 2023). Social dimension of food system has multifacet elements consisting of human health, healtier diet, the fight against overweight, obesity, diet-related diseases, food availability and affordability, fair return, fostering competitiveness, assuring occupational health and safety, workers' social rigths, respecting human rights, promoting fair trade, and enhancing animal welfare. Environmental dimension includes reducing carbon footprint, achieving global climate targets and biodiversity commitments and effectively respond to the world triple environmental crisis consisting of climate change, biodiversity, and pollution. Building better operators' capacity to produce adequate amount of nutritious and diverse food for world population at an affordable price is an important element of economic dimension of the system. In addition, fairer economics return for primary producers and SMs enterprises and fair distribution of value-added among supply chain actors are part of economic dimension. The economic dimension also covers fostering job opportunities, competitiveness of supply sector, and consumer access to healthy diet at affordable price (EC, 2023). Globally, food system is a major driver of climate change and biodiversity loss which is responsible for 30% of the greenhouse gas (GHG) emissions of the world. The UN held a Food System Summit in 2021 to increase the awareness that food system transformation is urgent. Several countries have designed National Pathways having the priority actions for the transformation towards more resilient and sustainable food systems (EU, 2023). A sustainable food system provides everyone easy access to healthy, environmentally sustainable, culturally appropriate, and nutritious diets in all times. Meantime it protects and restore of natural resources and ecosystems. Therefore, all food system actors' representatives, at every level of governance, must involve in the development and management of a sustainable food system (Food Policy Coalition, 2023).

Transformation of food system depends on achieving potential yield (reducing yield gap) and by changing land use from calorie-rich to nutrient-dense food production activities, as well as opportunities improving incomes. The escape of labour from agriculture to non-agriculture sectors has contributed income improvements. This transformation has affected farm size, use of natural resources and income disparity between urban and rural peoples. Resilient and inclusive food system requires radical changes in all components of the system encompassing production, consumption, trade, and governance (Ruben *et al*., 2021). The recommended diet affordability has improved over time in the countries, on the other hand, food systems are could not deliver optimal nutrition and health outcomes, environmental sustainability, inclusion and equity for all (Ambikapathi *et al*., 2022).

Béné *et al*. (2021) determined food system drivers based on literature survey and analysed their correlation with the dimensions of food system. These drivers were categorised into demand/consumer, production/supply, and trade/distribution. Demand/consumer side drivers include demographic transition, rising income of the consumers, urbanisation and associated lifestyle, and

attention increasingly paid to diet. Production/supply side drivers consists of innovation technology, intensification of agricultural production, improved access to infrastructure, degradation in agro-ecological conditions, and climate change. Trade/distribution related drivers cover policies facilitating trade, internalisation of private investment and growing concern about food safety.

Türkiye prepared a report on food systems, initiated the food systems transformation in 2019. The National Pathway was defined with an aim "to create sustainable, resilient and equitable food systems with concrete actions in order to make a significant contribution to the realization of the vision of the 2030 Agenda for Sustainable Development" (MoAF, 2021a). Although, transition towards sustainable food system has taken place in national policy agenda and documents, assessment of national agri-food policies from food system perspective considering sustainability dimension indicators is lacking. The aim of this study is to fulfil this gap in literature and provide evidence for policy makers.

The focus of the study is to provide a synthesis of agri-food policy transitions towards to a sustainable food system in Türkiye. The third section of this study provides a brief information about current state and policy transformation trend towards sustainability in agri-food sector considering economic, environmental, and social dimensions of food system. In the section four, the impact of the policies and progress towards to a sustainable food system are evaluated based on indicators and empirical evidence. Final section concludes with some policy recommendation regarding EU green deal policy and climate change action to accelerate transition to sustainable food system.

This study primarily uses national policy documents and report published on agricultural policies and statistical data to evaluate and analyse agri-food policy changes (by the chronological order) and transition to a sustainable food system. The study uses comparative static analysis of agri-food statistical data to demonstrate trend in and performance of the agri-food sector in beginning part. Secondly, main policy documents governing agri-foo policies are discussed and main result of the policy impact assessment studies and reports are summarised in the study. Finally, an evaluation based on the food system sustainability indicator used in the literature including economic, environmental, social, and food/nutrition dimensions (Béné *et al*., 2020) are presented. The food system sustainability evaluation does not cover all the food system sustainability indicators since some of them are not readily available or exist in both national and international data sources. Thus, limited but most important major indicators are considered and discussed. As a matter of fact, it was highlighted by Valls Bedeau *et al*., (2021) for the Mediterranean countries that sound data analysis can play important role for shaping policies and investment plans, and identifying leverage points in food system. Thereby better resource allocation can be achieved to obtain significant and better sustainable impact.

2. Current State and Transformation Trend Towards Sustainability in Agri-Food Sector

2.1. *Current State of Agri-food Sector*

Türkiye, an upper-middle-income country, is among the first-twenty largest economies in the world, with a GDP of about $1.119 billion in 2023. Turkish economy experienced high rates of average annual GDP growth rate (5.5%) between 2003 and 2023 (TurkStat, 2024a). Key macroeconomic, demographic, agri-food indicators including food security and food related health indicators corresponding last two decades is presented in Table 1.

In terms of agricultural value-added and food export value, Türkiye has important place in the world. However, as of 2020, Türkiye realized $US 67.8 billion (measured by 2015 constant US dollar) agricultural value-added which contributed 1.9% of the world and 20.4% Europe agricultural value-added in the same year. Moreover, Türkiye realized $US 18.8 billion food export ($US 6.7 billion net-export value) and placed as 24th (18th in net-export) among the food exporting countries in ranking in 2020 (FAO, 2022).

The share of agriculture in GDP has continued to exhibit a declining trend over last 20 years. Its contribution to GDP was measured as 10%,

Table 1 - Key macroeconomic, demographic and agri-food sector indicators.

Economic and demographic	*2000*	*2013*	*2023*
GDP (billion USD)	273	958	1,119
Population (million)	64.7	76.7	85.4
Population density (inhabitants/km^2)	83	102	110
GDP per capita (USD)	4,249	12,582	13,110
Trade volume as % of GDP	30.1	30.6	55.0
Agriculture in the economy			
Agriculture in GDP (%)	10.0	6.9	5.2
Agriculture in employment (%)	36.0	21.0	14.6
Agri-food exports (% of total exports)	12.8	11.2	10.9
Agri-food imports (% of total imports)	3.3	5.0	5.7
Characteristics of the agricultural sector			
Agricultural Land (thousand ha)	40,479	38,423	38,559
Share of arable land in agricultural land (%)	58	54	52
Crop share in total agricultural production value (%)*	62	49	45
Livestock share in total agricultural production value (%)*	38	51	55
Food security and food related health indicators			
Food and non-alcoholic beverage in household expenditure (%)** -The lowest quintile in the parenthesis	27.5 (41.4)	19.9 (30.4)	22.8 (39.3)
Persistent at-risk-of-poverty-rate (%)		13.0	12.3
Severe material and social deprivation rate (%)***		19.2	14.4
Obesity rate of 15+ population (%)****	15.2	19.9	20.2
Poverty rate***** (60% of the median income) -Rural poverty rate in the parenthesis	25.4 (41.1)	22.4 (37.2)	21.7

*Source: TurkStat (2023a). *2020, **2002 and 2022, ***2015 and 2023, ****2008, 2014 and 2022 and *****2006 and 2013.*

6.9% and 5.2% respectively in 2000, 2013 and 2023. It can easily be observed from annual data that very high variability of agricultural value-added from one year to another reflects very high dependency on climatic factors or weak resilient of food supply to climate change. As a matter of fact, agricultural value-added growth rate has fluctuated from 8.7% to -5.9 during 2003-2023 period and annual average of growth rate has realized as 2.4 percent. Agriculture still plays an important social role in Turkish economy with about 15% employment share and being a key to the rural economy: generating most of the farm household income and employment. Rural population in Türkiye is among the most disadvantaged and vulnerable groups in terms of living standards and food inequalities. However, unidimensional (multidimensional) poverty rate as average of 2006-2016 was calculated for 14% (40%) and 25% (51%) respectively for urban and rural areas (Öztornacı and Şengül, 2019). Considerably high level of rural poverty contributed migration from rural areas to urban areas, therefore major source of urban poverty has been migration of rural poor population. In addition, government policies penalizing agriculture and neglecting social and physical infrastructure development in rural areas has contributed both rural and urban poverty (Türkekul *et al*., 2017). Family-owned farms are dominant with a large number of small farms in agricultural production, and most of the farm labor is provided by the family members. The agriculture structure is characterised by many small and highly fragmented

Table 2 - The average yield and production of some agricultural products.

	2001-2003	*2011-2013*	*2021-2023*
	Yield (Tonnes/hectare)		
Wheat	2.07	2.73	2.94
Rice	5.94	8.18	7.88
Corn	4.40	7.82	9.20
Grapes		9.10	10.00
	Production (Thousand metric tonnes)		
Red meat	773	1,045	1,458*
Raw milk	9,505	16,894	22,756*
Chicken meat	728	1,698	2,331
Organic agriculture**	310	900	1,128
Good Agricultual Practices***		2007: 56	2022: 5 336
Tomato	9,232	11,391	13,132
Citrus		3,814	5,984

**2020-2022 average and **2002-2003, 2012-2013, 2021-2022 averages.*
Source: TurkStat, 2023a. www.tarimorman.gov.tr,a

farms. Farmer registry system records hold by Ministry of Agriculture and Forestry (MoAF) indicated that the number of farmers was 2.7 million in 2003 and 2004, thereafter, the number of farmers has steadily declined to around 2.2 million, with a total of 15 million hectares of land cultivated (www.verikaynagi.com). The indicators of the productivity growth and the input use in agriculture are presented in Table 2 and Table 3. Productivity growth has played an important role in the growth of agricultural value-added for beginning of green revaluation, particularly from 1980s and outwards with productivity enhancing inputs including high-yielding seeds, heifer, quality feed ingredients, chemical inputs and mechanisation.

The productivity improvement may be connected to increased amount of irrigated area, agricultural R&D expenditure, high-yielding seed use and cows-cattle feeding, cattle breeding, upgrading farm holdings structures, farm size growth, land consolidation, and agricultural extension (i.e., in advance weather condition information through cellular phone, knowledge sharing among farmers via WhatsApp).

Land distribution in Türkiye is not highly skewed, farm size is small, and farmers are predominantly cultivating on their own land.

Table 3 - Input use in agriculture.

	2001-2003	*2011-2013*	*2021-2022*
Fertilizer (N+P+K equivalent) use per hectare (Kg)	70.50	89.30	100.30
-Nitrogen	57.40	72.70	81.40
-Phosphorus	10.20	12.30	13.70
-Potasium	2.90	4.30	5.50
Pesticide use per hectare (Kg)*	2.14	2.07	2.62
Traktor (hectare area per tractor)	22.00	16.70	13.70
Feed production (thousand metric tons)**	5,403	14,536	26,802
Seed distribution (thousand metric tons)	112	694	1,303

**2006-2008 and **2021-2023*
Source: TurkStat, 2023a. www.tarimorman.gov.tr,a

However, about 80% of agricultural enterprises cultivates 60% of the total land and 17% of the landowner's lease land. The enterprises cultivate on lease land in only 3% of total land. About 83 percent of farms has less than 10 hectares of land[1] and 65 percent of farms have less than 5 ha. National average farm size was 6.8 hectares and only about 6 percent of all farms cultivate more than 20 ha. Contrary to the large number of small farms, commercial farms have also emerged during last two decades. The land ownership pattern varies regionally due to the differences in geography and the crops produced (TurkStat, 2020). A significant number of farm holdings also carry out animal husbandry. Specialised farms are generally located in the Mediterranean and Aegean regions. The average land parcel size has decreased, due to the inheritance laws. However, the inheritance law changed in 2012 indicating parcels under 2 ha in dry areas (1 ha in irrigated areas, 0.5 hectare in case of orchards and 0.3 hectares in case of greenhouses) are not allowed to be divided among heirs (MoAF, 2021b).

Türkiye has 78 million hectares total land area of which 38.6 million hectares are utilized agricultural area (UAA). The UAA consist of 20.2 million hectares arable land, 3.7 million hectares permanent crops land, and 12.7 million hectares permanent meadows and pastures land. Fallow land account for about 13.9 percent of total arable land. Forest land covers 20 million hectares (TurkStat, 2024a). The registered total irrigated area is about 6.7 million hectares with a 4.41 million hectares having modern irrigation network (MoAF, 2021a). Arable crops cover about 52% of the total utilized agricultural area. Permanent meadows and pastures account for 38% of the UAA. Fruit, vegetable and ornamental crops is covering 11.5% of the utilized agricultural area.

Crops value accounted for about 45% of the total agricultural production value in 2023, of which, fruit (37%) and vegetables (19%) make up 56% of crops. Livestock and animal production value accounted about 55 per cent of agricultural production value in 2023. Arable farming value-added accounts for about 69% of the total agricultural GDP of which, fruit and vegetables make up 44% of crops. Livestock sector production value constitute 26 percent, forestry production value constitutes 2 percent and aquaculture production value constitute 3 percent (TurkStat, 2023a).

An adequate climate, high soil fertility, and relatively better rainfall in some regions permit a wide variety of crops that grow in Türkiye. Thus, according to the latest three-year average, 42.2 million tonnes of cereals, 34.9 million tonnes of vegetables, 24.2 million tonnes of fruit, 21.5 million tonnes of milk, 2.33 million tonnes of poultry meat and 1.46 million tonnes of red meat has produced in Türkiye. The major industrial crops produced in Türkiye are cotton, sugar beets and tobacco (TurkStat, 2023a).

Türkiye has implemented intervention policies in agriculture since the early 1930s. Particularly, import substitution policy started in early 1960s to until 1980s. In addition, agriculture was tightly under control to meet the general policy objectives including increasing yields and production, maintaining price stability, and developing exports. Some agricultural products have been taxed, and some received subsidies. In summary, agricultural support was directed towards import-competing farm products between 1980 and 2000 (OECD, 2023a).

A variety of policy measures had been implemented to fulfil these objectives before 2000s. In this period, agricultural support measures were consisted of domestic support (input and output price support, subsidised credits) and border measures included quantitative import restrictions, and tariffs. The input support measures consisted of farm inputs subsidies including credit, fertilizers, pesticides, and investments in infrastructure. The output support measure consisted of generally intervention price and intervention buying managed by Grain Board and Unions of Agricultural Sales Cooperatives (ASCUs). Regional programmes were implemented to reduce regional disparities

[1] Average farm holding size was 6.1 hectare in 2001 (Farm Census 2001) and 7.6 hectare in 2016 (Farm Structure Survey 2016).

in term of income and technology. Government still funds the agricultural R&D, extension, and training services. The general veterinary services, milk and suckler cow premiums, animal disease control, and border measures (prohibitively high ad-valorem tariff) were main policy measures for livestock sector.

It had criticised by many stakeholders, including international institutions such as OECD that the policies have been inefficient, failed to enhance productivity, heavy burden on consumers and taxpayers and been a source of Türkiye's macroeconomic instabilities such as budget deficit, current balance deficit and high inflation. The Government embarked a restructuring programme called "agricultural reform and implementation programme (ARIP)" in 2001. Commodity price support carried out by ASCUs on behalf of the government, subsidies for farm inputs and credit were all phased out with the ARIP program. Most of the state economic enterprises (SEE) have been privatised and agricultural sales cooperatives' unions was released to their autonomy that reduced the government involvement in the processing and marketing of agricultural products covering cotton, tobacco, sugar beet, oilseeds, hazelnuts, and olive.

Furthermore, the regulatory and supervisory authorities established for sugar and tobacco sectors to control over supply and reduce excess carry-over stocks. As an alternative policy measure, de-coupled direct income support scheme was put in place in 2001. Premium payments for oilseeds have been implementing since mid-1990s and tea pruning has fully compensated to control excess supply over years. Farmer diverting from over-produced hazelnuts and tobacco were granted to cover the costs. Farmer also granted for pruning one seventh of tea plantation. Agricultural sales cooperatives and their unions (ASCUs) were provided financial aid for restructuring and transformation from under the public authority to autonomy. On the other hand, in parallel to ARIP, Türkiye has tried to harmonise institutional framework and its agricultural policies with the EU since mid-1990s, after Custom Union agreement and full membership negotiations started in 2005. The need to reform the country's agricultural policies stems both from harmonisation of policies with the EU Common Agricultural Policy, as Turkey is a candidate country, and from the changing domestic macroeconomic policy environment (disinflation policy) and bilateral-multilateral trade relationships such as WTO commitments.

Following ARIP, the several state-owned economic enterprises (SEEs) including Turkish Grain Board (TGB), tobacco monopoly (TEKEL), sugar enterprise (TŞFAO), the Meat and Fish Board (EBK) previously carried out agricultural policies for decades were privatised (except TGB) and restructured by the mid-1990s and early 2000s. ASCUs and SEEs became more exposed to market forces. Under the ARIP, the budget for supports procurement carried out by TGB started to determine within central government budget, instead of borrowing from commercial banks during intervention buying period, subject to approved by the parliament.

The Turkish Grain Board, the Meat and Milk Board (re-established and structured) and Bank of Agriculture are still active and has important role in the agri-food sector and markets. In addition, the Agricultural Credit Cooperatives is playing an active role in farm inputs distribution including fertilisers, pesticides, animal feed, farm equipment and machinery, credit and the marketing.

Under ARIP, direct income support payments as de-coupled and coupled compensatory payments implemented during 2001-2008, thereafter support policy has re-orientated towards to the interventionist style policies such as extension of intervention buying and abolished de-coupled direct payment. However, high tariff rate for many agri-food products remained in place, but compatible with WTO commitments.

In conclusion, Turkish agricultural policy has not changed notably over time. According to Agricultural Law put in place in 2006, the primary policy objectives are to (1) ensure the food security, (2) enhances productivity growth and reduce vulnerability to adverse weather conditions, (3) improve self-sufficiency, (4) raise stable farm incomes, (5) enhance competitiveness, (6) develop rural areas, and (7) ensure food safety and harmonise policies and institutions with those of the EU.

Table 4 - Key legal, strategic and programming document related with agri-food system.

Document	*Key goal and objectives*
Law on agriculture (no: 5488), 2006	The law aims to develop and implement the necessary policies to improve the agriculture and rural areas in accordance with the development plans and strategic papers. Agricultural support programmes must be financed from budgetary and external sources, resources allocated from the national budget must not be less than 1% of the gross national product.
Strategic Plan: 2019-2023 Revised in 2022	Agricultural policy objectives set are to increase the welfare of rural people and to ensure a stable high quality food supply.
11th Development Plan: 2019-2023	The Eleventh Development Plan presents a long-term perspective based on the vision of "stronger and more prosperous Türkiye that produces more value-added and shares more fairly". The main objective is to create an efficient agricultural sector that is environmentally, socially, and economically sustainable, internationally competitive with its production structure that considers supply and demand balances as well as adequate and balanced nutrition of the people.
3rd Agriculture and Forestry Council, 2019	The aim is to develop plans for the sector. Actions to be taken are i) Agricultural production and supply security, ii) Food safety, iii) Rural development and marketing, iv) Fisheries and aquaculture, v) Soil and water resources, vi) Biological diversity and climate change, vii) Forest, and viii) Institutional capacity. Council specifically addresses that agricultural policies will be designed using a holistic approach by considering of the principles of the sustainability for at least five-year period based on the development plans.
National Strategy for Agriculture and Rural Development: 2019-2023	NRDS aims to correctly determine the development dynamics of rural areas that fall relatively behind the national welfare level and to mobilize the economic and human resource potential in these areas within the framework of the determined strategies.
IPARD 2021-2027	IPARD III aims to improve the rural vitality to invest in agriculture and related areas.
National Program for Agricultural Support Policy	Presidency Decision, adopted each year, aims to increase the competitive capacity of the sector, productivity, and quality, develop new technology with national recourse, protect the genetic resources, apply environmentally friendly agricultural practices and to boost the efficiency of the agricultural policies for ensure the agricultural production and supply security.

Source: Koç and Bayaner, 2022.

The objectives of the policies were clearly stated and defined in policy and policy related papers of the government. There are several policy-related regulations and strategic documents on which the design and implementation of the policies are based on. Some of the regulations are "law on agriculture, organic farming, agricultural producer unions, protection of plant breeder's rights for new plant varieties, agricultural insurances, soil protection and land use and seed growing". In addition, there are several other strategic documents related to different aspects of the agriculture in general and the policies. These are development plans, ministry strategic

plan and strategic action plan, rural development strategic plan, agriculture and forestry council, water action plan, climate action plan, green deal paper and EU harmonization paper.

National Program for Agricultural Support Policy is announced each year as a Presidency Decision. The program for 2023 is basically the same as the one announced in 2022. The scope of agricultural support measures has not changed for over last three decades much however the amount of payments budget changes in nominal monetary terms (Official Gazette, 2021 and 2023). The agricultural policy objectives are set by development plans and official documents. Key legal, strategic, and programming document are given in Table 4. The Eleventh Development Plan: 2019-23 layout the main agricultural policy objective to develop an efficient agricultural sector compatable with the EU agricultural policies, that is environmentally, socially, and economically sustainable which reflects the main dimensions of sustainable food system.

The objectives of the agricultural policy set in the Strategic Plan: 2019-23, compatible with the Development Plan is to increase the rural welfare, to ensure a stable and a high quality food supply, and to achieve a sustainable and more competitive agricultural sector while considering the EU CAP and the WTO rules.

Agriculture and Forestry Council was formed by the stakeholders in 2019, addressing an agricultural policies designed using a holistic approach by considering of the principles of the sustainability for at least five-year period. The main pillars of "Türkiye Agricultural Drought Strategy and Action Plan": 2018-22, are to develop a capable institutional structure and make the agriculture resilient to drought.

Several laws and regulations regarding agrifood and rural development have enacted over last two decades which are generally aligned with the EU counter parts and corresponding to the food quality and safety, environmentally friendly production, and reducing environmental degradation and negative externalities, fair competitiveness in the markets, reducing excess supply and risk mitigation.

The latest agricultural support programme, called basin-based support system not fully compatible with that of EU's CAP, was put in place in 2017. There are 941 agricultural basins based on the soil characteristics and climatic conditions. Nineteen crops strategically important for food security, import dependency, regional economy and competitiveness were determined. The focus of this program is to diversify agricultural production, increase productivity and reduce the planted area of water-intensive crops in draught prone areas. As part of the new program, Turkish Grain Board is not allowed to procure crops through intervention buying if they are not on the subsidized crop list of their specific agricultural basin" (Koç *et al*., 2019). This program was a main step in direction towards sustainable food production since support payments considered environmental and climate changes issues such as drought and water availability in the agricultural basins, contributing environmental sustainability.

A risk management program in agriculture with the objective of providing income stability by protecting farmers against all types of natural disasters was put in place in mid-2000s. The law on agriculture insurance (No. 5363) enacted in 2005, provides a comprehensive state-supported agricultural insurance system. An agricultural insurance pool (TARSIM) was formed for collecting premiums paid by farmers and government premium support and compensates farmers' losses. Government premium payments is put in the agricultural support budget. Participation in program is voluntary. The risk management program has reformed from covering yield risk to income risk recently. This revenue-protection insurance, covering 70% of insured farm revenue scheme, was introduced in 2022. Producers receive additional support and grants for the natural disasters resulting yield losses and price variations (www.tarsim.gov.tr). Reducing farmers' risk (either yield or income) is a main policy tools to protect (enhance) farm income and also incentive for farm specialisation and productivity growth, therefore fall in economic dimension of food system sustainability.

Rural development projects were implemented in various regions and provinces in order to better utilize natural resources and to eliminate so-

cio-economic differences observed in rural areas until mid-2000. Rural development projects generally aimed to improve infrastructure in rural areas, employment possibilities, increase the income of the rural population, raise their living standards, improve crop and animal production and mobilize the rural population. What makes rural development projects different was that they were multi-purpose, integrated, generally "one size fits all" style, politically decided location or region specific projects and partially funded by international institutions. However, they were not flexible to explore potential of individual or collective enterprise capabilities. These projects had also several other shortfalls: i) requirements of local traget stakeholders and appropriate financial planning were not taken into account, ii) they failed to ensure coordination between organizations in projects and frequent changes in the main implementing organizations emerge as a lack of organization, iii) they did not conduct a comprehensive and detailed socio-economic analysis and thoroughly examine the potentials of the locations or regions such as natural resources, agriculture, industry and workforce before the preparation of the projects has not clearly revealed what can be done in the short, medium and long term, iv) processing and marketing of the increased production did not adequately considered, v) comprehensive monitoring and impact assesment (ex-ante and ex-post) were not carried out. In short, these rural development projects were like a one-time injection and neither the purpose nor the permanent rural improvement had been achieved (Anonymous, 2004). Although rural development project vision has gradually changed during last several decades, the radical change was introduced during mid-2000s with the EU funded IPARD programs. Measures have been implemented in the area of investments in physical assets, processing and marketing, agriculture-environment climate and organic agriculture, leader approach and diversification of farm activities and business development. Rural development supports paid from central government budget expenditure account for about 7% of total agricultural and rural supports (MoTF, 2024).

In order to align with IPARD, the "national rural development strategy for 2007-2013" first set out the priorities which is an important step toward social, economic, and environmental dimension of sustainable food system. These priorities are also covered in the strategy paper (2014–2020), categorised under five pillars: "the rural economy, the rural environment, rural settlements, rural society and rural capacity development" (MoAL, 2015), the priorities are: (i) "increasing employment and income generating activities in rural areas, (ii) strengthening the capacity for the efficient utilisation of natural resources, (iii) increasing the living standards of the rural population through the adoption of modern agricultural techniques, (iv) creating employment opportunities in diverse livelihoods (including tourism, textiles, handcrafts and forestry products) and promoting these in disadvantaged areas, (v) promoting small and medium-sized enterprises and providing support for micro-finance and marketing and (vi) reducing inter- and intra-regional disparities, reducing the migration flow from rural areas and strengthening participatory approaches though vocational training, extension and consultancy services".

IPARD programmes of the EU facilitates Türkiye's alignment with the acquis in the rural development. The Agriculture and Rural Development Support Institution (TKDK), having coordination offices in 42 provinces, implements the rural development programmes in agricultural holdings (producing red meat, milk, poultry meat, and eggs), processing and marketing activities (milk and dairy products, red meat and products, poultry meat and products, seafood, and fruits and vegetables), farm diversification, diversification of plant production, processing and packaging, beekeeping and production, processing and packaging of bee products, craftsmanship and value-added local products, aquaculture, machine parks, renewable energy investments, and rural tourism (TKDK, 2023).

Türkiye moved away from the principles of the reformed CAP thanks to the agricultural law of 2006. Payments were linked for many products. Commodity output support increased, decoupled direct income payments gradually decreased and were abolished in 2009. Direct payments are

fully coupled. Area-based payments for "fertiliser" and "diesel" based on cultivated land differentiated according to the product groups have been increasing. Import protection remains unchanged. Other forms of support payments are premium payments, compensatory payments for farmer transition, livestock support at various forms, insurance, rural development, and environmental set-aside (Agricultural Land Conservation Program for Environmental Purposes called CATAK), ended in 2018 (MoAF, 2021d).

Farmers in the National Farmer Registration System (NFRS) are eligible to receive support payments. Compensatory payments are provided as a premium for products such as oilseeds, cereals, pulses, cotton, olive, and milk. Coupled area payments are granted to farmers for producing organic farming, fodder crops, using good agricultural practices, and certified seeds-saplings. So-called "diesel payment" and "fertilizer payment", non-decoupled area-based payment, are given separately. Producers receive payments for soil testing and analyses. Payments are granted to animal producer and breeder in about 30 different areas. Farmers are promoted to use biological and biotechnical practices to reduce the chemical use and residues. Electricity used for irrigation in agriculture has subsidized in some years and some provinces. Payments are granted for the rehabilitation of the traditional olive orchards. Fresh fruit and vegetable production, floriculture, and aromatic plant producers under 0.5 hectares, except for tea and hazelnut producers, receive small scale farm business payment. Those who are living or committing to live in rural areas graduated from the related departments of agriculture, animal husbandry, forestry, food, and aquaculture education are granted for farming. Agricultural enterprises and farmers enjoy interest rate concessions (Official Gazette, 2023).

"Export subsidies are applied to 14 commodity groups, out of the 19 groups eligible under Turkey's WTO commitments. This included processed fruit and vegetables, poultry meat and eggs. Export subsidies are granted in the form of reductions of the exporters' debts to public corporations (for example, for taxes, and telecommunications or energy costs). Production quotas are applied at the farm level for sugar beet" (OECD, 2023a).

2.2. *Climate change policies and environment*

Türkiye prepared the Green Deal Action Plan to support green transformation in all relevant policy areas. Plan aims to establish Türkiye's compliance with the European Green Deal to strengthen Türkiye's transition to a resource-efficient, more sustainable, and green economy (MoT, 2021). The Action Plan was developed aiming at reducing the pesticides use, chemical fertilisers and anti-microbials; increasing renewable energy use; further developing organic production; sustaining water use and reuse of wastewater; and reducing food loss. Türkiye signed the Paris Agreement and developed necessary regulations to comply with it. Although there are no current policies and specific targets for agriculture, Türkiye offers to reduce agricultural emissions by fuel savings resulting from land consolidation, grazing lands rehabilitation, controlling fertilizer use, implementation of modern farming practices and encouraging the use of minimum tillage techniques in its Nationally Determined Contributions (NDCs).

Land consolidation has been implemented in Türkiye since 1961. Total consolidated area has reached 6.34 million hectares by 2023 (www.tarimorman.gov.tr,b). Agricultural areas sensitive to erosion has identified and efficient erosion control methods has been implementing in these areas (MoAF, 2021c).

It has been determined that the total amount of surface and groundwater that can be consumed technically and economically is about 112 billion m^3 per year. With the studies carried out to date, only 44 billion m^3 (39%) of this reserve can be utilized (Former Ministry of Development, 2018). The share of agriculture in water use was measured as 74.1% in 2012 and 77% in 2022, the average of last decade is 72% (Ministry of Environment, Urbanization and Climate Change, 2024). The water footprint of production in Türkiye was calculated as 139.6 billion m3 per year which consist of 64% green, 19% blue and 17% grey water footprints. Agriculture

Table 5 - Productivity and environmental indicators.

	Türkiye		*International comparison*	
	1993-2002	*2011-2020*	*1993-2002*	*2011-2020*
			World	
TFP annual growth rate (%)	0.9%	1.6%	1.7%	1.1%
			OECD average	
Environmental indicators	2000*	2021*	2000*	2021*
Nitrogen balance, kg/ha	27.8	37.9	32.2	30.4
Phosphorus balance, kg/ha	8.0	9.2	3.3	3.0
Share of agriculture in total energy use (%)	5.0	4.5	1.7	2.0
Share of agriculture in GHG emissions (%)	14.2	14.0	8.6	10.5
Share of irrigated land in AA (%)	8.0	11.7	-	-
Share of agriculture in water abstractions (%)	75.4	72.1**	46.6	49.7
Water stress indicator	18.6	26.1	8.3	7.4

*Note: * The closest available year, ** The number is average of 2012-2022 period which obtained from the relevant Ministry water use indicators (Ministry of Environment, Urbanization and Climate Change, 2024).*

Source: OECD, 2023a.

accounts for the largest share with 89% from the water footprint (WWF, 2014).

A "Program on Enhancing Efficiency of Water Use in Agriculture" was introduced in 2015 aiming to decrease the underground water use and increase the "water-saving irrigation technology" adaptation. Türkiye will continue to invest in modern irrigation systems through rural development project and credit support. Sectoral Water Allocation Plans (SWAPs), "a scenario-based evaluation of water resources, considers the usable water potential, the needs of each sector and the economic outputs of water use of the sectors under the changing socio-economic and environmental indicators". In SWAPs, projections of the water demand for the agriculture were produced (MoAF, 2021c).

National Climate Change Strategy: 2014-2023 (NCCS) was implemented to fully integrate climate change-related objectives into its development policies (MoECC, 2012). The "Strategy and Action Plan for Combating Agricultural Drought": 2023-27 was declared in 2022. The action plan was designed to implement drought-combatting activities and to minimise the effects of drought (MoAF, 2022). The General Directorate of Agricultural Research and Policies co-ordinates and support research on sustainable use of soil and water resources and climate-friendly agriculture.

Water stress in Türkiye is increasing and currently above the OECD average. Average rainfall is expected to decline due to climate change, and the increasing pressure on the hydrological system. Nitrogen and phosphorus balances have been increasing, and phosphorus balance is above the OECD average. Currently, agriculture uses 4.5% of total energy and accounts for 14% of the national GHG emissions (Table 5) (OECD, 2023a).

2.3. *EU approximation in agri-food and rural development measures*

Türkiye has been harmonising agricultural and rural policies with the EU CAP since mid-1990s and particularly since 2005 with starting of membership negotiations, but not fully accomplished. CATAK, designed to compensate farmers for environmental degradation to shift to permanent crops, has a limited alignment with the environmental acquis. EU's Common

Table 6 - Total budgetary support to agriculture.

	2000-02	*2020*	*2021*	*2022p*
Total value of production (at farm gate)	22,169	52,251	53,410	68,491
Of which: share of MPS commodities (%)	71.38	79.81	87.87	85.89
Total value of consumption (at farm gate)	22,577	56,854	62,502	74,329
Producer Support Estimate (PSE)	6,045	13,995	8,957	9,699
Support based on commodity output	5,158	6,501	7,086	7,891
Market Price Support	4,836	5,588	6,165	7,056
Payments based on output	321	913	922	835
Payments based on input use	426	6,422	748	803
Percentage PSE (%)	25.54	23.07	15.94	13.63
General Services Support Estimate (GSSE)	3,507	1,076	1,952	3,650
Agricultural knowledge and innovation system	29	64	47	34
Inspection and control	67	13	11	14
Development and maintenance of infrastructure	513	807	1,408	1,892
Marketing and promotion	2,888	192	486	1,710
Percentage GSSE (% of TSE)	36.34	7.14	17.89	27.34
Consumer NPC	1,25	1,09	1,12	1,07
Total Support Estimate (TSE)	9,552.27	15,071	10,909	13,349
Transfers from consumers	4,893	4,763	6,527	4,705
Transfers from taxpayers	4,999	11,017	5,876	8,655
Percentage TSE (% of GDP)	3.91	2.09	1.33	1.51
Total Budgetary Support Estimate (TBSE)	4,716	9,483	4,745	6,293

Source: OECD, 2023b.

external tariff will be adopted for every agricultural product. Support payments will be linked to cross-compliance standards. Veterinary policies need to fully be aligned with the EU acquis. Legislation of Common Market Organisation (CMO) should be developed and aligned. Türkiye still needs to develop a strategy for agricultural statistics and align agricultural support policy (European Commission, 2019).

An Integrated Administration and Control System (IACS) was put in place. The FADN (farm accounting data network) was integrated with the registration system. As part of rural development program, 25 local action groups under the LEADER programme were established. The intellectual property law, further implementing regulations quality policy were adopted. Organic farming legislation was aligned. There has been some progress regarding food safety, veterinary and phytosanitary policy. Food establishments fully be upgraded. Bovines and small ruminants have been identified and registered. Measures for disease outbreaks have been applied. The administrative capacity of official controls has improved. Food safety rules have been aligned. Progress on the specific rules for feed is limited. Phytosanitary policy should further be strengthened. Rules for new foods and for GMOs need to be aligned. Türkiye should adopt a fisheries and aquaculture law compatible with the EU acquis. Institutional capacity has improved further (European Commission, 2019).

The report published by OECD on support measures shows that Türkiye transfers about 16% of gross farm receipts to agricultural producers which is near the OECD average in 2020-22. This indicates a decline of transfers from 25% in 2000-02 (OECD, 2023b). However, OECD estimates that the amount of market price support (MPS) about 57%, resulted from reductions of exporters' debts and tariffs. Producer prices were approximately 11% above the border prices in 2020-22. This is primarily the result of support for beef, sunflowers, poultry, and eggs. Prices of other commodities are more aligned with reference border prices. Premium payments to producers of specific commodities are also provide. Area-based payments are granted as crop insurance and the fertiliser and diesel cost. The details of OECD estimates of agricultural support are presented in Table 6 (OECD, 2023).

General Service Support Estimate (GSSE) accounts for 4.3% agricultural production value in 2020-22, above the OECD average. The largest components of this are for development and maintenance of infrastructure, and marketing and promotion. Total Support Estimate (TSE) was 1.6% of GDP in 2020-22 (Table 6). The consumer nominal protection coefficients (NPC) declined from 1.27 in 2000-2002 average to 1.07 in 2022 indicating that consumer's access to food with a price close to the world reference prices (OECD, 2023a).

Türkiye's agricultural support budget has steadily decreased in terms of euros since 2016. However, the GDP share of the budget has been oscillated between 0.4-0.6%, less than 1% target set out in the agricultural law. Agricultural budget accounts for approximately 2.0% to 3.0% of the central government budget. According to "Agricultural Policy Model" (APM) classification, market and direct producer support payments account for the largest proportion from agricultural supports. The share of structural and rural development payments has varied between 8 and 21 percent. Market and producer support includes direct payments and input subsidies. Direct payments account for about 47% and input subsidies make up of 44% of the total payments. Other payments account for about 9% of the total payments. About 55% of the payments under the structural and rural development measures are paid for competitiveness measures. Payments for rural economy and rural population are about 35-50% of the payment on average. Environmental and societal services account for about 6% of total payments, on average. These transfers also include IPARD payments (Koç and Bayaner, 2022).

3. Policy impacts and state of food system sustainability

3.1. *Agri-food policy impacts on performance*

In literature on policy impact analysis, there are limited studies focused on economic performance of agri-food system including performance of agricultural value-added growth and competitiveness. The result of this studies is given below.

Aramyan *et al*. (2024) carried out a competitiveness study comparing five IPARD countries: "Albania, Montenegro, North Macedonia, Serbia, and Türkiye with five neighbouring EU countries: Bulgaria, Croatia, Greece, Hungary, Romania and the EU-average". In the study large number of indicators for 2015-2021 used to measure country and sectoral level competitiveness. The agri-food sector competitiveness performance of Türkiye relative to EU average (z-score) are found as -1.20, -0.84, -0.80, -0.57, -1.29, -0.22 respectively for conditions of resource and factor, demand, competition and firm dynamic, innovation-and-entrepreneurship, relating a supporting industry, and government. These results indicate aggregated level competitiveness of agri-food sector in Türkiye is relatively week comparing its main trade partner EU average. But, revealed comparative advantage (RCA) score indicates that all but milk and dairy products, cattle meat, wheat, and maize are well above threshold score level. However, RCA score is 8.2, 2.7, 3.2, 1.9, 3.4, 5.1 and 1.8 respectively for eggs, chicken meat, fruit, vegetable, tomato, pulses and processed cereal products and preparation.

Koç *et al*. (2019) estimated a spatial produc-

tion function with province level panel data including land, capital, labor, chemical inputs, policy support measures and credit use per hectare, for periods covering 2004-2014. The empirical results indicates that agricultural value-added growth depend not only on its production factor endowment, but also the agricultural supports, agricultural credits use and agricultural growth in neighbouring provinces. It was found that the main inputs improving provincial level agricultural value-added growth were fertilizer, pesticide, and agricultural credits, while agricultural supports measure has significant negative impact due to the spillover effect. Thus, domestic supports or subsidies linked to selected commodities (e.g. dairy or cotton) without considering spillover effect can potentially produce a negative impact on performance of agriculture.

3.2. *Food system sustainability indicator*

The food system sustainability drivers; economic, environmental, social, and food/nutrition dimension base on Béné *et al*. (2020) classification is given in Table 7. Some of the indicators are presented on three-year-averages to understand the evolution of the sustainability.

There is a positive development in most of the food system sustainability indicators such as irrigated land, biodiversity index, dietary energy supply adequacy and protein supply. Greenhouse gas emission has dropped slightly in percentage term while considerable increased in absolute term. Percentage of irrigated land and national park area have increased. Türkiye is one of the plant gen centres in the World, however there are 12,141 vascular plants recorded. Average dietary energy supply adequacy and average protein supply indicators have also improved during last decade. All the population have access to improved water resource and to electricity. However, especially food and nutrition indicators have not exhibited considerable improvement and it has even been exhibited slightly worsening trend in some subfood categories during last decade. However, the share of animal origin in dietary supply was 24.3 percent in 2000-2002 and 39 percent in 2020-2022 on average (FAO, 2023). In addition, household spending on food away from home has increased from about 4% in 2003 to 5.9% in 2023 (TurkStat, 2024b).

4. Discussion and Conclusion

Although, Turkish economy experienced high rates of average annual GDP growth rate for last two decades, the GDP share of the agriculture and rural development budget has been oscillated between 0.4-0.6 percent during last 20 years. Türkiye's agricultural support budget has steadily decreased in terms of euros since 2016. OECD reports that Türkiye transfers about 16% of gross farm receipts to agricultural producers. Agricultural policy measures are dominantly coupled with production and rural development programs. Rural development support measures have radically changed and increased in monetary term with IPARD. Yields of some crops and animal production have increased considerably in parallel to the increase in the input use and technological advance. Total factor productivity has also increased. Food security and food system sustainability indicators are show an improvement.

Determination of the future pathway of the agro-food policies in Türkiye will be a complex process since it requires an interaction between different actors, stakeholders and institutions in decision-making process. However, the future policy context is expected not to change remarkably.

Agro-food policies need to develop around four key themes: improving food safety and quality; transition to sustainable production system via efficient use of resources; increasing access to affordable food; and conserving soil, water, and biodiversity. Türkiye has various structural bottlenecks, such as the large number of small-sized farms and high number of plots per farm, aging farm population, capital constraints for young farmers and weak collective action among farmers.

The objectives of the Turkish agricultural policy have not changed over time. The objectives are to meet the food security, improve self-sufficiency levels, increase productivity, raise farm incomes, enhance competitiveness, develop rural areas, and harmonise policies and institutions with those of the EU.

Table 7 - Food system sustainability indicators.

Environment	Air quality	Greenhouse gas emission (%)1 2001-2003 and 2019-2021 average	13.6 13.4
	Water quality	Water pH[2]	7.0 - 8.5
	Water use	Agricultural water withdrawal (%)[3]	74
	Soil and land quality	Soil carbon content (ton C ha -1for land under cultivation)[4]	35.96
		Agricultural land use as % of arable land	62.0
		Percent of irrigated land area (2006 and 2016)	24.1 - 31.4
Biodiversity	Wildlife (plants, animals)	Benefit of biodiversity index (national park area, million km^2) (2014 and 2023)[5]	21.7 24.4
	Agrobiodiversity index dimensions	Average of 80 countries by dimension: status 56, action: 47.8 and commitments 21.4[6]	61.97, 54.32 and 10.27
	Crop diversity	Crop diversity index (vascular plants)[7]	12,141
Energy	Use	Agricultural and forestry energy used as % of total energy use[8]	4.5
Economic	Financial performance	Agricultural value added per worker ($) in 2003 and 2023	3,425 12,648
	Employment rate	Agricultural under-emplacement (%)	46.1
	Economic distribution	Gini index for land distribution	0.09
Social	Gender / equality	Labor force participation rate, female (%)	34.5
	Inclusion (national)	-Number of cooperatives (Pakdemirli, 2019) -Number of cooperative members(thousand)	11,982 3,931
		Employment in agriculture (%)	16.0
Food & Nutrition	Availability	Average dietary energy supply adequacy (percent) (average of 2000-2002 and 2020-2022)[9]	156 159
	Availability	Average protein supply (g/cap/day) (average: 2000-2002 and 2020-2022, in the parenthesis is share of animal origin)[9]	103.7 (24.3) 110.7 (39.0)
	Access (Affordability)	Food share in total household expenditure (%)	26.0
	Physical accessibility	Rail lines density (total route in km per 100 square km of land area) (2000-2002, 2010-2012 and 2018-2021)[9]	1.10 1.20 1.30
	Utilization (Water)	Access to improved water resource (%)	98.8
	Utilization (Energy)	Access to electricity (%)	100.0
	Stability (Economic)	Price volatility index (yearly CPI-2024)	67.07
	Stability (Supply)	Per capita food supply variability (kcal/pc/d) (average of 2000-2002 and 2018-2021)[9]	33.67 28.33
Food Safety	Number of cases of food-borne illness	Percentage of children under 5 years affected by wasting (%), (2004 and 2022)[9]	1.10 1.70

Food waste & use	Loss and waste	Food loss per capita (kg/year)[10]	931
Nutrition	Diet	Diet diversification	
	Undernutrition	Stunting (percentage of the population unable to afford a healthy diet, 2017-2021 average)[9]	6.82
	Overnutrition	Prevalence of obesity (%) in 2008 and 2022 (female in parenthesis)	15.2 (18.8) 20.2 (23.6)
	Nutrient deficiency	Vitamin A supply (retinol equivalents) (µg/cap/d) (average of 2010-2012 and 2019-2021)[9]	4.67 4.33
	Fruits and vegetables consumed	Number of non-consumed person as percentage of population aged 15+ (2014 and 2022)[11]	33.6 53.6

Sources: 1. OECD, 2023a; 2. Sert, 2019; 3. Ministry of Environment, Urbanization and Climate Change, 2024; 4. https://webdosya.csb.gov.tr; 5. OGM, 2023; 6. Jones et al., (2021); 7. https://nuhungemisi.tarimorman.gov.tr; 8. OECD, 2023a; 9. FAO, 2023; 10. www.tugis.org.tr; 11. TurkStat, 2023b.

Note 1: There are a total of 13 404 taxa in Turkey, 24.4% of which are endemic and 12 141 of which are vascular plants.

Note 2: indicators without references are taken form https://data.tuik.gov.tr and https://tarimorman.gov.tr.

The policies for food, health, climate, and the environment are interconnected. Therefore, a strategy should be developed at the viewpoint of the sustainable food systems approach. Policies for food and health; food, climate, and environment; and domestic and international commitments should be coherence. Future planning must take into account of the possibility of systemic risks for the future, including possible other pandemics and regional-global food security issues and climate change impact.

Designing the future agri-food and rural development policies should be based on an holistic approach that must considers international agreements and commitments, decoupling agricultural payments, improving and strengthening institutional capacity, the role of the private sector, considering health of consumer and farm workers, environmentally friendly agricultural practices, a participatory and a science-oriented approach and promoting young farmers joining to agriculture and rural development initiatives.

Agriculture in Türkiye has been seriously affected by climate change over last decades, Türkiye faces an increasing aridity and frequency of severe droughts. Current policies aim to reduce the vulnerability of agriculture to drought while encouraging the production of water-intensive crops. More support should be given to research and development (R&D) of drought-resistant varieties and water use efficiency. Total factor productivity growth can be enhanced by gradually increasing the farm size, better farm management, and innovation through R&D, extension and consultancy services, farm income risk management and ensuring commodity price stability.

Agricultural policies strongly influence the production decisions of farmers. State enterprises are still important in the agri-food marketing system for some commodities. Planning agricultural production and commodity-specific coupled support should be replaced by decupled policies that improve the competitiveness, efficiency, and sustainability of production for a sustainable food system.

There are several policy documents in Türkiye. However, a need assessment for support policy development is still required based on the international agreements and the current situation of agriculture and farm holdings. Areas of required legal arrangements, intervention, improvement, and competitiveness should be determined and policy should be developed to close the gap. Payment or incentives should be directed to main structural problem areas instead of dividing it to so many different purposes. EU

policy frame can be a reference guide for this.

Nearly all the "United Nations Sustainable Development Goals (SDGs)" are linked either directly or indirectly to the food system: food security, responsible consumption and production, climate action, life below water, and life on land related directly to environmental sustainability. As a result, agri-food policy should address these goals effectively.

Although there is a positive development in most of the food system sustainability indicators, especially some of the indicators such as food and nutrition indicators need to be improved. Existing policy evaluation and impact assessment system and data base should be further improved and updated for monitor and evaluate sustainable food system.

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Agrifood policies and challenges of the agrifood system in Egypt

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Abstract

Agrifood policies shape the different stages of the Agrifood sector from production to consumption. In Egypt, the agrifood sector is a key player in the Egyptian economy providing jobs and income, mainly for rural and vulnerable households. Though the system is not on full potential and face several challenges. Challenges include climate change, water and land scarcity, rising population, poverty and inequality. Over the years, several agrifood policies had been implemented to overcome these challenges. Agriculture and food subsidies, land tenure and crop procurement are the main policies applied by the Egyptian government. Instead of the drawbacks of some of the policies in the sector, Egypt succeeded in increasing agricultural production and ensuring access to food.

Keywords*: Agrifood policies, Agriculture production, Agro-processing, Food subsidies, Food consumption.*

Introduction

Egypt is a food import dependent country with cereal dependency ratio was more than 40 percent. Instead of the economic growth achieved in Egypt with a GDP per capita of 11,566 constant 2017 International USD, poverty and food security remains a challenge for the development of the country. Among Egyptians, 29.8 percent are considered as poor and 7 percent are considered undernourished (FAOSTAT, 2024; CAPMAS, 2024).

With 57 percent of the population in rural areas and concentration of poverty in rural areas, agrifood sector in Egypt is a key player in the economy to ensure food and income to vulnerable individuals. Agriculture, forestry, and fishing represent around 11 percent of GDP value added and employs around 19 percent of total employment in 2022 (World Bank Group).

Several Agrifood policies had been implemented over the years to ensure food security for the growing Egyptian population. Policies as food and agricultural subsidies, land use policies, trade agreements, and food safety regulations shape Egypt's Agrifood system. Agrifood policies attempt to overcome the challenges faced by the sector as climate change, smallholdings, limited access to information and technology and food dietary habits (Gouell and El-Miniawi, 1994; FAO, 2023). With Egypt's vision 2030, the Egyptian government policies aim a radical transformation of rural areas and improvement of rural livelihoods to achieve rural development and ensure decent life in rural villages. The "DECENT LIFE" initiative targets 4,500 villages for investment in infrastructure and public services, the establishment of agriculture services centers, development of irrigation shops, canals and markets (Ministry of Planning and Economic Development, 2024).

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However, the agrifood system in Egypt is challenged by the growing population, limited resources climate change and global uncertainty as what was observed during the food crisis of 2008, the COVID-19 pandemic, and the Russo-Ukrainian war.

The present chapter overviews the Agrifood system in Egypt (section 1) with a discussion of the different policies implemented over the years (section 2). Section 3 concludes.

1. Overview of the agrifood sector in Egypt

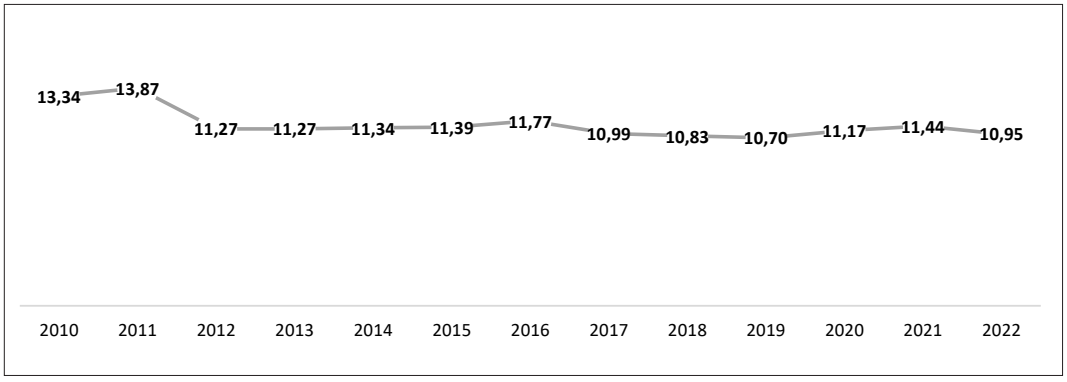
The Agrifood system is a key pillar of the Egyptian economy playing a prominent role in job creation, poverty reduction and ensuring food security. The system can be divided into several stages: input production, agriculture production, agro-processing and trade and services. The Agrifood system accounted for 24.2 percent of GDP in 2015. The food processing activities are concentrated in Lower Egypt, with 78.3 percent of food processing gross output. While Upper Egypt is the main player of primary agriculture with a contribution of 30.2 percent to agricultural gross output. The sector is characterized by a dominant presence of SMEs representing at least 90 percent of the Agrifood production and export firms. Agrifood SMEs generate more than 90 percent of employment in the sector. However, they are more vulnerable to external shocks because of their size, lower productivity and limited access to resources and finance (IFPRI, 2018; Abu Hattab *et al*., 2021).

Agriculture Sector

The agriculture sector is the third largest sector in the Egyptian economy, with a value added around 10.95 percent of the Egyptian GDP and around quarter of the Egyptian population working in the farming and fishing industries. This share was stagnant since 2012, but increased during the COVID-19 pandemic. The sector was considered as the most resilient sector during the pandemic with a share of value added of 11.44 percent of GDP (Figure 1). In the FY 2020/2021, the sector attracted 6.8 percent of total implemented investment. It is the fourth sector after transportation and storage, real estate and manufacturing sectors (General Authority of Investment and Free Trade, 2022). The role of the agriculture sector differs geographically, with a higher share of employment in agriculture in Upper Egypt governorates, while Lower Egypt has a relatively higher share of GDP from agriculture (Kassim *et al*., 2018; Rocha *et al*., 2023; USAID, 2024; FAO, 2023).

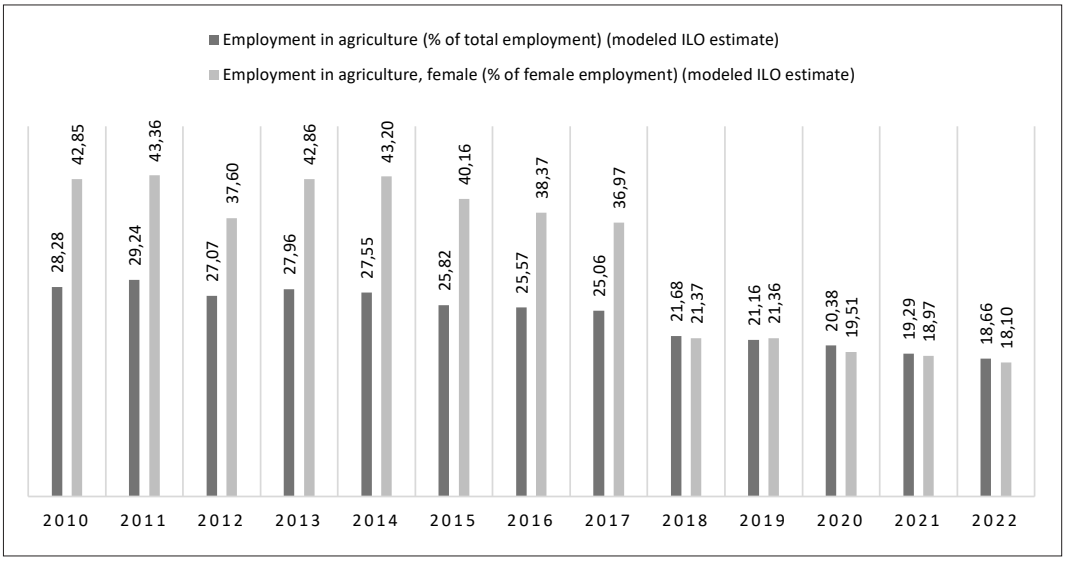
Agriculture used to be a major source of wage and self-employment in rural Egypt. In 2010, employment in agriculture counted for 28 percent of total employment. This share decreased over the years to reach 18.66 percent during 2022. Similarly, for female employment, with female agriculture employment was around 43 percent of female employment in the same year. However, this share decreased over time to reach around 18 percent of female employment in 2022 (Figure 2).

Figure 1 - Agriculture, forestry, and fishing, value added (% of GDP).



Source: Word Bank Group, 2024.

Figure 2 - Employment in Agriculture (2010-2022).



Source: World Bank Group, 2024.

This decline in the share of agriculture in total employment can be attributed to several factors, including the increase in worker productivity, rural-urban migration for better economic opportunities, and the diversification of the Egyptian economy towards industry and services. However, the agriculture sector remains the third most important sector in terms of GDP and main source of income for the low-income households, with a growth rate of 10.8 percent in the FY 2021/2022 (General Authority of Investment and Free Trade, 2022).

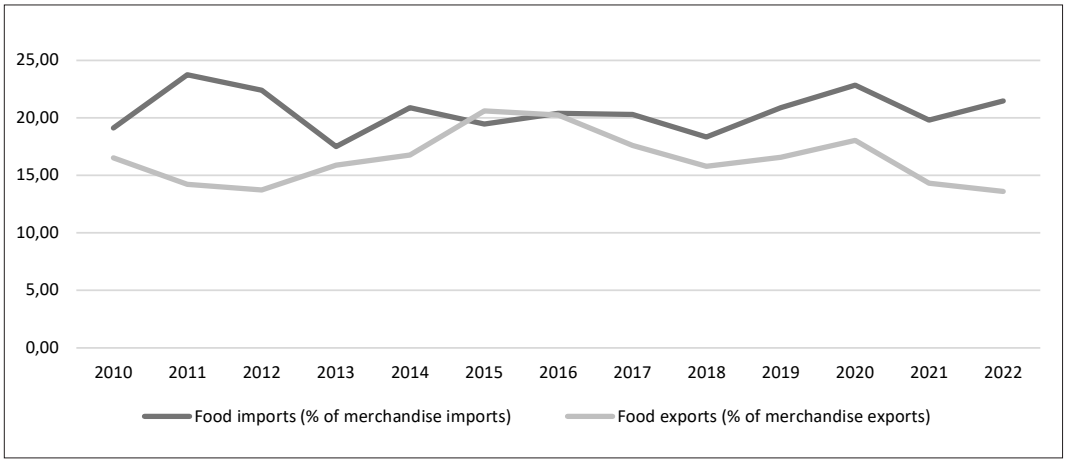
The agriculture production in Egypt is concentrated around the Nile River and the sector is dominated by smallholdings, with less than 1 hectare, supported by irrigation systems. Egyptian farmers cultivate around 4.6 million ha annually along the Nile River, and 2 million ha are cultivated in new lands in the desert. Around 80 percent of the cultivated area is covered by wheat, clover, rice and cotton. Cash crops as cotton and cereals as wheat are mainly used in the industrial sector as raw materials (Khalaf, 2017; World Bank, 2022).

Food and Beverage Sector

The Egyptian agriculture sector is characterized by strong backward and forward linkages with the rest of the economy. As a result, the food sector is one of the top five sectors with high labor absorption potential, with 13 percent of total non-petroleum exports, 500 Milliard EGP investment in the sector and 5,200 industrial institutions. The food and beverage sector is the first sector in employment and the second top industry by manufacturing value added, with 21 percent of value added in manufacturing in 2019 (FAO, 2024a). The sector employs over 750,000 individuals; this corresponds to around 35 percent of jobs in the manufacturing sector and approximately 16 percent of the overall labor force in the country's direct employment. Meanwhile, indirect employment in the Agrifood sector was estimated at approximately 2.25 million workers (Kamel and El Bilali, 2022; Rocha *et al.*, 2023; USAID, 2024).

The sector ranks the third one in terms of exports. Egypt exports high-quality but low value-added agriculture products. The sector represents a major source of foreign currency. However, Egypt is considered as a net food importer with food imports representing 21.48 percent of total merchandises in 2022, compared to food exports that represent around 13.61 percent of total merchandise (Figure 3).

Figure 3 - Food Exports and Imports (% of total merchandises) - 2010 to 2022.



Source: FAOSTAT, 2024.

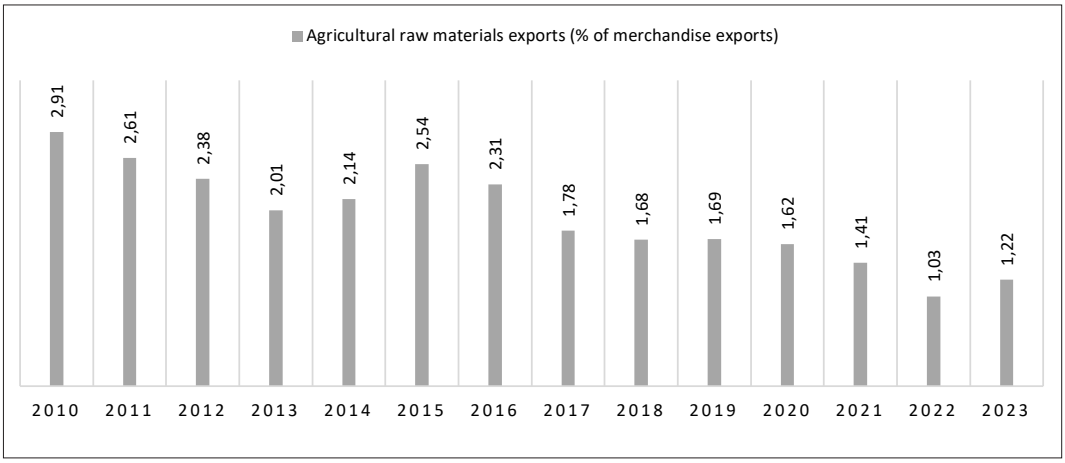
The food trade deficit balance is explained by the rising population with a population growth rate of 1.6 percent, putting pressure on food supply and widening the food supply-demand gap. Dependence on food, mainly cereal imports increased, with cereal dependency ratio is higher than 40 percent. The dependence on food imports leaves the country vulnerable to any fluctuation in international food prices, to external shocks and to any interruption in the global food supply chain. This was observed during the Food crisis of 2008, the COVID-19 pandemic and the Russo-Ukrainian war.

The country exports mainly raw products as cotton, fruits and vegetables, herbs and spices and imports intermediate and final products (Kamel and El Bilali, 2022; Rocha *et al*., 2023; USAID, 2024; Embassy of Switzerland in Egypt and UNIDO, 2022) (Figure 4). The value added of the Agrifood system is low and below the potential of the sector. Based on the estimates of the Oxford Business Group (2022), Egypt processes less than 10 percent of its fresh production and exports less than 1 percent of its processed products. Additionally, the Egyptian Agrifood sector suffers from high transaction costs because of the weak linkages between producers and processors, informality, and asymmetric information. Although Egypt is one of the world's leading producers of fruit and vegetables and the world's largest exporter of fresh citrus, Egypt is not on the list of top food processors for any of these items (Embassy of Switzerland in Egypt and UNIDO, 2022). Smallholders, who represents a majority of the domestic agriculture production, have limited access to the global value chain because of the competition and the quality and safety requirements. They are mainly poor, with small land area and limited access to technology and to market. They are forced to sell their products through the traders, most of the time without a legal contract. Additionally, the Egyptian food-processing sector is dominated by SMEs, which limits the benefits of economies of scale, leading to the manufacturing of products of sub-optimal quality and packaging. This might explain the low value added in the global value chain (Abu Hatab *et al*., 2021; Kamel and El Biali, 2022).

Food Consumption

Egyptians have diverse dietary habits, with staples like bread considered as a significant component of the Egyptian food basket. The share of dietary energy supply derived from cereals, roots and tubers is around 66 kcal/cap/day in 2018/2020. The increasing income resulted in an increase in protein consumption, processed food, imported goods and caloric restriction, mainly among the high-income households. While for the low-income households there is a heavy consumption of fats and sugars, mainly

Figure 4 - Agricultural Raw Materials (% of merchandise exports).



Source: Word Bank Group, 2024.

because of the food subsidies policy. The subsidy system covers around 73 percent of the Egyptian population. Subsidized bread is key component of the Egyptian households' food basket, produced mainly from imported wheat. Egypt is the first wheat importer worldwide, spending around 3 billion USD yearly on wheat imports. With soaring international wheat price, the subsidies budget imposes more pressure on the government's budget (Kamel and El Bilali, 2022; Ben Hassen and El Bilali, 2022).

Food expenditure represents more than 30 percent of total expenditure of low-income households. This important share leaves the poor households and their food security vulnerable to any price or economic shocks as what was observed during the COVID-19 pandemic. According to the Economic Research Forum's MENA COVID-19 Household Survey data; around 48 percent and 46 percent of the 2,007 households surveyed were unable to buy the usual amount of food due to increased prices and lower incomes, respectively. While 44 percent had to reduce the meals or portions they usually eat. And around 21 percent of households were unable to purchase the usual amount due to food shortages. These percentages are higher among individuals living in rural areas.

Recently, the Russo-Ukrainian war and the currency depreciation resulted in soaring food prices, putting more pressure on household's purchasing power and threaten food security. Food costs in Egypt increased by estimated 17 percent in 2022 (Ben Hassen and El Bilali, 2022). According to the World Bank (2023) forecast, food inflation accounted for 24 percent to 33 percent of the prevalence of food insecurity in the MENA region. In Egypt, 27.5 percent of the population are considered as moderate or severe food insecure (FAOSTAT, 2024). The combined effect of the food, fuel, and fertilizer shocks had dire effect on rural households who mainly depend on agriculture as a source of income. An estimate of 13 percent of the population may suffer from a deterioration in diet due to deprivation of one of the food groups such as grains, fruits, vegetables, dairy products, protein foods and added fats (Abay *et al*., 2022).

2. Agrifood policies and challenges faced by the Egyptian agrifood sector

Agrifood policies shape the different stages of the agrifood sector from production to consumption. The implemented policies and strategies, since 1950s, were characterized by a dominant role of the government and public sector in the different stages of the food supply chain. The aim was to ensure equitable distribution of income and affordable food to urban areas from rural and peri-urban areas. Policies include land reclamation for agriculture, investment in irriga-

tion infrastructure, price control, crops rotation, areas allocation and agriculture input and food subsidies. Government's control over producer prices and crop procurement is a key agrifood policy instrument used by the Egyptian government since the 1950's. These policies aimed to guarantee enough production from strategic crops such as wheat and to ensure food security. Agriculture subsidies as fertilizers, credit and pest control had been provided by the government to encourage adoption of new technologies and reduce risks, mainly for small farmers. The agriculture cooperatives play a significant role in these policies. However, these policies resulted in a decline in yields and exports. The dependence on imports increased and the rural-urban gap increased. Land reform measures applied in the 1950s, and the cumulative effects of inheritance laws, resulted in land fragmentation. Egyptian agriculture sector is characterized by smallholdings that hinder the farmer's ability to benefit from economies of scale and the implementation of new technologies (Gouell and El-Miniawi, 1994; FAO, 2023; World Bank, 2023; Salem *et al.*, 2024; Kassim *et al.*, 2018).

Over the years, with structural reform programs, the role of the public sector diminished leaving more space to private sector to drive growth and job creation in the agrifood sector (FAO, 2023). There were two agriculture policy reform programs implemented since late 1980s: the Agricultural Production and Credit Project (1987-1995); and the Agricultural Policy Reform Program (1996-2002) (Kassim *et al.*, 2018). The reforms consisted of removing price controls, input subsidies, crop areas control, crop procurement and control of private farm processing and marketing. Regarding trade policies, there was a reduction in the maximum tariffs and adjustments of non-tariff barriers. In addition to comprehensive research and extension programs that developed new high yield crop varieties. These policies resulted in the increase of income, productivity and the Egyptian sector's exposure to the international competition. Moreover, major shifts in cropping pattern were observed. The area devoted to cotton decreased from 15 percent of total cropped area to only 8 percent. While the area devoted to fruits increased by 165 percent over the same period. And areas devoted to winter vegetables increased by 94 percent and summer vegetables increased by 32 percent (Gouell and El-Miniawi, 1994; FAO, 2023; World Bank, 2023; Salem *et al*., 2024).

More recently agrifood policies focus on crop improvement and crop variety development through research to increase crop yield, improvement of storage capacities, and reduction of transaction costs. The policies aim to increase the Egyptian sector's participation in high value global value chains and to increase the competitiveness of agricultural products in the international markets. These objectives are reflected in the Sustainable Agricultural Development Strategy towards 2030. The strategy aims to ensure food security, decrease dependence on imports and increase exports. The strategy promotes the sustainable and efficient use of natural agricultural resources, land, water, increasing agricultural investment and achieving rural development (Kassim *et al*., 2018; FAO, 2024b).

Agrifood policies and measures are used to overcome challenges faced by the agrifood system in Egypt. These challenges include climate change, energy, water and land scarcity, poverty, increasing population and increasing dependence on imports.

Climate Change and the agrifood sector

Egypt is highly vulnerable to climate change, among the top five (African Union, 2023). Climate change characterized by high temperature, water scarcity, limited precipitation and CO^2 emission threaten the different stages of the agrifood sector in Egypt. The environmental considerations might jeopardize the different dimensions of food security in the country.

Food availability is expected to be affected by climate change. Increasing temperature and variation in precipitation rates would result in a decline of several crop yields, with an estimated decline of wheat production by 15 percent, rice by 11 percent and maize by 19 percent by 2050 The delta region, where agriculture production is concentrated, is expected to lose around 30 percent of its food production by 2030. Though, cotton production is expected to increase by 17 percent by 2050 as a result of the increasing tem-

perature (Perez *et al*., 2021; UNFCC, 2022; Abu Hatab, 2023; UNDP, 2023).

Limited water resources are one of the key challenges facing-the agrifood system in Egypt Droughts, floods and water scarcity have negative drawbacks on agriculture and food production. The used irrigation system, the extensive rice cultivation and intensive agricultural production techniques put more pressure on the already scarce water resources. Available water from Nile River, the main source of irrigation, is expected to vary with the increasing temperature, rising sea level and the Grand Ethiopian Renaissance Dam (UNDP, 2023).

Several laws and policies were implemented to consider environmental aspects and the negative impact of climate change on agriculture and natural resources. Egypt achieved a significant progress in climate change adaptation. Adaptation measures include change in sowing dates, in crop patterns and switching to heat and drought tolerant crops (African Union, 2023). Egypt's 2014 Constitution includes several environmental laws, as Law No. 48 of 1982 on protection of the Nile River, and its amendments and Law No. 12 of 1982 on irrigation and drainage, and its amendments. The government had regulated rice production and encouraged shifts from the flood to pressurized irrigation in old land to control the drain of water supply. In the extended reclaimed land in the desert, new efficient irrigation technologies are implemented. In 2021, a new law on water resources and irrigation was approved by the Parliament. The law imposes penalties on farmers who do not respect the specified area of land cultivation (Perez *et al*., 2021; UNFCC, 2022; FAO, 2023; Abu Hatab, 2021; El Nour, 2024).

Other resources challenges include land and energy. Soil degradation resulting from the intensive agriculture practices and informal urbanization are other significant challenges to agriculture production. In 2018, the Parliament amended the Agriculture Law and impose more strict penalties for informal construction on agricultural land (El Nour, 2024). Several reforms of energy subsidies have been implemented to face energy scarcity, limit wasteful consumption and ensure transition to clean energy. Moreover, the Sustainable Development Strategy of Egypt 2030 seeks a series of institutional and legislative reforms to ensure efficient management of natural resources as water and to promote sustainable consumption patterns. The strategy accounts for environmental consideration and encourages the participation of the private sector and civil society (UNDP, 2023).

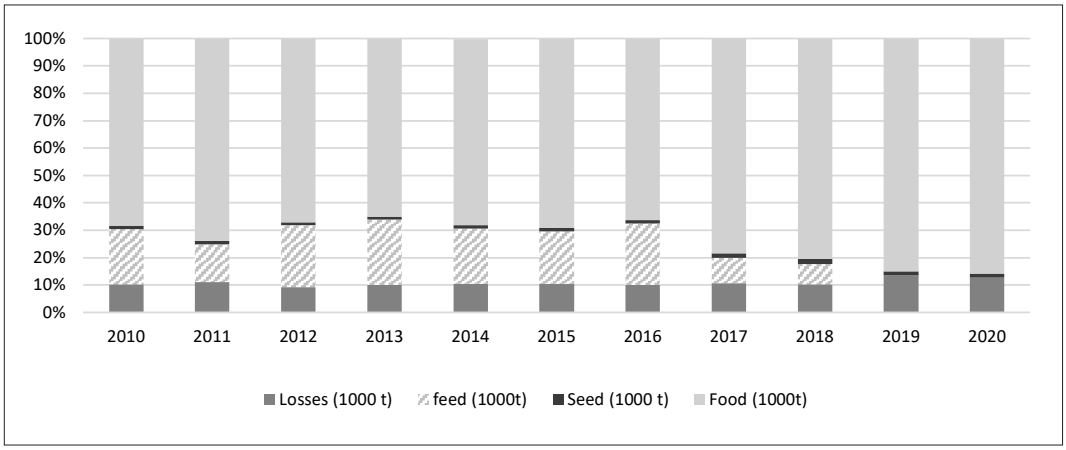
The decline in agriculture and food production, from climate change, would result in an increase in food prices, limiting the economic access to food. Additionally, vulnerable farmers in rural areas affected by climate change might lose their income, sell their assets and fall into poverty as a result of climate change (Ibrahim and Ramadan, 2023). The Egyptian government applied several measures and policies to ensure food consumption, mainly for poor households. These policies will be discussed in more details in the next sub-section.

Poverty and Food Subsidies

Socio-economic challenges such as poverty, rural-urban migration, and income inequality threaten food security in Egypt, mainly economic access to food. Poverty is concentrated in rural areas and food expenditure represents more than 30 percent of poor household total expenditure.

Several agrifood policies focus on consumption to ensure food security. Food subsidy system is a key food policy in Egypt, implemented since the Second World War to ensure access to basic food items. It has been considered an effective social safety tool for protecting the poor, mainly during times of economic hardship. The Egyptian food subsidy system plays a major role in reducing poverty and ensuring food security. Estimates show that poverty would increase by 3 percent if the food subsidy system is eliminated (El-Laithy, 2020). However, food subsidies constitute an important burden on the government's budget. Food subsidy budget was 32 percent of the total subsidy budget in the 2016/2017 fiscal year (Ministry of Finance, 2017). Throughout time, a variety of problems plagued the food subsidy system including ineffective targeting, leakage and waste and dependence on imports. The subsidized food products are energy-rich, but nutritionally poor in carbohydrates such as

Figure 5 - Wheat uses 2010-2022.



Source: FAOSTAT, 2024.

cereals, wheat and sugar. Excessive consumption of subsidized foods in Egypt leads to high levels of overweight (45 percent) and high levels of malnutrition (a quarter of Egyptian children) (Smulders *et al*., 2013; SOLIDAR, 2013; Breisinger *et al*., 2013; Ecker *et al*., 2016; Ramadan, 2015 and UN-ESCWA, 2015).

The Egyptian Government intervention in the different stages of the subsidized products supply chain distortions the market, creating a complex system of price controls, compulsory procurement, and controlled distribution through government outlets (Gouell and El-Mikawi, 1994). As discussed by Ramadan and Thomas (2011), such intervention prevents the economic agents from having their expected response, reducing the beneficial effect at any stage and limiting its effects passing through to other agents at other levels of the chain. The intervention in the bread supply chain over the years, resulted in the leakage of the purchased wheat to the black market and as animal feed instead of reaching the targeted population (Figure 5).

The high cost of the system and its ineffectiveness due to excessive waste and the lack of precise targeting of those who are eligible, and the rise in international prices for wheat and various food products, shed the light on the importance of reforming the Egyptian food subsidy system.

Since 2014, many reforms had been implemented to the system. These reforms include liberalizing the subsidized products supply chain, especially the local bread supply chain. This reform ensures that consumers are the main beneficiary of the subsidies. Bread subsidy is not universal anymore. The new bread system consists of providing 150 subsidized loaves of bread per month per individual for households who have bread ration cards. The new system provides a more balanced diet by offering 33 different products, allowing consumers to choose products that match their preferences and needs. Additionally, the beneficiary database was updated and revised to reduce inclusion and exclusion errors (Abdallah and El Shawarby, 2018; FAO, 2015).

Supply-Demand Gap in an uncertain world

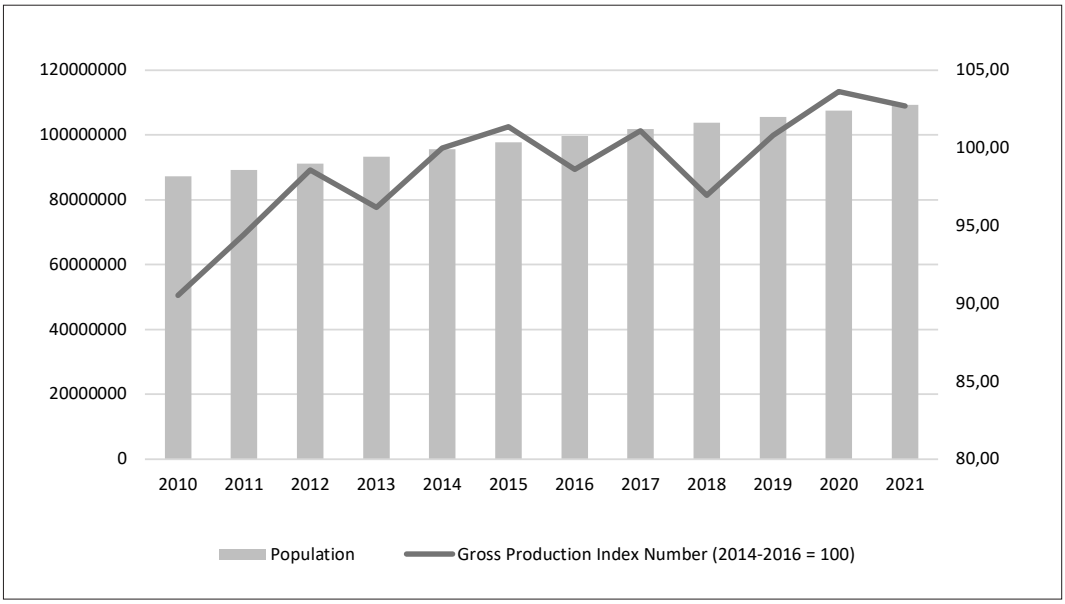
The local agricultural production is not sufficient for the rising consumption. Egyptian population annual growth rate is 1.5 percent, with total population reaching more than 100 million Egyptians in 2021. Agricultural production is varying over time. In 2021, Gross Production Index increased to 102.70 compared to 90.53 in 2010, with 2014-2016 as base year (Figure 6). This increase in agriculture production is not sufficient to provide enough food supply for Egyptians, mainly during crisis.

Figure 7 shows the variation of food supply per capita per day. It had been declining over years since 2008. The supply-demand gap increases dependence on imports, leaving the

country vulnerable to any disturbance in the global food value chain and fluctuations in international food prices. This was observed during the different crisis over the years, as the food and fuel crisis of 2008, the COVID-19 pandemic and the beginning of the Russo-Ukrainian war. In 2008, the government's reaction to the food price crisis consisted of expanding the food subsidies system to protect the poor from any rise in food prices. Other measures include increasing the wages of public employees, reducing tariff rates on several commodities, and banning rice exports (UN-WIDER, 2015). During the pandemic, the precautionary measures and policies implemented disrupted the different stages of the food supply chain, locally and globally. These measures threaten food security with negative drawbacks on agriculture production and the livelihoods of poor households. Individuals limited mobility and income loss negatively affected food access, physically and economically.

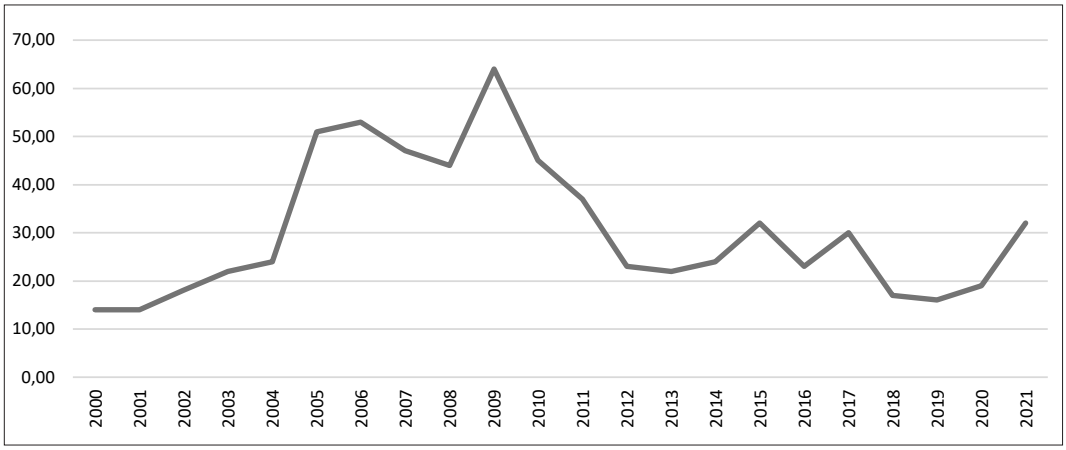
As a result, several policies were implemented to mitigate the negative drawback on the different dimensions of food security. Policies include the delay of agricultural taxes, new credit facilities to farmers, economic stimulus package to SMEs in fish, poultry and livestock and expanding existing social protection programs as Takaful and Karama programs. Additionally, the government invested in new silos and modern storage capacities to reduce the grains waste. The low level of the technology used in the different operations, poor infrastructure and storage are important drivers of the losses at the different stages of the value supply chain. Loss in the Egyptian food production is estimated at 14.2 percent. Losses in wheat, a strategic crop in Egyptian diet, is around 13 percent. The Egyptian government increases investment in land reclamation and cultivation and infrastructure project in the agricultural sector. These projects include field irrigation improvement projects and high-tech storage silos. As a result, the wheat cultivated area exceeded 3.4 million feddan, and the grain silos capacity doubled to enhance food availability (FAO, 2020; Salem *et al.*, 2024). As showed by Figure 7, food supply per capita started increasing since 2020, reflecting the positive effects of the different new policies and investment in the sector.

Figure 6 - Egyptian Population and Agriculture Gross Production Index.



Source: World Bank Group, 2024 and FAOSTAT, 2024.

Figure 7 - Per capita food supply variability (kcal/cap/day).



Source: FAOSTAT, 2024.

3. Concluding remarks and future directions

The chapter overviews the agrifood sector in Egypt and its different stages, agriculture production, food and beverage industry and food consumption. Egypt's agrifood system faces various challenges but also presents opportunities for growth, job creation and food security. Several agrifood policies had been implemented over the years to ensure food availability, access to food and to address the challenges faced by the sector as climate change, poverty and vulnerability to food imports.

Since 1950, the agrifood policies were characterized by a dominant presence of the government and public sector. Policies as land reforms aimed to reduce inequality. Though this policy resulted in land fragmentation and smallholdings. Similarly, food subsidy, the key instrument of the Egyptian agrifood policy resulted in price distortion and poor diet habits for poor households. However, over the years, several reforms had been implemented. The reforms are characterized by a shrinking role of the public sector leaving space to the private sector to lead job creation and economic growth.

Different new laws, regulations and investments had been implemented. As a result, Egypt succeeded in increasing agricultural productivity, cereals storage capacity and access to basic food items by vulnerable households. The agriculture sector in Egypt is a resilient sector, but the agrifood sector is still not on full potential. Egypt is mainly located in the downstream stage of the global supply chain.

More policies and measures are required to increase investment and innovation in the sector and increase its contribution to the global value-added supply chain. Climate Smart Agriculture and strategies resilient to climate change are necessary to ensure the sustainability of the agricultural production. Investments in rural development, nutrition, education programs and increasing small farmers' access to technology and information would increase their productivity, their income and their resilience. Reducing transaction costs and increasing investment in infrastructure for distribution and storage would increase food availability and affordability and enhance food security.

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Agri-food policy trends in Algeria: Selected explorations

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Abstract

This study addresses the urgent need to enhance food security in Algeria, exacerbated by nearby economic and geopolitical instabilities. It investigates six critical challenges, beginning with an overview of agricultural settings in Algeria. First, it questions the prioritization of strategic sectors, compelling a thorough reevaluation. Second, it highlights ongoing rural development issues, emphasizing insufficient investments in infrastructure. Third, it addresses price stability management by reconsidering the efficacy of different storage mechanisms. Fourth, the study examines agrarian structures, advocating for a meticulous evaluation to optimize land market efficiency. Fifth, it explores irrigation water management, questioning concerns of abundance and scarcity. Lastly, it confronts climate change challenges, emphasizing the need for more resilient agricultural practices. By analyzing these fundamental aspects, this study aspires to offer insights that can inform strategic policies and public interventions, ultimately contributing to the enhancement of Algerian food security in light of current and future challenges.

Keywords*: Food security, Food policy, Trends, Challenges, Agricultural development, Algeria.*

1. Introduction

The geopolitical scene in the Mediterranean is undergoing instabilities that directly affect the agricultural sector in the region (Abis & Demurtas, 2023). Addressing food security in Algeria has become increasingly urgent, given the current alarming situation marked by economic deterioration and international political changes. Although the government has prioritized food security in its public policy objectives since gaining independence in 1962, the academic discourse on this subject is gaining momentum. Traditionally, food security has been examined through historical analysis,[1] focusing on post-independence events and occasionally exploring further back into the colonial era. Recent studies, such as those by Bouzid *et al*. (2022), Bessaoud

[1] In terms of historical and exploratory analysis, with a specific focus on underlying questions, noteworthy academic works include those by Henni (2009) and Bedrani (1982). These comprehensive studies extensively document various facets of Algerian agriculture.

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et al. (2019), Adair *et al*. (2022), and Sahali *et al*. (2016), contribute significantly to the evolving understanding of food security in this respect. Some studies adopt a sector-specific approach, as seen for example in the works of Makhlouf *et al*. (2015) and Bekkis *et al*. (2022).

Primarily, it is imperative to acknowledge the well-established fact that the contemporary challenges a nation faces are strongly tied to its complex historical narrative. Disregarding this hinders comprehensive understanding. Secondly, honing in on a specific aspect of the broader issue proves to be the most effective approach for arriving at more accurate conclusions. Nevertheless, the current emphasis in this study diverges from comprehending the issue of food security in Algeria through these approaches. Instead, this study shifts the focus to the present, aiming to provide a concise summary of the predominant challenges today – a structured inventory resembling a to-do list. This pragmatic shift aims to stress the importance of providing a big picture of the prevailing major issues as formidable hurdles that must be addressed to enhance the country's food security situation.

Up until the tumultuous events of the bloody decade in the 1990s, successive governments prioritized food security as an objective within their developmental plans, subject to periodic evaluations. However, it is evident, based on Swearingen (1992) estimation, that the intended objective was not realized. Post this period, Algeria embarked on a policy initiative geared towards enhancing national food security, with a focus on the development of specific priority agricultural sectors and land utilization (Bessaoud *et al*., 2019). What can we say again about the results in terms of food security dimensions? Assessing the outcomes in terms of food security, it is apparent that considerable work and effort are still required across various domains, as highlighted in studies by Bouzid *et al*. (2022), Daoudi & Bouzid (2020), particularly concerning both quantitative and qualitative aspects.

This study aims to present, albeit not exhaustively or in exhaustive detail, some significant contemporary challenges facing Algerian agriculture nowadays with the goal of enhancing food security. The identified issues encompass rural development concern, strategic sectors priorities, farm prices stability, agrarian structures, irrigation water resources, and the climate change. The approach adopted here is straightforward, simple, and succinct. Each point directly addresses a specific problem, followed by a solution for consideration, at least at the conceptual level. This deliberately sidesteps the conventional complexities associated with a nation's food security, with the hope that these concise reflections will provide a foundational framework for more detailed elaborations on each covered aspect.

2. Algerian agriculture: An overview

At first, it seems useful to get the big picture on the Algerian agriculture in terms of some key aggregates. Table 1 displays the key aggregates of the Algerian agriculture in the last two decades, namely 2000 and 2022. These figures are obtained mainly from FAO (2023) statistics[2].

Over the past two decades, there has been a significant shift in population distribution. The urban population has almost doubled, increasing by 79.6% from 18.68 million in 2000 to 33.57 million in 2022, while the rural population has decreased by 9.4% from 12.49 million to 11.32 million. However, the number of individuals employed[3] in agriculture has risen by 127.3% from 1.28 million in 2000 to 2.91 million in 2022. This indicates a growing reliance on agriculture for employment, driven by the need to sustain food production for a growing population despite urbanization trends.

The agrifood trade figures reveal a concerning trend: agrifood exports as a percentage of

[2] Official website https://fao.org/faostat/en/#data.

[3] Data on employment in agriculture are provided form The Arab Organization for Agricultural Development (AOAD, 2023).

Table 1 - Some key aggregates of the Algerian agriculture in 2000 and 2022

Aggregates		*2000*	*2022*
Population	Urban	18.68 millions	33.57 millions
	Rural	12.49 millions	11.32 millions
	Agricultural Labor	1.28 millions	2.91 millions
Agrifood exports (%) of total exports		1.14%	0.82%
Agrifood imports (%) of total imports		21.07%	28.90%
Agricultural Lands (ha)	Arable land	7.66 millions	7.53 millions
	Land equipped for irrigation	0.60 millions	1.38 millions
Crop share in agricultural production value (%)		48.33%	68.38%
Livestock share in agricultural production value (%)		51.67%	31.62%
Value added (agriculture, forestry and fishing)		4.6 million USD	24.4 million USD

total exports have decreased by 0.82%, while agrifood imports have risen by 28.90%, highlighting a growing dependency on imported food and posing challenges for food security. Additionally, the area of arable land has slightly decreased by 1.7%, but the land equipped for irrigation has more than doubled, reflecting efforts to improve productivity through better water management. The composition of agricultural production value has shifted significantly, with the crop share increasing by 41.5% and the livestock share decreasing by 38.8%, indicating a strategic focus on crop cultivation.

From this analysis, the big picture can display these major challenges and concerns: the dramatic increase in the urban population, coupled with the decrease in the rural population, underscores a strong urbanization trend. This presents a challenge for maintaining agricultural productivity in rural areas, as it may result in a shrinking rural workforce. Despite this trend, there has been a substantial increase in the number of individuals employed in agriculture. This suggests that agriculture remains a vital source of employment for a significant portion of the population, highlighting its importance in sustaining food production for the growing population (45.6 million in 2023). The agrifood trade figures indicate also a concerning trend. The percentage of agrifood exports relative to total exports has decreased by 28.1%, while agrifood imports as a percentage of total imports have risen by 37.1%. This growing dependency on imported food products poses a significant challenge for food security and self-sufficiency.

3. Strategic sectors choice: Reevaluating priorities

The strategic sectors chosen in Algerian public policies have consistently reflected the prevailing patterns of large-scale food consumption. It is noteworthy that, despite the absence of a comprehensive list of these products or sectors within regulatory frameworks, the selection has consistently prioritized public support for fundamental sectors. Among these, the primary focus has been on durum wheat, soft wheat, potatoes, and milk. This strategic choice is underpinned by the substantial influence these particular products exert on the daily dietary preferences of the typical Algerian consumer. The decision to prioritize these sectors aligns with the recognition of their significant weight in the typical Algerian daily basket of goods. These sectors are heavily subsidized, reflecting a policy orientation towards output support to ensure these essential goods are affordable for the population (Makhlouf *et al*., 2015).

The objective here is not to challenge the existing choices, which are indeed legitimate given

the strategic importance of the selected sectors. Rather, the focus is on reevaluating priorities and considering an alternative perspective. This involves incorporating sectors based on their alignment with production potential and local heritage. In essence, the aim is to emphasize, as a priority, sectors that exhibit high production potential, align with the country's inherent vocation, and are naturally and historically adapted to Algeria's diverse bioclimatic conditions. Particularly when considering the Northern region of the country, priority sectors should include the vineyard, dates, orange, olive, fig, and apricot for fruit cultivation. Likewise, for vegetable production, emphasis should be placed on crops such as artichoke and garlic. In terms of livestock breeding, sheep meat emerges as another sector deserving high priority. Moreover, the ongoing conversion toward Saharan agriculture will pose other options. This shift in perspective recognizes the importance of aligning agricultural priorities not just with current large-scale consumption patterns but also with the innate potential of the land and the preservation of local heritage. By focusing on sectors that inherently thrive in Algeria's bioclimatic conditions, this approach aims to optimize production efficiency while respecting the historical and environmental contexts of the country. It signifies a different approach that considers the natural strengths of the region and seeks to harmonize agricultural priorities with the rich heritage and ecological characteristics of the country.

Compiling a pertinent, comprehensive, and inclusive list of strategic sectors by the government is key factor for addressing the population's food requirements at a reduced cost. The solution lies not in downstream price support but, more effectively, in upstream support for producers. The overarching goal of this strategic choice should be the preservation of the national heritage and ensuring the food sovereignty of the country. Central to this objective is the preservation of gene banks, which can serve as a lever for the sustainable development of Algerian agriculture.

4. Rural development issue: Still insufficient infrastructure

The Algerian government's expenditure on agricultural development for rural areas has significantly increased from 17.1 million USD in 2001 to 60.6 million USD in 2022. While this level of investment is comparable to neighboring countries such as Morocco, Tunisia, and Egypt, it remains substantially lower than in countries like France (725.1 million USD in 2021), Spain (359.3 million USD in 2021), and Turkey (220 million USD in 2022)[4]. This disparity highlights primarily the ongoing challenges of underinvestment in rural infrastructure in Algeria.

In the early 2000s, with the return of social peace, increased oil revenues, and the end of structural adjustment programs, the Algerian government initiated several agricultural policies that took into consideration the rural sphere. The National Agricultural Development Plan (PNDA) was launched, and in 2002, it was expanded to include the rural dimension, becoming the National Plan for Agricultural and Rural Development (PNDAR). A National Strategy for Sustainable Rural Development (SNDRD) was developed by the government for the period 2005-2015, aiming to promote economic activities and develop natural and human resources to reduce rural exodus, especially from mountainous areas, by involving local communities in regional projects (Bessaoud, 2006; Souidi & Bessaoud, 2011).

Several actions have been taken for the benefit of a rural population approaching 11 million inhabitants (FAO, 2023), characterized by low agricultural income and high unemployment rate. Key actions focused on improving food security for rural households, particularly in deprived areas, and promoting rural professions to support development activities. The PNDAR relied on implementing a participatory policy and an investment support mechanism to generate and supervise demand from farmers and investors. A concrete example of this approach is the Integrated Rural Development Proxim-

[4] According to FAO (2023) statistics.

ity Project (PPDRI), which was strengthened by the Agricultural and Rural Renewal Policy (PRAR) in 2008. Financial resources, supported by multiple funds (FNDA[5], FNRPA[6], FLDDPS[7], FDRMVTC[8] and FPZPP[9]), over the period 2000 to 2021.

Adair *et al*. (2022) emphasize that public spending was distributed as follows: 46% for investment in agricultural businesses, 31% for regulation, and 16% for rural development, desertification, small farms, and livestock. Additional financial resources, supported by the Ministry of Agriculture and Rural Development (MADR) operating and equipment budget. It is also important to point out that the Algerian government has decided to close the support funds (FNDA and FNDR[10]) agriculture[11], and has been committed to budgetary programming from January 2023, which is focused on results in order to have more transparency in public finances.

All agricultural support measures have been oriented towards expanding and conserving soils, acquiring livestock, transportation logistics, specialized livestock equipment, irrigation equipment, and equipment for rural artisanal production linked to agricultural activity. Ambitious public programs such as the National Reforestation Plan (PNR) aimed at promoting viable rural livelihoods, enabling rural populations to improve their income and living conditions. By the end of 2021, the Ministry of Agriculture reported achieving over 840,000 hectares of reforestation, targeting over 1 million hectares.

In the last decade, there has been a growing trend toward Saharan agriculture. Recognizing the potential of these vast, arid regions, the government has intensified its efforts to develop this sector. In 2024, the Ministry of Agriculture and Rural Development identified a real estate basin with a total area of 163,999 hectares across thirty Saharan perimeters to attract investors to the Saharan regions. This initiative underscores the strategic shift toward harnessing the agricultural potential of the Sahara.

Several persistent challenges in rural development persist. The first major challenge is insufficient infrastructure, which hampers efficient agricultural production and distribution. Inadequate roads, irrigation systems, and storage facilities limit the ability to bring products to market and reduce overall productivity. Secondly, there is a need for increased investment in modern agricultural technologies. Many rural areas still rely on traditional, less efficient farming methods. Introducing advanced technologies can significantly boost productivity and sustainability. Thirdly, access to finance remains a significant barrier for many rural farmers. Without adequate financial resources, farmers cannot invest in necessary inputs, equipment, or infrastructure improvements. Improving access to credit and financial services is crucial for empowering rural farmers and supporting their development (Ibrahim, 2023; Capone *et al*., 2021).

5. Price stability: It would be better to manage instability

The stability of food prices is a critical dimension of a country's food security, directly impacting accessibility and occasionally precipitating social and political unrest (Grafton *et al*., 2015; Bellemare, 2015). Raising food prices, particularly, adversely affect households, disproportionately affecting the economically vulnerable (Swinnen & Squicciarini, 2012). Notably,

[5] *Fonds National de Développement Agricole* (Ex. FNDIA), in english: National Agricultural Development Fund.

[6] *Fonds National de Régulation de la Production Nationale* (National Fund for the Regulation of National Production).

[7] *Fonds de Lutte contre la Désertification et de Développement Pastoral de la Steppe* (Fund for Combating Desertification and Pastoral Development of the Steppe).

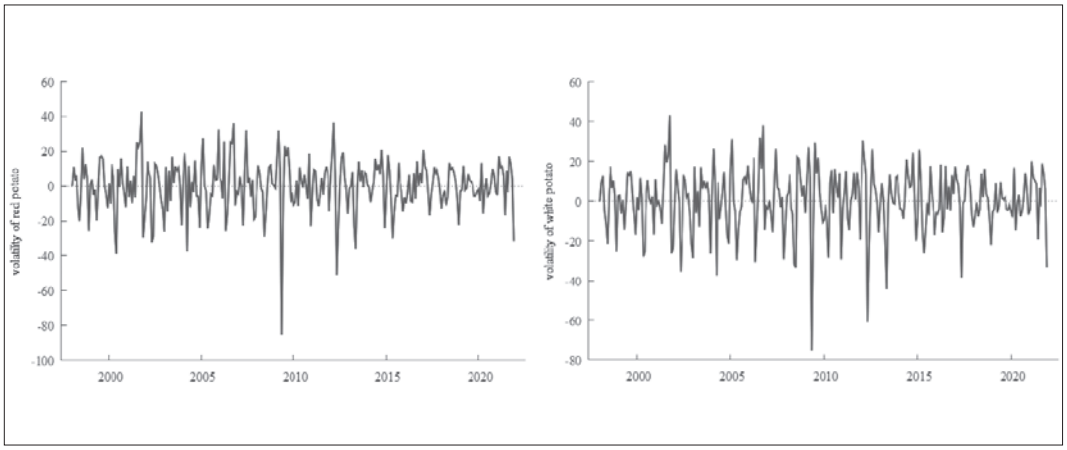
[8] *Fonds de Développement Rural et de Mise en Valeur des Terres par Concession* (Rural Development and Land Development Fund by Concession).

[9] *Fonds de Promotion de la Santé Animale et de la Protection Phytosanitaire* (Fund for the Promotion of Animal Health and Phytosanitary Protection).

[10] *Fonds National de Développement Rural* (National Fund for Rural Development).

[11] Article 167 of Law No. 20-16 of December 31, 2020 relating to the finance law for 2021.

Figure 1 - Prices volatility of red and white potatoes in Algeria.



it is revealed that the instability of agricultural prices represents a fundamental characteristic inherent in agricultural markets, as elucidated by Gérard *et al*. (2008) and Boussard (2010). Comprehensive documentation exists regarding research into the causes and implications of agricultural price instability. The monumental studies conducted by Gérard *et al*. (2008, 2013) and Boussard (2017) significantly contribute to the understanding of this subject. Nevertheless, effectively managing this inherent instability remains a major challenge for public policy, particularly for less developed countries. The mechanisms employed for addressing this challenge involve both public and private storage systems.

The Algerian government has implemented subsidy and support programs for farmers, primarily aimed at enhancing productivity. Notably, some of these programs are specifically designed to alleviate consumer prices. Since gaining independence, consumer price support has been directly provided and has impacted various food products considered strategically important. Presently, consumer price support primarily centers around wheat and milk. Government intervention maintains a direct upstream presence in these two sectors, but its influence extends indirectly downstream to impact consumer prices. Direct intervention by public authorities in agri-food prices is notably constrained, primarily facilitated through the public storage mechanism for large-scale consumed products, predominantly potatoes and garlic.

To examine the effectiveness of the public storage mechanism in terms of price stabilization, consider the case of potatoes. Monthly prices for both red and white varieties were obtained[12] to eliminate nuances. The simplest measure of price volatility was then calculated using the following formula:

$$p_t = 100 \times [ln(P_t) - ln(P_{t-1})]$$

This formula[13] provides a straightforward assessment of price volatility over time, allowing an analysis of the effectiveness of the public storage mechanism in mitigating price fluctuations. The graphical representation of the outcomes in both instances is depicted in the Figure 1. Knowing that the initiation of public storage regulation mechanisms in 2010, it is discernible that the magnitude of price fluctuations has remained nearly constant, with minimal mitigation observed. This raises concerns about the efficacy of public storage mechanisms, warranting a

[12] Data on monthly prices of both varieties are obtained from CEIC data (https://www.ceicdata.com/).
[13] Where p_t is for price volatility index at time t, P_t for price at t, and P_{t-1} for price in last period $t-1$.

Table 2 - The evolution of farm landholdings by sizes.

Decades	*% <10 ha*	*% [10-50 ha]*	*% [50-100 ha]*	*% >100 ha*
1970s	79,21	18,93	1,37	0,48
1980s	88,02	11,31	0,59	0,09
1990s	79,21	18,93	1,37	0,48
2000s	59,26	30,63	8,07	2,04

more precise quantification through the application of more sophisticated analytical methods.

The prevailing challenge in managing agricultural prices, as is the case with the majority of agricultural commodities, lies in mitigating the impact of seasonality on these prices. In the context of this country, a comprehensive investigation into the volatility of agricultural prices is notably absent. However, a preliminary examination of the price series for most agricultural products unveils existing regularities in the overall price behavior. Consequently, conducting thorough studies on the behavioral patterns of agricultural prices becomes imperative, aiming to assess their controllability and address seasonality on an annual basis, among other timeframes. Moreover, a detailed comparative analysis between public and private storage efficiency is essential to gauge the effectiveness of these storage mechanisms.

6. Agrarian structures: Efficiency in question

The impact of agrarian institutions on agricultural sector performance, particularly in terms of productivity, is direct and significant, posing a fundamental concern for food security. Certainly, the issue of agricultural land in Algeria is intimately connected to its historical and political context. As highlighted by Tatar (2013), discussing land ownership and accessibility invokes a comprehensive historical process wherein land has been a central concern, subject to political and ideological choices during key periods in Algerian history. However, amidst the challenges facing Algerian agriculture nowadays, the current imperative is to embark on an investigation into existing agrarian structures, placing a central focus on their economic efficiency. Table 2 shows the evolution of farm landholdings in Algeria over several decades[14]. In the 1970s, small farms (<10 ha) made up 79.21% of all farms, but this increased dramatically to 88.02% in the 1980s due to land redistribution policies. By the 1990s, the distribution returned to the 1970s levels. However, in the 2000s, there was a significant shift: small farms decreased to 59.26%, while medium-sized and larger farms increased.

The evolution of farm sizes highlights several challenges. The fluctuating policies have led to instability in landholding patterns, making it difficult for farmers to plan long-term investments. Also, the increasing concentration of land in medium and larger farms raise issues related to access to land for small farmers and new entrants, exacerbating inequalities in the agricultural sector. Integrating these landholdings into a functional land market remains persistent public policy challenge, as legal and bureaucratic hurdles often hinder efficient land transactions and consolidation efforts.

However, economic theory asserts that there is no universally optimal structure applicable to all contexts when it comes to agrarian institutions. Beyond direct forms of farmland exploitation, it is crucial and pressing to judiciously inspect what is referred to as "*Faire valoir indirect*." The studies conducted by Bessaoud (2020) and Colin & Daoudi (2020) meticulously detail the insights into this aspect within the context of Al-

[14] The figures included in this table came from secondary data provided by Bedrani (1982), Henni (2009) and Benachenhou (2009).

Table 3 - Distribution of farmland area by type

Types of farmlands	*Area (ha)*	*(%) SAT**
EAC and EAI	2.33 millions	5.30%
Pilot Farms**	146,000	0.33%
Private Farms	6 millions	13.64%
Private Farms (APFA)	167,000	0.38%
Concession Farms	150,000	0.34%
Private Agro-pastoral Farms (*Arch* Rangelands)	More than 30 millions	More than 68%

Source: MADR (2022).

* It represents the total agricultural used area. It is estimated at more than 43 million hectares (MADR, 2022).
** The total number of pilot farms is 174 farms. The name of the pilot farm was changed to Agricultural Production Unit (UAP) and they were attached to a new Strategic Crop Development Company (EPE / Spa DCAS) in accordance with the guidelines of the high authorities of the State. The new company EPE / Spa DCAS will include in its portfolio, 4 subsidiaries: EPE / Spa Perennial Crops, EPE / Spa Oilseeds, EPE / Spa Seeds and EPE / Spa Dried Vegetables.

gerian farmlands. On the other hand, an in-depth examination of the size-productivity relationship of farms should be conducted using more sophisticated methodologies, as demonstrated by the study conducted by Benmehaia (2022). Additionally, the flexibility of such structures concerning the responsiveness for prices, as explored by Benmehaia (2021), warrants more careful attention. Given the limited number of studies on these aspects, the initiation of investigations into the efficiency of agrarian structures in Algeria will be beneficial for informing public policy and implementing regulations that effectively enhance productivity.

As agricultural land in Algeria has undergone significant upheaval, particularly since the economic liberalization of the early 1990s, the government has implemented several legal and regulatory mechanisms to address land tenure issues. Several successive regulation laws have been adopted by, including: *Access to Land Ownership*[15] (1983): Encourages the development of agricultural land and sets conditions for transferring ownership of private agricultural land and land intended for agriculture. *1989 Constitution*: Provided a new framework for agricultural land issues, encouraging private ownership of land and limiting government intervention in land matters, differing from the frameworks of 1963 and 1976. *Land Orientation Law*[16] (1990): Subdivides land assets by class: forest land, alfa lands, rangeland, agricultural land, Saharan land, and urbanized and urbanizable land. *Agricultural Orientation Law*[17] (2008): Establishes legal provisions for better exploitation of agricultural land and facilitates the transfer of usage rights. *Law on the Exploitation of State-Owned Private Agricultural Land*[18] (2010): Converts the right of perpetual enjoyment into the right of concession for the exploitation of State-owned private agricultural land and introduces a new type of private-private partnership to encourage investment in the agricultural sector. Table 3 displays the current distribution of farmland area by type in Algeria.

[15] *Accession à la propriété foncière agricole* (Access to Agricultural Land Ownership) via the Law 83-18 of 08/13/1983.
[16] Law No. 90-25 of November 18, 1990 on land orientation.
[17] Law No. 08-16 of August 3, 2008 on agricultural orientation.
[18] Law No. 10-03 of August 15, 2010 establishing the conditions and methods of exploitation of agricultural land in the private domain of the State.

The distribution of farmland area in Algeria, as shown in Table 3, reveals significant disparities among different types of farmlands. Private agro-pastoral farms, particularly those in Arch Rangelands, dominate with over 30 million hectares, accounting for more than 68% of the total agricultural area. This is followed by private farms, which cover 6 million hectares (13.64%). EAC (agricultural collective farms) and EAI (agricultural individual farms) occupy 2.33 million hectares, representing 5.30% of the total. Pilot farms, private farms under the APFA program, and concession farms collectively cover a much smaller portion, with 146,000 hectares (0.33%), 167,000 hectares (0.38%), and 150,000 hectares (0.34%), respectively.

It is important to note that a significant number of farms are untitled and unregistered, constituting a serious obstacle to agricultural development. This includes issues like lack of equipment and limited access to agricultural loans and credits. To address this, the government issued a circular[19] in 2018 to conduct a census of farmers without titles. The usable agricultural area (UAA) has been limited to over 8 million hectares since the 2000s. The UAA increased from 8.22 million ha in 2000 to 8.6 million ha in 2021, a minor increase of +4.55%. This increase is attributed to the development policies initiated by the government. Among these 8 million ha, over 4 million are herbaceous crops, including more than 3 million ha of cereals and over 3 million ha of fallow land, mainly in arid and semi-arid regions. This represents 0.19 ha per inhabitant, one of the lowest ratios in the Mediterranean (0.45 in Tunisia and 0.24 in Morocco). The irrigated area continues to increase, from 350,000 ha in 2000 to 1,489,988 ha in 2022, now representing 17% of the UAA. This quantitative evolution of 1.13 million ha of irrigated land, averaging 52 000 ha per year, was accompanied by efforts to develop water-saving irrigation systems (MADR, 2022).

7. Water resources: Saving water issue

The abundance of water resources in Algeria, particularly designated for the irrigation sector, have been comprehensively documented, as evidenced by the works of Hammani *et al*. (2009), Kherbache (2020), Zwarteveen *et al*. (2021), and Oulmane *et al*. (2022), which illuminate the extensive nature of this subject. However, it is somewhat perplexing to encounter academic expressions of concern regarding the scarcity of irrigation water, especially at the aggregate level, when fundamental facts challenge these notions of rationalization in a specific context. While such concerns may be valid for isolated regions with limited water resources, an analysis at the aggregate level could offer a different perspective.

The simple demonstration begins by providing key factual data related to Algeria's agricultural landscape. The total agricultural used area is quantified at 43 million hectares, with the cultivated area covering 8.5 million hectares, and the irrigated area specifically amounting to 1.3 million hectares[20]. Additionally, the analysis will then focuses only on the Albien Nappe, a significant underground (nonrenewable) water reservoir, which is estimated to contain 50,000 billion cubic meters[21]. Algeria's share of this resource is approximately 70%[22], translating to roughly 35,000 billion cubic meters. To further contextualize these figures, the demonstration assumes an average annual water consumption of 7 billion cubic meters within the agricultural sector[23]. Utilizing this approximation, it is calculated that to irrigate the 1.3 million hectares,

[19] Interministerial Circular No. 750 of July 18, 2018.

[20] Figures provided by FAO (2023).

[21] These Albien estimates are sourced from UNESCO (1972). It is essential to note that while the specific reservoir example used here pertains to Albien, the cumulative water resources in Algeria can be substituted without substantially affecting the drawn conclusions.

[22] Estimation of the UNESCO (1972).

[23] Estimation provided by Boudjadja *et al*. (2003). It is crucial to acknowledge that, specifically, the estimation of natural irrigation water potentialities in Algeria was reported at 18 billion m^3 per year in 2013, as per Mozas & Ghosn (2013). Importantly, substituting this particular estimation with alternative figures for irrigation water quantities would not significantly alter the conclusions.

a consumption of 7 billion cubic meters is necessary. Extrapolating this requirement to cover the entire cultivated area of 8.5 million hectares, the total consumption would escalate to almost 43 billion cubic meters. The ensuing revelation is rather surprising: relying solely on groundwater from the Albien aquifer, without factoring in other water sources like surface water, other aquifers regeneration, and additional irrigation water types[24], would necessitate a staggering 814 years to irrigate the entire cultivated land, constituting 20.5% of the used agricultural area.

This striking result challenges the conventional narrative of water scarcity, particularly at an aggregate level. The demonstration highlights that, given the abundance of the Albien aquifer, the issue of saving water becomes inconsequential in this specific scenario. The longevity of available water resources is emphasized by the estimation that, assuming a century encompasses three generations, Algeria's water reserves would be sufficient for the next 25 generations. While acknowledging the theoretical nature of this result, it provides an insightful approximation of the immense potential within Algeria's irrigation water resources. This demonstration prompts a reconsideration of water management policies, suggesting that the focus should be on efficient utilization rather than strict conservation in a context where the availability of water resources far exceeds current consumption demands.

The efficiency of irrigation water utilization poses a crucial inquiry for both public authorities and academics when considered on a broader scale. However, at a more granular level, such as individual farms or oases, the primary concern shifts towards the expenses associated with implementing water-saving technologies. Notable studies by Belaidi *et al*. (2022) and Oulmane *et al*. (2019) serve as recent contributions to this aspect. In the context of enhancing the sustainability of Algerian agriculture, the central challenge revolves around intervention strategies addressing extraction and distribution costs. The recommended solution advocates directing support primarily towards mitigating extraction expenses, with secondary attention given to the costs associated with adopting water-saving technologies. The inherent abundance of water resources in the region underscores the importance of public policy orientation towards managing extraction costs and the necessary infrastructural facilities. This strategic approach aims to maximize the effectiveness of water resource utilization while maintaining economic viability for agricultural stakeholders.

8. Climate change policies: Challenges towards resilience

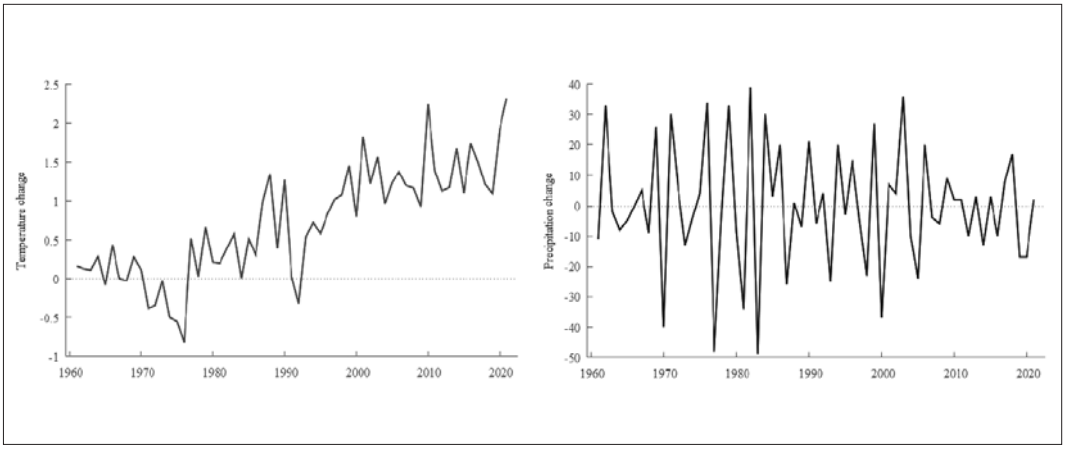
Climate change poses challenges worldwide, with agriculture standing out as a primary concern. In the context of Algeria, a straightforward examination of basic climate indicators, such as changes in temperature and precipitation[25] (as indicated by the two plots in Figure 2), reveals a discernible shift over the past two decades. The climate has exhibited a trend toward increased heat and reduced precipitation, contributing to an overall pattern of heightened aridity and greater climatic variability and uncertainty. Extensive documentation by various researchers, including studies by Boudiaf *et al*. (2020), Benmehaia *et al*. (2020), Bouabdelli *et al*. (2022), Shehzad *et al*. (2022), Chaouachi & Balsalobre-Lorente (2022), Bouregaa (2023), and Benmehaia (2023), has provided broad insights into the evolution and impact of the two primary components of climate – temperature and precipitation – on Algerian agriculture.

Effective mitigation of the challenges posed by climate change necessitates global-scale interventions. However, at the regional level, individuals are compelled to acknowledge this prevailing trend, albeit with the fervent hope that its consequences will not escalate into catastrophic scenarios. In the face of this inevitability, local efforts become centered on proactive adaptation

[24] These factors are of utmost importance for other practical and realistic considerations.

[25] Data provided from Trading Economics website (https://tradingeconomics.com/algeria). The two variables are expressed in terms of first differences to capture the annual changes in the data.

Figure 2 - Evolution of changes in temperature and precipitation in Algeria.



strategies, emphasizing the urgent need for communities to develop and implement measures that enhance resilience in the wake of evolving climatic conditions. Recent studies investigating the climate-agriculture interactions in Algeria have yielded valuable conceptual and practical recommendations. These findings, articulated by Bessaoud *et al*. (2019), Adair *et al*. (2022), Bouzid *et al*. (2022), Bouznit *et al*. (2022), Bouznit & Aïssaoui (2023), Benmehaia (2023), offer pertinent guidance for policymakers and stakeholders grappling with the impacts of climate change on the agricultural landscape.

At the Algerian public policy level, since the 2000s, the government has strategically prioritized climate variations. Public institutions have been established as part of the national climate change strategy. The National Climate Change Agency, created in 2005, aims to integrate climate change considerations into all development plans and contribute to environmental protection[26]. This agency is supported by an orientation council[27] and a scientific council[28], both comprising representatives from ministerial departments and experts in climate change.

Several government programs and action plans have been adopted in this context. The National Forestry Strategy for 2035 includes measures to conserve natural resources in forests, alfa lands, and other areas, restore affected ecosystems, and strengthen their resilience to climate change and drought (Safar-Zitoun, 2019). The National Climate Plan (PNC), developed in 2019 in cooperation with GIZ[29], complements previous plans like the National Action Plan for the Environment and Sustainable Development (PNAEDD), the National Strategy and Action Plan for Biodiversity (SPANB), and the National Strategy for Integrated Waste Management (SNGID) by 2035. The PNC aims to develop future plans in the short (2020-2025) and medium term (2025-2035) to reduce climate change effects, including 155 measures to adapt to the climate situation, with 76 measures for mitigation (Prime Ministry, 2019).

Additionally, the Algeria National Drought Plan (2019), in collaboration with the UN through the Convention to Combat Desertification (UNCCD), aims to strengthen the resilience of communities and ecosystems to drought. The

[26] Art. 4 of Executive Decree No. 05-375 of September 26, 2005 establishing the National Climate Change Agency (ANCC), setting out its missions and defining the terms of its organization and operation.

[27] Order of December 5, 2023 appointing the members of the ANCC agency's steering committee.

[28] Order of April 18, 2019 designating the members of the scientific council of the ANCC agency.

[29] The *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH is a German federal enterprise that promotes international cooperation for sustainable development.

National Action Plan to Combat Desertification[30] (PAN-LCD) initiated 12 actions, such as mitigating drought effects, adapting rangelands, protecting watersheds, promoting sustainable mountain development, eliminating poverty, and improving living conditions.

9. Conclusion

This study provided a selective examination of the pressing issues affecting the agricultural sector in Algeria, particularly on the aspect of food security. The geopolitical instabilities in the Mediterranean and internal economic challenges highlight the urgent need for effective strategies to enhance food security in Algeria. Despite the government's longstanding prioritization of this goal, significant gaps remain, necessitating a shift in focus towards current challenges and practical solutions.

The study identifies key areas of concern, starting with the strategic prioritization of agricultural sectors. Traditional staples like wheat and milk have dominated public support due to their importance in the Algerian diet. However, a reevaluation of these priorities to include crops and livestock better suited to the country's diverse bioclimatic conditions could enhance sustainability. Moreover, the rural development, a critical component of agricultural policy, remains hampered by insufficient infrastructure. Despite increased investment, the disparity in funding compared to other countries highlights ongoing challenges. Initiatives like the PNDAR and various participatory policies have aimed to address these issues, but the rural population continues to face significant obstacles. Enhancing infrastructure, modernizing farming techniques, and improving access to finance are essential steps to support rural farmers and boost agricultural productivity.

Price stability is another crucial aspect examined. The inherent volatility of agricultural prices poses a significant challenge, with current public storage mechanisms proving inadequate in mitigating fluctuations. Effective management of price instability, particularly through a detailed analysis of behavioral patterns and comparative studies of public versus private storage efficiency, is necessary. Addressing seasonality and implementing robust storage solutions can help stabilize food prices and ensure greater food security. Subsequently, the study addresses the efficiency of agrarian structures and water resource management. Legal reforms have been implemented to facilitate land ownership and use, but many farms remain untitled and unregistered, hindering development. On the water resources, it seems that the expansion of irrigated areas and the abundance of water resources, particularly from the national reserves, offer opportunities for improved water management. However, efficient utilization and addressing extraction costs are critical to maximizing these resources. Finally, the study highlights also the importance of climate change policies, with the government prioritizing resilience through various strategic plans, regulations and action programs.

It is important to note that the enumerated conclusions are not exhaustive or comprehensive. Instead, they serve as a concise foundation, intended to spark more in-depth investigations into each addressed aspect. The hope is that these succinct reflections will act as a catalyst for detailed analyses and, ultimately, contribute to comprehensive solutions for enhancing Algerian food security.

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Agri-food trends and policy: Green deal challenges and opportunities in EU pre-accession countries (Albania, Kosovo, North Macedonia)

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Abstract

EU pre-accession economies, including Albania, Kosovo and North Macedonia, rely heavily on agriculture that is a key employer in rural areas. The main challenges in the agriculture sector remain low productivity, lack of infrastructure, and poor access to finance and markets. EU membership aspirations and the pursuit of European Green Deal (EGD) guidelines provide a yardstick to assess regional agricultural policies, emphasizing sustainable practices and organic farming. The need for balanced increase in production and demand, improved supply chains, and compliance with EU standards is evident. Although, the Green Agenda for the Western Balkans (GAWB) emphasizes the countries' commitment towards sustainability, yet implementation is inconsistent due to low level of support for agriculture and rural development in terms of environmental benefits, and for organic agriculture specifically. Aligning policies toward the EGD, developing a reliable quality infrastructure, and increasing the financial support and capacity building interventions is crucial for sustainable transformation. Further research on economic viability and behavioral factors affecting environmentally linked policy adoption is necessary to inform policy interventions.

Keywords*: Green Agenda, Organic Agriculture, Western Balkans, EU integration.*

1. Introduction

European Union (EU) pre-accession countries, such as Albania, Kosovo, and North Macedonia (part of the Western Balkans [WB]), still heavily rely on agriculture as a major sector in their economies. Agriculture is a crucial source of employment and income, primarily because a significant portion of the population resides in rural areas and engages in agriculture. Farmers in these countries in South-East Europe face numerous challenges, including slow productiv-

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ity growth, lack of mechanization and modern equipment, unclear property rights, and limited access to finance, technology, services, and markets (Martinovska Stojcheska *et al.*, 2024).

The agri-food sector as a whole faces challenge in creating market institutions, and establishing marketing and distribution chains. Albeit to different extent across the WB countries, challenges also arise in meeting EU food safety and quality requirements, complying with veterinary and phytosanitary standards, and building the administrative capacity to support these processes. The organic sector in particular is subject to additional specific requirements. Several studies have identified the shortcomings in the food safety system and the associated risks and concerns among consumers (Grunert *et al.*, 2021; Haas *et al*., 2021). Farmers' non-compliance with these standards undermines their market access, leading to low farm income, continuous out-migration of youth, and the abandonment of agricultural land.

The agri-food sector in the region has significant development potential, for example by adopting certain structural changes such as farm consolidation and value chain integration, and certain institutional changes such as quality infrastructure as well as food safety and agricultural support services (Sanfey and Milatovic, 2018; Aramyan *et al*., 2024). Moreover, the WB region's geographical location is suitable for supplying agri-food produce to the EU which is already its major trading partner (Sanfey and Milatovic, 2018; Martinovska Stojcheska *et al.*, 2024).

Given the EU membership aspirations of Albania, Kosovo, and North Macedonia, the Common Agricultural Policy (CAP) of the EU significantly influences their agricultural policy developments. An important driver towards sustainability has also been their ambition to align with the European Green Deal, a comprehensive policy initiative aimed at transforming the EU into a more sustainable, resource-efficient, and climate-neutral economy. The EU Farm to Fork Strategy, part of the Green Deal, aims to enhance soil health, expand organic production, reduce fertilizer and pesticide use in agriculture, and promote biodiversity (EC, 2020).

The whole WB region is committed to aligning with key aspects of the European Green Deal and aims to achieve climate neutrality along with Europe by 2050. This commitment is underscored by the adoption of the Green Agenda for the Western Balkans (GAWB) in 2020, along with an accompanying Action Plan in 2021. Action 46 of the GAWB specifically focuses on promoting environmentally friendly and organic farming practices, as well as reducing the use of synthetic chemicals in food production (RCC, 2021). This presents both opportunities and challenges for developing organic farming in the WB region. Re-orientation to organic farming is a promising solution for the WB economies – since it generates more jobs, creates more production value and profits, and has less environmental costs compared to the conventional production methods (Znaor, 2013). However, concerns remain regarding the effectiveness of agriculture and rural development policies in driving sustainable transformations in agri-food systems, particularly regarding greener policy instruments and measures related to climate change, biodiversity loss, and natural resource management. While the EU-27 aims for organic agriculture to comprise 25% of the total utilized agriculture area by 2030 (FiBL, 2024), the Western Balkans have yet to reach this target, experiencing slow growth of organic agriculture. Concerns have been raised about the integration of environmental and sustainability objectives into policy frameworks in WB countries, as well as the extent to which these goals are translated into actionable measures (Zhllima *et al.*, 2021). In addition, any new policy vision is often observed mostly as a scientific effort or an imported policy reflection, rather than a genuine, locally emerged social or economic need (Seremesic *et al.*, 2021; Zhllima *et al*., 2021). Therefore, this paper aims to investigate and compare the agricultural policies of three EU pre-accession countries (Albania, Kosovo, and North Macedonia) and their commitment—both strategic and operational—in relation to the EU Green Deal, focusing on measures that promote environmental benefits. The results are important for understanding the level of agricultural policy preparedness of the Western Balkans to meet the Green Agenda targets related to the environment.

The framework for comparing and assessing agricultural policies in EU pre-accession countries such as Albania, Kosovo, and North Macedonia, in light of the EU Green Deal, involves evaluating strategic policy frameworks, financial resource allocation, and implementation of various support measures. Special emphasis is placed on measures that promote environmental actions, including support for organic agriculture. This approach enables comparative analyses based on both qualitative and quantitative indicators of policy alignment with the EU Green Deal. Policy objectives and targets in GAWB are compared with the Farm to Fork Strategy, the EU Strategy for Biodiversity 2030, and other targets emerging from the Water Framework Directive. Quantitative analysis is based on a comparative assessment of measures and criteria of the agriculture and rural development budgetary support across countries, with a focus on payments, to measure support for environmental benefits and organic agriculture. The Agricultural Policy Measures Classification (APMC) tool is employed as a unified classification approach (Rednak *et al.*, 2013). Total Budgetary Support (TBS) encompasses all transfers to agriculture and rural development from national and other sources, including IPARD funds, categorized into three pillars: market and direct producer support, structural and rural development support, and general support to agriculture (Rednak and Volk, 2018). Structural disparities are analyzed using relative indicators such as total budgetary support per area or unit of production, as well as the share of gross value added in agriculture to all activities in the country. The analysis uses the latest available figures (2022), with 2010 serving as the baseline year.

The structure of the paper is as follows: the next section highlights the main economic and agri-food sector trends in Albania, Kosovo, and North Macedonia. The third section analyzes the agri-food policies in these countries towards the EU Green Deal, while the final section consists of a discussion and conclusions.

2. Main macroeconomic and agri-food sector trends

In the last three decades, the WB countries have undergone a transition of the political system, market, and society as a whole. Since the early 2010s, the Gross Domestic Product (GDP) and the Gross Value Added (GVA) nearly doubled in Albania, Kosovo, and North Macedonia (Table 1). At the same time, the overall population has decreased, due to high out-migration and also lower birth rates.

Despite economic growth, a significant portion of the population is still at risk of poverty (about 21-22% after social transfers, compared to the EU average of 16.8% in 2021) (EUROSTAT, 2023). The income inequality expressed through the Gini coefficient has stayed relatively low with a declining trend, averaging roughly 31-33%, indicating that although poverty rates are still high, there is some equity in the distribution of income (EUROSTAT, 2023).

Table 1 - Key macroeconomic indicators.

Indicator	*Albania*		*Kosovo*		*North Macedonia*	
	2010	*2022*	*2010*	*2022*	*2010*	*2022*
GDP at current prices (mill. EUR)	9 003	17 972	4 402	8 896	7 109	13 034
Population (‘000)	2 913	2 794[1]	2 181	1 774	2 055	1 837
GDP per capita (EUR)	3 091	6 433	2 480	5 073	3 459	7 115
GVA at current prices (mill. EUR)	7 825	15 702	3 687	7 145	6 132	11 269

Source: WBC StatDatabases (2024).

[1] This is an official estimate for 2022. In Albania a population census was carried out by the Albanian Institute of Statistics (INSTAT) during 2023, and data was made available in 2024, indicating the population is circa 2.4 million (see https://www.instat.gov.al/media/13626/cens-2023-census-botim.pdf).

From 2010 to 2022, all three countries experienced significant developments in their agri-food sectors. While the absolute GVA of agriculture in Albania has increased (Table 2), its share within the total economy has declined (from 20.7% in 2010 to 18.6% in 2022). In addition, the sector employment and its share of total employment reflects structural changes. This trend indicates faster growth in other sectors rather than a decline in agricultural productivity. Similarly, Kosovo and North Macedonia have seen a decrease in the share of agriculture's GVA (from 16.2% and 11.7% in 2010 to 7.4% and 8.6% in 2022, respectively) (Table 2). In parallel, the number of people engaged in agriculture has almost halved due to an overall population decrease and massive migration from rural to urban areas and abroad.

The value of agri-food product exports has seen substantial growth since 2010, especially in Albania and Kosovo. This remarkable increase in export values highlights the expanding capabilities and international competitiveness of the agrifood sector. The growth in the absolute values of agri-food exports is followed by an increased share in the total exports, with the exception of North Macedonia where its share in the total exports slightly decreased, despite the export value growth. In addition, the value of agri-food product imports doubled in all three countries from 2010 to 2022, albeit with a decreasing share of the value of total imports (Table 3). The major imports include cereals, meat, and processed foods unavailable domestically. The trade balance in agri-food products worsened for all three countries over this period. This reflects the need for strengthening the agri-food sectors which would lead to a more favorable export position for certain commodities and an increasing contribution to the local economies.

3. Agri-food policy towards the EU green deal

3.1. *Strategic policy framework*

The agricultural policy framework in the pre-accession countries is supported by relevant legal and regulatory acts on agriculture and rural development. All countries have adopted long-term national strategies defining the development of the sector (endorsed by respective ministries of agriculture during 2021 or 2022 covering a period until 2027). The strategic objectives in Albania, Kosovo, and North Macedonia are strongly related to those of the EU CAP (Table 4).

Environmental benefits are reflected as top strategic objectives, albeit with varying terminology: either environmental protection (Albania), sustainable management of natural resources (Kosovo), or environmental practices (North Macedonia). Key objectives in all three

Table 2 - Agri-food sector contribution to the economy.

Indicator	*Albania*		*Kosovo*[2]		*North Macedonia*	
	2010	*2022*	*2010**	*2022*	*2010*	*2022*
GVA of the agriculture, forestry, and fishery sector (mill. EUR)	1 617	2 658	599	658	720	965
Share in GVA of all activities (%)	20.7	18.6	16.2	7.4	11.7	8.6
Employment in agriculture, forestry, hunting and fishery sector ('000 persons)	496	427	14	9	122	69
Share in total employment (%)	54.9	34.7	6.2	2.2	19.1	10.0

Source: SWG WBC StatDatabases (2024) based on labor Force Survey data.
**Note: Another base year is reported for Kosovo (KAS, LFS 2012-2022) due to data limited availability in 2010.*

[2] In Kosovo there are three types of statistics used for revealing the importance in agriculture. According to the Census of Agriculture there were 362400 persons working in agriculture which make up 25% of the employed persons while the Survey on Agriculture Holding in 2019 report 270181 workers or 23.5% of labour force. While LFS report a very low number of workers (13900 in 2012 and 9110 in 2022). For more details see GIZ (2022).

Table 3 - Key agri-food trade indicators.

Indicator	*Albania*		*Kosovo*		*North Macedonia*	
	2010	*2022*	*2010*	*2022*	*2010*	*2022*
Export of agri-food products (mill. EUR)	69	435	25	119	418	711
Share in export of all products (%)	5.9	10.6	8.3	13.0	16.5	8.6
Import of agri-food products (mill. EUR)	633	1255	483	1197	528	1135
Share in import of all products (%)	18.2	15.7	22.4	21.0	12.8	9.4
Trade balance in agri-food products (mill. EUR)	-564	-820	-458	-1078	-110	-424

Source: SWG WBC StatDatabases (2024).

countries also include actions aimed at mitigating, adapting to, and combating the effects of climate change. In Albania and North Macedonia, another critical policy framework is the ongoing implementation of the Instrument for Pre-Accession Assistance in the Rural Development Programme (IPARD), supported by the EU and currently in its third programming cycle covering the period 2021-2027. The IPARD programme's strategy outlines the promotion of environmentally friendly farming practices and the protection and enhancement of biodiversity, landscapes, water, and soil and support measures for climate change mitigation. The IPARD measure focusing in particular on agri-environment and climate action has not yet been implemented in both countries. Some countries address these issues through separate strategic documents that address climate action, resource utilization, biodiversity, and related matters.

Climate change mitigation and adaptation are central to *Albania*'s policy framework, particularly within the National Strategy for Development and European Integration (NSDEI) 2021-2027, demonstrating the government's dedication to aligning climate and developmental objectives. Specific climate actions are outlined in the National Plan for European Integration 2022 and the Strategy on Agriculture, Rural Development, and Fisheries (SARDF) 2021-2027, (both endorsed by the Government of Albania) (UNIDO, 2024). SARDF

Table 4 - Strategic objectives of the agricultural and rural development policy.

Albania	*Kosovo*	*North Macedonia*	*EU CAP*
• Enhancing the sustainability and competitiveness of the agri-food sector • Strengthening environmental protection and climate-related actions • Bolstering the socio-economic fabric of rural areas • Promoting sustainable maritime and aquaculture development	• Increasing the competitiveness of the agri-food sector and improving the efficiency and sustainability of farm production • Sustainable management of natural resources (land, forests, and water) • Supporting businesses in rural areas and enhancing employment and social infrastructure • Comprehensive institutional and sector reform to create efficient public services	• Improving the competitiveness, economic sustainability, and income of ag. holdings • Applying environmental practices and climate change mitigation and adaptation • Ensuring sustainable development of rural areas • Sharing knowledge, innovation and digitalization in agriculture and rural areas	• Ensuring fair income for farmers • Increasing competitiveness • Improving the position of farmers in the food chain • Climate change action • Preserving landscapes and biodiversity • Supporting generational renewal • Vibrant rural areas • Protecting food and health quality • Fostering knowledge and innovation

Source: Martinovska Stojcheska et al., 2024, DG AGRI.

2021-2027 prioritizes achieving a sustainable and competitive agri-food sector, particularly in terms of budgetary support, alongside other strategic goals such as environmental protection while organic agriculture is separately emphasized as its objective.

In *Kosovo* ambitious policies have been developed towards climate adaptation and mitigation. In this regard, the National Climate Change Strategy 2019-2028 serves as a cornerstone for policy action in mitigation and adaptation towards climate change. The Climate Change Law (08/L-250 approved in January 2024) aims to improve environmental protection through the prevention and control of greenhouse gas emissions from agriculture and other sources like industry and transportation. It foresees the development of Kosovo's first Strategy on Climate Adaptation including an Action Plan. One of the strategic objectives of the Strategy for Agriculture and Rural Development 2022-2028 emphasizes the sustainable management of natural resources, including land, forests, and water. This objective encompasses climate adaptation and the promotion of renewable energy sources, with a strong focus on implementing sustainable practices across land, water, and air. Key priorities include biodiversity protection, enhancement of ecosystem services, and conservation of habitats and landscapes which enable the agricultural sector to effectively manage natural resources, ensuring ecological integrity for future generations.

In *North Macedonia*, sustainability is at the core of all economic activities, as outlined in the National Development Strategy until 2040. The Smart Specialization Strategy (2023-2027) prioritizes Smart Agriculture and Food with higher value-added, aiming to foster innovations for green and digital transformation in the sector. The country's long-term Climate Action Strategy, along with its Action Plan, sets a vision for North Macedonia to achieve a prosperous, low-carbon economy by 2050 through sustainable and climate-resilient development pathways. Additionally, the National Adaptation Plan focuses on comprehensive policies and measures for climate adaptation. The key sectoral policy document, namely the National Agricultural and Rural Development Strategy 2021-2027 (MAFWE, 2021), establishes three specific objectives to increase the adoption of environmental practices in production, thereby contributing to climate change mitigation and adaptation: (1) promoting sustainable energy use; (2) fostering sustainable development and efficient management of natural resources such as water, soil, and air; and (3) enhancing biodiversity protection, ecosystem services, and conservation of natural habitats and landscapes.

Table 5 - Agricultural and rural development policy budgetary transfers by countries in 2010 and 2022.

Indicator	*Albania*		*Kosovo*		*North Macedonia*	
	2010	*2022*	*2010*	*2022*	*2010*	*2022*
Total budgetary support to agriculture (mill. EUR)	19.0	85.6	11.0	93.4	83.9	165.4
Market and direct producer support measures (%)	4.7	41.3	31.8	61.5	78.8	71.6
Structural and rural development measures (%)	78.9	43.9	39.0	38.5	12.6	19.3
Other measures related to agriculture (%)	16.3	15.1	29.1	-	8.7	9.0
Total budgetary transfers in total GVA (%)	0.2	0.3	0.3	1.3	1.4	1.5
Total budgetary transfers in AgGVA (%)	1.2	2.6	1.8	14.2	11.7	17.1
Total budgetary transfers per total agricultural area (EUR/ha) [a)]	16	73.5	27	226	75	132
Total budgetary transfers per inhabitant (EUR/capita)	6.5	30.6	5.0	52.6	40.8	90.0

Source: SWG WBC APMC database (2024); Note: [a)] in absence of previous and latest figures for Kosovo, 2014 Agricultural Census data was used for calculation.

3.2. *Agricultural and rural development policy measures and payments*

Actual budgetary transfers to the agriculture sector and rural areas reflect the *de facto* policy priorities of the countries. Budgetary support for agriculture has seen substantial increases in Kosovo and Albania, and it has remained consistently significant in North Macedonia over the past decade (Table 5). While a large part of the strategic objectives focuses on structural changes and rural development, these priorities are not equally transposed into concrete support. In Albania, the share of such measures has fallen from 79% to 40% but has increased in absolute terms. In Kosovo, they have remained stable at around 39%, with a significant value increase proportional to the whole agricultural policy support. In North Macedonia, they have somewhat increased to 19% in 2022, although still below the policy target of over 30% (MAFWE, 2021).

3.3. *Organic farming*

Organic agriculture is considered a key component of the Green Agenda for the Western Balkans, in line with EU Green Deal (RCC, 2021). It focuses on promoting sustainable agricultural practices that contribute to environmental protection and climate change mitigation. Organic agriculture has been proposed as a sustainable alternative to conventional agriculture, with potential benefits such as higher biodiversity, improved soil and water quality, enhanced profitability, and higher nutritional value (Reganold and Wachter, 2016). Organic farming enhances total microbial abundance and activity in agricultural soils on a global scale (Seufert and Ramankutty, 2017; Lori *et al*., 2017). Moreover, organic farming provides quality food without adversely affecting soil health and the environment, highlighting its sustainability in global agriculture (Eyhorn *et al.*, 2019).

In *Albania*, organic food regulations and legislation are partially aligned with those of the EU. There is no organic agriculture action plan for the country. The Albanian government is currently drafting a new law on organic production, expected to be adopted in 2024, to fully align with EU regulations (OECD, 2024). A Commission for Biologic Production in the Ministry of Agriculture and Rural Development (MARD) and a control body for organic certification exist, according to Law Nr. 106/2016 "On biologic production, labeling of biologic products and their control". However, there are yet institutional gaps and budgetary limitations pertaining to organic certification (EC, 2023) which show the low capacity of Albania to implement the right measures and maintain the commitments stated in GAWB. In terms of budgetary support, the existing measures for organic farms do provide lump sums for certified farms in Albania since 2018, starting at 1,000 EUR in the first year, increasing to 1,500 EUR in the second year, and reaching 2,000 EUR in the third year based on certification/conversion stage. Additional government initiatives include subsidies for planting medicinal and aromatic plants (MAPs), certification under Global Gap standards, and VAT exemption on imported insects for biological control.

The organic agriculture sector has a potential for development, with MAPs, chestnuts, olive oil, and dried mushrooms and berries providing attractive opportunities for the export market (Bernet and Kazazi, 2012; Arndt, 2022). While the demand in the internal market has been stagnant (Zhllima *et al.*, 2017; Skreli *et al.,* 2017), the international market demand for the organic products from Albania has increased. According to statistical indicators provided by MARD, the overall number of operators is less than 150 and the share of organic agricultural land to total agricultural utilised land is around 0.1%. Compared to 2010, the organic certified area is 2.5 times higher (731 ha in 2022 versus 284 ha in 2010), while the number of certified farmers has slightly increased (140 farmers in 2022 versus 130 farmers in 2010). The number of farmers is very low due to lack of internal demand and price premiums in the local market.

The export demand for organic MAPs cultivated in Albania has been the main driver for converting to organic agriculture in the country. Alongside MAPs, olive trees are the most important in terms of conversion area (Zhllima *et al.*, 2021; Arndt, 2022). The growth of the organic sector has not been matched by an

expansion of traceability and inspection services. Exporters heavily depend on foreign bodies and laboratories to ensure compliance and build trust with international buyers (UNIDO, 2023). Due to weak quality infrastructure and limited culture for quality, costs for fulfilling market standards are very high. This is one of the obstacles for increasing the number of organic farmers in Albania, despite the cost of certification being partly subsidized. Farmers are reluctant to convert into organic farmers because they appear to be more cautious about the stringent market access rules associated with organic farming compared to conventional methods (Zhllima *et al*., 2021).

In *Kosovo*, the Law on Organic Farming was approved in 2012, aiming to establish a foundation for organic production, ensure market integrity, promote fair competition, and protect consumer interests. The law addressed production principles, labeling, control systems, import rules, and sanctions for non-compliance. It also mandated data collection and statistical reporting related to the National Program for Organic Farming. To implement this law, the Ministry of Agriculture, Forestry, and Rural Development (MAFRD) issued eight Administrative Instructions in 2019, detailing responsibilities, control systems, standards for organic production, import criteria, and labeling requirements. Similar to other countries in the region, organic food regulations and legislation in Kosovo are partially aligned with those of the EU.

The Action Plan for Organic Agriculture (2018-2021) aimed to boost organic production and market share in Kosovo. The National Organic Action Plan (NOAP) for 2023-2026 aligns with the European Green Deal, promoting sustainable farming practices to reduce environmental impact and enhance biodiversity. These initiatives underscore Kosovo's commitment to developing its organic sector and supporting environmental sustainability.

There are currently no local organizations that certify products as organic, and consequently, no local accreditation agencies to accredit these organic certification bodies in Kosovo. Certification and control operations for organic farming are conducted by several international organizations (OECD, 2024).

Within organic agriculture, 77% (424 ha) was for MAPs, 22% for barley, rye, oats, corn, and sunflowers, and 1% for open-field vegetables in 2022. In addition, there are 373,488 ha of certified zones for the collection of MAPs, 35 certified companies, and 45 collection centres throughout the country.

North Macedonia's government adopted the National Strategy for Organic Agriculture (2008-2011) in 2007, laying the groundwork for further development of organic production with a target to reach 4% of arable land under organic production by 2020. The Law on Organic Agricultural Production was adopted in 2009, harmonized with the European regulations 834/2007 and 889/2008. A National Action Plan followed in 2013 (MAFWE, 2013) and lasted until 2020. The preparation of a new legal framework for organic production to align with the new EU legislation (EU Regulation 2018/848) is ongoing. There are two local organic certification bodies: Balkan Biocert Macedonia and Pro-Cert, both of which are authorised by MAFWE.Other possibilities exist for international certification (OECD, 2024).

In North Macedonia, the dominant measures for environmental protection are those dedicated to supporting organic farming. Other measures linked to environmental benefits and climate change in the National Program for Agriculture and Rural Development 2023-2027 include aid for premiums for insurance of primary agricultural production against natural disasters and adverse climatic events, aid for consolidation and protection of agricultural land, and analysis of the physical and chemical properties of the soil as a basis for applying good agricultural practices.

In terms of budgetary support, organic production is supported by the Law of Agriculture and Rural Development (2010). This one comprehensive measure for organic products (measure 215) incorporates different payment schemes, such as direct payments per output, per area, and per livestock head. Additional direct payments are provided for processing of organic products from the domestic origin (including post-harvest handling and pack-

Table 6 - Payments for organic production by countries, in million EUR.

Country	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*
Albania	0.00	0.00	0.01	0.00	0.01	0.03	0.00	0.07	0.09	0.85
Kosovo	0.00	0.00	0.00	0.02	0.04	0.28	0.52	1.67	0.08	0.09
North Macedonia	0.40	0.50	0.40	0.80	1.40	1.40	1.40	1.50	2.00	1.90

Source: SWG WBC APMC database (2024).

aging of MAPs of organic origin), and direct payments for trade or export of fresh and processed organic products from the domestic origin. Special direct payments are also provided for expert control and certification of organic production, for agricultural holdings that have performed agrochemical or soil analysis, or organic products analysis of pesticide residues and heavy metals, and direct payments for areas intended for green manure or crop rotation.

The area under certified organic production in North Macedonia has shown an increasing trend. In 2022, there were 4,556 hectares of certified organic land or land undergoing conversion, compared to 2,909 hectares in 2013 (SSO, 2024). Production of organic cereals dominates, followed by organic forage crops. Sheep make up the largest share of organic livestock due to the extensive grazing practices already in place. Despite this growth, only 0.9% of the land is certified organic (SSO, 2024), or even less according to international statistics (0.69%, FiBL, 2024; EUROSTAT, 2024). This is a significant distance not only from the 4% national target but also from the European Commission's ambitious goal of "at least 25% of the EU's agricultural land under organic farming. by 2030" as outlined in the Green Deal's Farm to Fork Strategy.

The number of certified organic operators has tripled over the last decade, reaching 913 operators in 2022. Interestingly, a survey of the organic farming operators' drivers to start and continue organic farming revealed that every fifth organic operator in the country had no previous experience in agriculture and that most would recommend organic practices to others on value-based motivations (Martinovska Stojcheska *et al.*, 2018). This unique perspective could be valuable to the policy maker.

While all three countries have implemented measures to support organic farming, the extent of financial support varies. As shown in Table 6, North Macedonia has made the most significant strides in this regard. From 2013 to 2022, the payments for organic production in North Macedonia increased from 0.40 million EUR to 1.90 million and cumulatively amounted to EUR 11.8 million over the decade. The share of organic payments within its Structural and Rural Development measures has risen to 6.03% in 2022. This indicates a stronger policy focus on promoting organic agriculture in North Macedonia compared to Albania and Kosovo, where realised payments for organic production in 2022 reached EUR 0.09 million in Kosovo and 0.85 million EUR in Albania, or less than 0.24% and 2.22%, respectively.

What is specific for Kosovo, where financial support for organic farming started in 2016 with relatively small amounts allocated to organic producers, is the extraordinary single allocation of EUR 1.7 million in 2020. However, already in 2021, there was a sharp decrease in funding, with only EUR 0.08 million allocated to organic farming. Various factors could be attributed to this drastic downturn in payments, including the pandemic effects, policy shifts, and budget reallocations to other measures. This cut was immediately reflected in a drastic decrease in the number of hectares that received direct payments for organic production in 2021/2022 (198 ha), when compared to 2020 (1,672 ha). Such a significant and sudden reduction certainly has potential implications on environmental sustainability, and agricultural practices, altering market dynamics and consumer choices, as well as reflecting slow policy progress towards the green agenda goals.

3.4. *Alignment to EU agri-environment strategic framework*

Following the EU Green Deal, particularly the Farm to Fork Strategy and the EU Biodiversity Strategy for 2030, EU pre-accession countries face both challenges and opportunities in aligning with these ambitious, yet non-binding, EU-level targets. By signing the Green Agenda for the Western Balkans 2020 (RCC, 2021), the WB countries have expressed their interest in following the EU Green Deal commitment, focusing on areas like pesticide and antimicrobial use reduction, over-fertilization control, organic farming expansion, animal welfare improvement, and biodiversity protection. This translates to promoting more efficient and reduced fertilizer and pesticide usage, alongside a significant increase in land dedicated to organic farming. Western Balkan countries aim to promote environmentally-friendly (zero pollution) and organic farming and reduction of synthetic chemical products used in food production in 2030 (GAWB Action number 46). This goal presented in the GAWB action plan does not contain any quantified targets. On the other hand, the EU's Farm to Fork (F2F) has defined specific targets to be achieved by 2030: 25% increase in organic farming land, 10% reduction in overall agricultural land use by 2030, 20% reduction in fertilizer use, and 50% reduction in pesticide use, compared to the average level used in the period 2015-2017. Table 7 compares the state and progress of Albania, Kosovo, and North Macedonia with EU agricultural and environmental key targets through the GAWB Action 46 versus the F2F targets.

The countries differ in the level of institutional framework; North Macedonia is most aligned, waiting on the adoption of the new law on organic production in line with the EU *acquis*. The share of organic area ranges from 0.1 % in Albania to 0.7 % in North Macedonia, far below the 10.5% average in the EU (Table 7).

The estimations on the usage of fertilizers and pesticides in the Western Balkan countries (considering the lack of relevant data) are also far below the EU levels. The data of EUROSTAT (2023) show that in 2022 in EU is reported a consumption of a total of 322 thousand metric tons of pesticides[3], which makes up an average of 2.05 kg per ha of Utilized Agriculture Area (UAA). EU has to achieve an overall use of 1.73 kg per ha of UAA in 2030, a level which Albania and North Macedonia are already under according to data available.

There is much work to be done however on control and monitoring of the use of fertilizers and pesticides. In Albania, there is no National residue monitoring plan and the Nitrate Directive is not yet aligned. There is a need to develop capacity, as well as accreditation and validation methods for Albania's laboratory network.

In Kosovo, the quality of fertilizers and pesticides is considered low, and there is no state control system to verify the concentration of active substances, which is crucial for ensuring effectiveness and safety. Other significant problems include proper storage and field-application techniques. The monitoring and controlling system needed for market access and for the safe use of pesticides requires further institutional structure; there has also been limited progress to align water legislation with the EU acquis.

In North Macedonia, measures on sustainable use of pesticides have not been implemented, and there is a need to collect reliable data on national pesticide use and its impact on human health. The implementation of the Nitrates Directive in North Macedonia is at an early stage. Last, but not least, besides the lack of consistent and reliable data on fertilizers and

[3] In the EU, in the years 2018 to 2022, there was experienced an overall decrease of 46% in the use and risk of chemical pesticides and 25% in the use of more hazardous pesticides from the baseline period of 2015-2017; and between 2021 and 2022, there was a decrease, relative to the baseline, of 12% for chemical pesticides and 4% of more hazardous pesticides. Member States are obliged to monitor water. To avoid pollutant runoff into water systems, the highest amount of nitrogen from manure that can be applied annually is 170 kg/ha, and freshwater and groundwater nitrate concentrations must be less than 50 mg/l of nitrates.

Table 7 - Alignment and progress of Albania, Kosovo and North Macedonia with EU levels with regard to key agri-environmental targets.

	Albania	*Kosovo*	*North Macedonia*	*EU*
Legislation	Established relevant legislation, but labelling and certification for organic products is pending.	Lacking organic farming institutional structures.	Established relevant legislation, competent authority, control bodies and accreditation and certification system for organic production.	Legal criteria are defined.
Organic area as share of total UAA	0.1% (2022).	0.4% (2022) (own estimation).	0.7% (2022).	10.5% (2022).
Fertiliser use	95 kg/ha (2022).	Estimated use 44 kg nitrogen per ha of arable land (based on fertiliser imports).	46 kg/ha (2021).	Reduced from 143 kg/ha (in 2018) to 125 kg/ha (in 2021).
Pesticide use	1.1 kg/ha (estimated 2021).	Law on chemicals designed to align with EU REACH and CLP Regulation needs to be implemented.	0.2 kg/ha (estimated 2021). Law on phyto-pharmacy (2020) is aligned with the EU *acquis*.	2.05 kg/ha (2022).
Monitoring and controlling system	• National residue monitoring plan not available. • Alignment to Nitrate Directive is not yet transferred. • No validated screening methods.	• Requires institutional consolidation. • Limited progress to align water legislation with EU *acquis*.	• Implementation of Nitrates Directive is at an early stage.	• Member states are obliged to monitor water.

Source: EC (2023), FAOSTAT (2024), EUROSTAT (2024), authors' elaboration.

pesticide use, it is difficult to set baselines and definitions to account for other targets, such as nutrient losses from agriculture, antimicrobials sales, agricultural area under high-diversity landscape features, allocation for areas of natural constraints, etc.

4. Discussion and conclusions

The EU Green Deal prioritizes sustainable agriculture and minimizing the environmental footprint of food production (EC, 2019). Aligned with these goals, the Green Agenda for the Western Balkans (GAWB) outlines a regional strategy for environmental sustainability (RCC, 2021).

Based on the comparative analyses it can be concluded that in relation to agricultural and rural development strategies, the EU pre-accession countries address environmental aspects and sustainable transformation as an important part of their strategic goals. However, translating these goals into actual measures, and budgetary support for the environmental targets, is largely missing. The only country in the analysis where environmental benefits are more pronounced is North Macedonia. Those benefits are mostly represented by support for organic farming with

the allocation of dedicated funds, however these funds still comprise a modest share of the total budgetary transfers. In Albania and Kosovo, organic farming receives very limited support through the national agricultural policy. Other measures such as payments to farmers in areas with natural and environmental constraints, agro-environment and animal welfare, and overall support providing environmental and societal benefits are lacking or are insignificant (Martinovska Stojcheska *et al.*, 2024).

Organic agriculture presents a promising avenue for the Western Balkans to contribute to both the Green Deal and GAWB objectives. Organic practices can demonstrably reduce greenhouse gas emissions, enhance biodiversity, and promote a circular economy. However, implementing EU organic standards and certification processes within the Western Balkans faces certain limitations.

While there is significant development of the legal framework for organic agriculture, along with competent authorities, control bodies, and accreditation and certification systems in the countries, harmonizing with the provisions of EU Regulation No. 834/2007 and EU Regulation No. 889/2008 has been adopted with varying degrees of success. In addition, following the "moving target" of EU policy and the changes introduced with the latest EU Regulation 2018/848 implies that its transposition, implementation, and enforcement into the national legal frameworks are still missing in the Western Balkan countries (SWG, 2022).

Besides straightforward policy support, achievement of the ambitious organic farming goals requires a balanced increase in both production and consumption/demand, which implies a substantial transformation in the structures of agricultural holdings and supply chains. Only a few farms in the countries are well integrated into the supply chain, as farms produce small quantities and of insufficient quality to compete in the market while compliance with food safety and quality standards has been a challenge (GIZ, 2019).

The domestic market for organic products is still underdeveloped; consumers are very price-sensitive, thus organic food prices are a major barrier to organic product purchases, along with lack of immediate availability, limited assortment, lack of information (especially in media), and lack of transparency and trust towards organic labels (Daniloska *et al*., 2017; AAEM, 2022). The domestic market lacks clear indications to consumers regarding organic attributes due to weak marketing and poor consumer education.

Nevertheless, there is a strong overall preference for organic food, perceived as safer and healthier than conventionally produced food – indeed, food safety and health concerns can be a primary driver behind organic food demand for instance for Albanian consumers (Imami *et al*., 2017). In addition to food safety and quality, increasing environmental awareness is another key factor behind the growing consumer preference for organic food (Wojciechowska-Solis and Barska, 2021). A recent study conducted with Kosovo consumers showed that health concerns, certification, and environmental concerns significantly influence consumers' attitudes toward organic food products (Miftari *et al*., 2022). Along with increasing consumer income, the desire to consume quality food is growing, implying increasing pressure to improve food safety and quality standards (Canavari *et al.*, 2017). Still, the limited awareness of Western Balkan consumers about organic products contributes to low domestic demand (Imami, *et al.*, 2017; Daniloska *et al*., 2017). Many consumers are familiar with the terms "bio" or "organic" but do not have a clear understanding of the meaning of these labels.

Currently, a proper network of marketing channels, collection points, and appropriate cooling and conservation facilities is lacking that would help establish functional markets for organic products. Similarly, there is a lack of support, both financially and in terms of know-how, for farmers to enter export markets. Financial constraints are a significant barrier for farmers to switch to organic agriculture because of the costs of investments to meet international quality and quantity requirements, as well as costly certification (Zhllima *et al*., 2021).

There is an unlocked potential for opening and developing new employment opportuni-

ties and new market perspectives for organic farmers. Yet, certain obstacles related to agro-technical practices need to be addressed as well as providing sufficient educational and informational activities for the development of organic production and sustainable practices in general. Farmers' probability of adopting sustainable practices, including organic farming is positively influenced by their perceived behavioral control (i.e. farmers' self-confidence and know-how), and by a supportive environment and information awareness (Zhllima *et al.,* 2021; Rizzo *et al.,* 2024). Growth in the organic sector needs to be supported by ambitious research and innovation, appropriate advisory services, support from processors, wholesalers, and retailers, knowledge exchange, and training opportunities for all organic operators and other stakeholders in the chain. Digital innovation in facilitating sustainable transformation, as has been shown in other sectors, should be explored and applied, taking into account its potential positive impact in promoting green development and sustainability relating to agricultural practices and rural development (Mićić, 2017).

The EU's Farm to Fork Strategy outlines ambitious environmental goals, including a significant reduction in pesticide and fertilizer use, a shift towards more sustainable farming practices like crop rotation and cover cropping, and an increase in organic farming land. The challenges for Albania, Kosovo and North Macedonia lay ahead in reducing the level with proper use of fertilisers and pesticide, and increasing the share of organic area. To attain the desired sustainable agri-food systems in line with the Green Deal, challenges include potentially reduced yields, land demand, changes in diet, food waste, and distribution and access to food. External factors require shifts in the system itself, from land management to distribution, diets, education and spatial optimization (Boix-Fayos and de Vente, 2023). Recent studies estimate potential declines in agricultural output in the range of 7% up to 15%, to be followed by higher food prices, if the EU strategy is implemented as planned (Beckman *et al.,* 2020; Barreiro-Hurle *et al.*, 2021). Policymakers need to carefully consider these probable trade-offs and explore ways to achieve environmental objectives without jeopardizing food security, especially in terms of availability and affordability (Beltrán *et al*., 2022). Striking a balance between environmental sustainability and ensuring food security at affordable prices is a crucial challenge that policymakers in the WB need to carefully consider. Addressing these issues is critical in order to alleviate some of the challenges towards ensuring sustainable and just agri-food systems transformation in the WB, not only in strategy and "talking points," but more substantially in actual policy implementation.

The findings have demonstrated the need for further research to inform targeted evidence-based policy interventions that will effectively address environmental sustainability in the context of agricultural policy in the EU pre-accession countries. While the EU Green Deal's objectives and the GAWB undoubtedly address critical issues like climate change, demographic shifts, and resource scarcity, the potential socio-economic risks associated with an ill-conceived implementation of the proposed measures cannot be ignored (Beltrán *et al.*, 2022). Policy impact evaluation is of paramount importance to assess the costs for various agents and sectors in pre-accession countries such as Albania, Kosovo, and North Macedonia. For instance, a rapid transition away from traditional agricultural practices could negatively impact farmers' livelihoods. Similarly, restrictions on certain production practices might result in economic adversity. Understanding the behavioral factors affecting the adoption of sustainable farming practices in this context will be crucial for informing agricultural policy (Dessart *et al.*, 2019). To mitigate these risks, policymakers should consider a phased implementation approach, allowing the actors throughout the whole "from farm to fork" chain to adjust. A more gradual implementation timeline with locally tailored approaches would allow farmers time to adapt and to adopt more sustainable practices without experiencing significant production losses.

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Analysis of the Moroccan agri-food system through national accounting "2015 Social Accounting Matrix": The role of the wheat sector in the agri-food complex

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Abstract

This paper evaluates the role of wheat in Moroccan agriculture. A social accounting matrix for 2015 disaggregates soft and durum wheat, focusing on agriculture and the agri-food industry. Results show that soft and durum wheat account for 19% of agricultural product resources. Their production contributes 21% to agricultural value-added, represents 3% of national value-added, generates 16% of agricultural wages, and 17% of agricultural capital. The industrial processing of these wheats contributes only 5% of the total value-added in the agri-food industry, generating 4.3% of labor and 5% of capital in this sector. Multiplier effects indicate that soft and durum wheat impact production activities by 2.66 and 2.6, respectively. An additional 1% injection would lead to an 84% increase in soft wheat production, a 16% rise in value-added, and a 26% increase in household income. For durum wheat, production would rise by 75%, value-added by 13%, and household income by 22%. Comparing the multiplier effects of wheat processing to production activities, the processing industry has a greater impact on production, value-added, and household income. These findings underscore the significant role of wheat in Morocco's agricultural and agri-food sectors, highlighting its economic and social importance. The multiplier effects suggest strategic investments and policy decisions could optimize benefits from wheat production and processing activities.

Keywords*: Agri-food system, Social accounting matrix, Soft wheat, Durum wheat, Wheat transformation, Agriculture.*

Introduction

The Mediterranean region's economic stability heavily relies on the agricultural sector. Agriculture and food security are critical issues since economic growth cannot occur without a strong relationship between agricultural development, environmental preservation, and food security.

Ensuring the food security of the population is one of the primary challenges of the agricultural sector. The global population continues to grow, and this increase is accompanied by rising food demand, particularly in developing countries where agricultural production does not keep pace with population growth. This situation makes the food system dependent on the international market, which has become increasingly

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unstable with significant price volatility. This dependency worsened after the 2008 global food crisis, which revealed the agricultural sector's vulnerability, as it faces a profound crisis and significant development challenges worldwide (Saidi, 2011). Additionally, with the advent of COVID-19, input and output prices have led to decreased incomes and weak investments (Elame *et al*., 2023). Food prices have skyrocketed, particularly the prices of cereals, which are the staple food for most populations.

Agricultural activity has been the foundation of food production long before the rise of the agri-food industry. With the advent of the agri-food industry, countries turned to intensifying agriculture to increase yields and ensure food supplies. The agri-food industry emerged to meet this objective. Over various stages of economic growth, this sector has taken an increasingly significant place in the final value of food products and the composition of consumers' shopping baskets, leading to substantial changes in the entire food system (Rastoin and Tozanli, 2008). It constitutes an essential link in the food system by providing products intended for final household consumption.

These two fundamental sectors, agriculture and the agri-food industry, form the backbone of the agri-food complex, ensuring the supply of agricultural raw materials and their transformation and packaging. The contribution of each sector to food production and value creation varies from country to country.

In Morocco, agriculture plays a crucial role in the economy, representing 14% of the national GDP (World Bank, 2016). However, this contribution is highly volatile due to the sector's dependence on climatic conditions. The sector also suffers from very low productivity and insufficiently valued productions (Erraoui & Fort, 2016). As for the agri-food industry, it has established its presence in the market with the creation of numerous companies in the field, with new production units enriching the agri-food system almost every year. These companies account for 27% of Morocco's total industrial production, or 4% of GDP (Erraoui & Fort, 2016).

The agro-industrial food system tends to globalize, meaning that companies and institutions in this system adopt new organizational forms to adapt to globalization phenomena. This transition places more importance on the agri-food industries, shifting from a rural economy focused on agriculture to an agri-food economy, which prioritizes agri-food industries and distribution to meet consumption needs.

Following the rise in international market prices, particularly for soft wheat between 2007 and 2008, and the resulting food crises, Morocco has prioritized food availability, leading to increased imports and a chronic trade balance deficit (Rerhrhaye & Ait El Mekki, 2017).

In Morocco, the agri-food system is complex due to the multitude of actors involved and their diverse statuses and sizes; multinationals coexist with family units (Rastoin *et al*., 2004).

1. Food System in Morocco

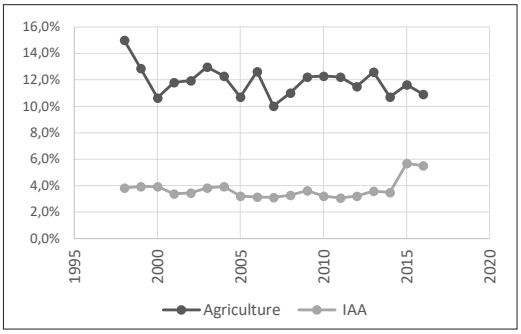
The agri-food system is composed of interdependent and interactive elements. It is a network of actors contributing to the creation of goods and services to meet consumer needs and ensure a country's food security. The concept of a food system describes all the activities involved in food production within a given society, the nature of the foods consumed, and their consumption patterns (Malassis & Ghersi, 2000).

In 2017, the agricultural and fisheries sector in Morocco represented 13.6% of GDP, valued at 131.62 billion DH. Moroccan growth is closely linked to the agricultural sector's performance: the significant fluctuations in the agricultural sector's value-added, reflecting its dependence on climatic conditions, particularly rainfall, affect GDP growth (Harbouze, 2019).

The agricultural value-added in 2015 was double that of the agri-food industries, a trend that has been ongoing for several years, as shown by the graphs below depicting the evolution of the value-added of the two sectors from 1998 to 2016.

We observe that variations in value added affect the agricultural sector more due to climatic fluctuations and international market price conditions. The value added by the agri-food industries averages 3.5% of the national GDP, which is significantly lower than the agricultural sector's share of about 12% on average.

Figure 1 - Evolution of the Share of Agricultural and Agri-Industrial (IAA) Value Added in Morocco's GDP.



Beyond agricultural production, Morocco has developed a diversified and competitive agri-food industry, notably in cereal processing, dairy products, and fruit and vegetable processing. This sector benefits from duty-free imports of raw materials for local consumption (cereals, crude oil, raw sugar) or export after processing, such as white sugar, whose global market sales have significantly increased since 2015. The agri-food industry has also benefited from the Green Morocco Plan through the increased agricultural production that can be processed and through the support granted to this sector (Harbouze, 2019).

According to the Ministry of Agriculture and Maritime Fisheries (MAPM), in 2016, the agri-food industry produced 160 billion DH (MM DH), accounted for 19% of industrial investments, 12% of industrial exports, and employed over 140,000 people.

1.1. *Cereal Farming in Morocco's Agri-Food System*

In Morocco, the food issue is characterized by the deficit in the solvable demand for staple foods and the significant insufficiency of domestic food supply. The country only partially covers its needs for basic food products such as cereals, milk, oils, meat, and sugar (Rerhrhaye & Ait El Mekki, 2017). A substantial part of food demand is therefore met by imports, which heavily impact the trade balance, especially when food prices rise.

The cereal sector is one of the main agricultural production sectors in Morocco. It plays multiple roles concerning the annual cultivation of arable land, the formation of the agricultural Gross Domestic Product, rural employment, and the utilization of industrial processing capacities (Aït El Mekki, 2006). It is a predominant crop for almost all agricultural operations and holds an important place in Moroccan consumption, with 180 kg per person per year of wheat consumed, ranking Morocco third in the world after Tunisia and Algeria (FAO, 2013). It also provides feed for livestock (barley and by-products) due to its major interdependence with animal sectors.

Cereals continue to play a central role among all plant products. This high level of cereal consumption is explained by several factors. Their consumption is encouraged by policies that keep consumer prices low for essential products and by the low incomes of some consumers (Marty *et al*., 2017).

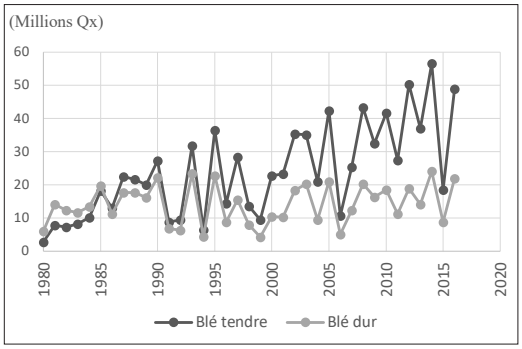
1.1.2. *Production and Imports*

The upstream sector includes wheat resources from national production and imports. National production is based on the cultivation of an average of 3 million hectares of wheat (soft wheat and durum wheat). These crops are practiced by almost all farmers, representing 60% of the cereals cultivated over the last five agricultural seasons and covering 37% of the UAA (Utilized Agricultural Area) (MAPMDREF, 2017).

In recent years, wheat production has seen significant progress with fluctuations primarily explained by climatic hazards (Figure 2). This progress reflects improved production levels and the gradual changes in consumer living standards and dietary habits, except for the years 2008 and 2010, when there was a significant drop in imports following price shocks in the international cereal markets, particularly the wheat market. However, production does not keep up with demographic growth, indicating a food deficit that increases the need for imports, especially for soft wheat, placing Morocco among the net cereal-importing countries and implying a risk of food insecurity.

The ambitions of the State to reduce soft wheat imports face real obstacles due to the projected decrease in international supply by 2030 and the scarcity of water, which implies a declining na-

Figure 2 - Evolution of Wheat Production in Morocco (MAPMDREF, 2016).



tional production that does not meet the demand (Rerhrhaye & Ait El Mekki, 2017). Wheat imports continue to be at the top of Morocco's agricultural import list, representing 45% of total agricultural imports and 27% of cereal imports in 2016 (MAPMDREF, 2016).

Due to its high dependence on cereal imports, with an independence rate between 40% and 50% (FAO, 2018), Morocco is one of the Arab countries most vulnerable to food price shocks, also influenced by its limited financing capacity.

1.1.3. *Wheat Consumption*

Morocco's food consumption model is still largely dominated by cereals. In 2014, wheat consumption was 171 kg per person per year, accounting for 73% of consumed grains and processed cereals. Expenditure on unprocessed and processed wheat reached 584 DH per person per year, representing 62.2% of cereal consumption expenditures (HCP, 2014).

Wheat production provides grains intended for direct household consumption or processing at mills, followed by secondary processing in pasta and biscuit industries to produce finished products. Additionally, straw production serves as livestock feed.

Cereal collection is managed by storage organizations. However, this collection system is deficient, as a significant volume of wheat bypasses the formal milling industry and goes through artisanal mills, which are not part of the formal circuit (FNM, 2001).

The milling sector generates an annual turnover of 20 billion DH and employs approximately 10,000 people. It comprises 137 mills that process soft wheat, 60 semolina mills that process durum wheat, and 19 barley mills (FNM, 2017).

2. Methodology

Through the disaggregation of the cereal sector, specifically soft wheat and durum wheat, within the Social Accounting Matrix (SAM), this study aims to elucidate the contribution of such staple products to agriculture and the broader economy. We will first define the SAM and its overall structure before beginning its disaggregation.

2.1. *Social Accounting Matrix (SAM)*

A Social Accounting Matrix (SAM) is a comprehensive table representing the production, distribution, and redistribution process of income among sectors, production factors, economic agents, and the "Rest of the World" (ROW, i.e., external agents to the considered economic system) over a specific period. As a representation of the entire economic system, the SAM highlights interrelations and the circular flow of income between goods, production, factors, and institutions (FAO, 2006).

The SAM is a double-entry table presenting the accounts of the Nation. It provides a comprehensive quantified overview of its structure and economic circuits. The SAM is an analytical tool that presents the accounts of the national accounting system in a matrix form, illustrating interrelations between the resource-use table and institutional sector accounts.

The flexibility of the SAM allows for the disaggregation of activities, institutional units, and production factors. It not only schematizes the real sphere of an economy but can also incorporate the financial sector or non-economic production activities as defined by SNA 93 (household domestic production). Including these activities does not necessarily require modifying the initial SAM structure if satellite accounts are used for this purpose (FOFANA, 2007).

From national accounts, we can define the branches identifying the agri-food complex. Upstream, primary branches supply raw materials, including agriculture, forestry, fishing, and

aquaculture, along with agro-supply sectors involved in food production, encompassing inputs such as energy, chemicals, agro-equipment, construction, and services like transport and trade. Downstream, we find the agri-food industries, hotels, and restaurants as the primary clients within the agri-food system.

Technically, the SAM is a square double-entry table that includes a series of account categories (FAO, 2006), typically:

- *Goods and Services Accounts*: These accounts provide an overview of the sources of final goods available in the economic system (production activities and imports) and their destinations (intermediate consumption activities and institutions).
- *Production Activities Accounts*: These primarily correspond to the production activities of the studied economy and generally refer to defined sectors.
- *Production Factors Accounts*: These accounts illustrate the remuneration of production factors by productive activities (receipts) and the allocation of these remunerations to institutions (expenses). They typically distinguish between labor and capital but may include natural resources like land and water.
- *Institutional Accounts (Economic Agents)*: Mainly households, businesses, and the government, these accounts record receipts in rows and expenditures in columns.
- *Capital Account or Savings-Investment Account*: This account records the allocation of resources for capital formation and the use of these resources for purchasing investment goods and stockpiling goods.
- *Rest of the World Account or External Account*: This account records payments made to and received from the rest of the world.

The disaggregation takes into account the wheat production chain from the farm to its initial processing into flour at industrial mills. Data collection for the secondary processing was challenging due to the confidentiality of the data that organizations are reluctant to disclose.

The updated social accounting matrix corresponds to the year 2015, so we chose 2015 as the reference year to present the most recent possible results. This year was characterized by favorable climatic conditions.

Data collection for filling out the SAM was conducted centrally at various departments of the Ministry of Agriculture and Maritime Fisheries, the Directorate of Statistics, the High Commission for Planning, offices (ONICL, ONCA, ORMVA), the National Federation of Milling (FNM), the National Federation of Grain Traders (FNCL), the Office of Exchange, industrial mills, and grain importing companies. Additionally, we relied on studies and surveys already conducted at the national level, which were useful in completing the database.

2.2. *Disaggregation of the SAM*

The definition of the various accounts considered all sectors involved in the production process at the farm level and the initial processing at the agro-food industries level up to final consumption by all resident institutions in various forms.

For goods and services, we distinguish between agricultural products and agro-industrial products.

- *Agricultural Products*: For the wheat SAM, we defined four accounts: two accounts for wheat (soft wheat, durum wheat), one account for straw, and one account grouping all other agricultural products.
- *Agro-Industrial Products*: These accounts correspond to wheat-derived products from their initial processing at industrial mills. We cite six accounts: two accounts for soft wheat products, namely F.N.B.T and free flours (luxury flour and FRS), and two accounts for durum wheat products, namely semolina, given the main product of this type, in addition to durum wheat flour, one account for bran, and one account for other agro-industrial products.

For production activities, we distinguish between agricultural production and agro-industrial production.

- *Agricultural Production*: For our case, only one group of activities is considered for disaggregation. We distinguish two production activities: soft wheat production and durum wheat production, whether rainfed or irrigated.

Table 1 - Table of product resources 2015 (billions of DHs).

Products	*Production*	*Imports*	*Trade and transport margins*	*Taxes*	*Total resources*
Soft wheat	16,4	5,5	3,7	0,57	*26*
Durum wheat	8,78	3	2,88	0,42	*16,4*
Straw	10	-	0	-	*10*
Free flours	8,4		0,48		*8,9*
FNBT	1,8		0,029		*1,8*
Wholemeal flour	1,9		0,066		*2,04*
Semolina	0,67		0,026		*0,7*
Bran	1,85		0		*1,85*

- *Agro-Industrial Production*: Within the agro-industrial branch, we disaggregate the initial cereal processing industry. This involves the activity of industrial mills nationwide, responsible for wheat milling. For this activity, we open production activity accounts for F.N.B.T, free flour production, durum wheat flour, and semolina.

For production factors used in the production of goods and services, we consider the value of land, agricultural and non-agricultural labor, agricultural and non-agricultural capital, and institutions including households (with an account for rural households with five income classes and urban households with five income classes), the state, and companies involved in the production and processing of soft and durum wheat. Finally, the rest of the world represents external exchanges, including Morocco's imports and exports of soft and durum wheat, alongside other product exchanges.

3. Results and discussion

3.1. *Analysis of the Results of the Disaggregated Matrix*

3.1.1. *Product Resources*

In 2015, the resources for soft wheat and durum wheat were estimated at 26 billion DH for soft wheat, representing 12% of total agricultural resources, while durum wheat resources were valued at 15.32 billion DH, accounting for 7% of total agricultural resources. These crops occupied 42% and 18% of the area, respectively, and contributed to 48% and 20% of total cereal production.

These resources mainly consist of domestic production. The 2014-2015 agricultural season experienced record production, leading to a reduction in imports, estimated at 5.5 billion DH for soft wheat (28% of agricultural imports) and 3 billion DH for durum wheat (16% of agricultural imports).

The value of domestic production was approximately 23.4 billion DH for soft wheat production and 11.7 billion DH for durum wheat production, including the value of grain and straw production.

Regarding wheat processing activities, the total milling at industrial mills in 2015 was estimated at 53.7 Qx, with 84% for soft wheat and 13% for durum wheat. The total resources from this processing were valued at 15.34 billion DH, comprising 58.17% free flour, 13.3% durum wheat flour, 12% FNBT[1], 12% bran, and 4.5% semolina. The production of the primary wheat processing industry represented 8.6% of the total production of the agri-food industry.

The product resources derived from the disaggregated matrix are presented in billions of DH in Table 1.

[1] FNBT: subsidizes common wheat flour, known as "National Flour".

3.1.2. *Value Added*

Agriculture contributed 13.13% to the national value added for the 2014-2015 agricultural season. Within this sector, the value added from soft wheat cultivation was estimated at 15.75 billion DH, with a production of 56.7 million quintals, representing 13.7% of agricultural value added and 2% of the value added across all sectors of the national economy. Durum wheat cultivation generated a value added of approximately 8.2 billion DH, with a national production of 24 million quintals, accounting for 7.13% of agricultural value added and only 1% of the national value added.

As for the value added by the primary processing industry of soft and durum wheat, it represents 5% of the value added in the agri-food industry sector. Free flours generate the highest value added, estimated at 2 billion DH, followed by durum wheat flour with a value added of approximately 283 million DH, FNBT with 244 million DH, and semolina with 40.6 million DH.

Table 2 - The value added of soft wheat and durum wheat and their share in agriculture and at the national level.

	Added value (Billions of Dhs)	*Share in agricultural VA (%)*	*Share in national VA (%)*
Soft wheat	15,75	13,7	2
Durum wheat	8,2	7,13	1
Other agricultural products	90,9	79,17	97
Total	114,8	100	100

Table 3 - The value added by the primary processing industry.

Products	*Added value*	*Share in the VA of the food industry (%)*
Free flours	2 073	3,7
FNBT	244	0,43
Wholemeal flour	283	0,05
Semolina	40,62	0,007
Total	2 640	5

3.1.3. *Household Expenditures*

Household expenditures for the final consumption of soft wheat grain amounted to 471.36 million DH, with 77.6% of these expenditures made by rural households, averaging 14 DH per person per year. Urban households accounted for 22.4% of these expenditures, with an average spending of 5 DH per person per year. However, household expenditures on durum wheat grain reached 1,274.3 million DH, with 52% spent by urban households at an annual average of 30 DH per person, and 48% by rural households with an average annual expenditure of 39 DH per person.

In terms of quantity, urban households consumed an annual average of 1.55 kg per person of soft wheat and 8.44 kg per person of durum wheat, while rural households consumed 4.6 kg per person of soft wheat and 11.9 kg per person of durum wheat annually.

Household expenditures on processed wheat products reached 15.24 billion DH, with 6.6 billion DH dedicated to the consumption of free flours, 4.9 billion DH for durum wheat flour, 1.8 billion DH for FNBT consumption, and 1.7 billion DH for semolina.

These expenditures highlight the significant role of wheat and its processed products in the diet and economy of Moroccan households, with notable differences in consumption patterns between urban and rural areas.

3.1.4. *National Flour Consumption and Expenditure Analysis*

National flour is primarily intended for low-income households, with 62% of expenditures made by rural households and 38% by urban households. The expenditures are higher among the less affluent household classes. For other wheat products, urban households tend to spend more, and the expenditures increase with the household income.

Expenditures on wheat grain consumption represent 2% of agricultural product expenditures, while expenditures on processed wheat

Table 4 - Household expenditure by standard of living class (in millions of DHs).

	Soft wheat		*Durum wheat*		*Free flours*		*Wholemeal flour*		*FNBT*		*Semolina*	
	Value	*%*	*Value*	*%*	*Value*	*%*	*Value*	*%*	*Value*	*%*	*Value*	*%*
Urban households	*105.68*	*100*	*668.4*	*100*	*4,179*	*100*	*2,916*	*100*	*692*	*100*	*1,037*	*100*
C1	12.3	11.6	81.4	12.17	602	14.4	328.6	11.27	164.3	23.7	131.38	12,6
C2	22.8	21.5	124	18.55	796.5	19	469.4	16	156.5	22.6	167.2	16.12
C3	24.6	23.27	141.7	21.2	867.3	20.7	580.3	20	156.3	22.6	207.7	20
C4	25.5	24.12	164.5	24.6	1,004	24	729	25	114.3	16.5	231.78	22.35
C5	20.5	19.4	156.65	23.4	909	21.7	794.3	27.24	99.3	13.35	297.3	28.6
Rural households	*365.68*	*100*	*605.94*	*100*	*2,460*	*100*	*1,993*	*100*	*1,133*	*100*	*826*	*100*
C1	46.54	12.7	64.25	10.6	243.34	10	208.6	10.4	214.4	19	80.4	9.7
C2	58.7	16	107.27	17.7	395.8	16	305	15.3	217.55	19.2	119.15	14.4
C3	72.88	20	123.67	20.4	441.5	18	416.8	21	228.12	20.13	156.5	19
C4	82.28	22	140	23	591.7	24	443	22.2	228	20	179.6	21.7
C5	105.28	28.7	170.91	28.2	788	32	615.16	30.8	246	21.7	286.24	34.6
Total expenses	*471.36*		*1,274.3*		*6,640*		*1,825*		*4,910*		*1,864*	

flour consumption account for 11% of food product expenditures.

3.2. *Analysis of Production Activity Multiplier Effects*

3.2.1. *Direct Upstream Multiplier Effects*

Once calculated, this effect measures the intermediate demand for goods and services of an activity from other activities providing the necessary inputs to increase production by one unit in the sector considered.

At the national level, a one-unit increase in soft wheat production activity leads to an increase in the use of seeds by 0.44 units, agrochemical products by 0.26 units, soil working machinery and equipment by 0.22 units, irrigation water by 0.07 units, and textile products for sacking by 0.05 units. The total direct upstream multiplier effect is 1.34 units. This implies that a 1% increase in soft wheat production activity will result in a 134% increase in intermediate consumption.

A 1% increase in durum wheat production activity increases the input demand by 124%, with the most significant increases in seed demand (41%), agrochemical products (24%), and agricultural machinery and equipment (19%).

Table 5 - Direct upstream effects by activities.

Activity	*Direct upstream effects*
Soft wheat	1.34
Durum wheat	1.24
Free flours	1.5
FNBT	1.6
Wholemeal flour	1.87
Semolina	1.96

An increase of one unit in wheat processing activity results in an additional demand for wheat, which is the primary input. The growth in free flour production implies an additional demand of 1.03 units of soft wheat for milling, 0.12 units of energy, and 0.15 units of materials and equipment. The total upstream multiplier effect is 1.5 units.

3.2.2. *Downstream Multiplier Effects*

Soft wheat is a basic input, particularly for the primary processing industry. An increase in this activity will lead to a rise in the demand for soft

Table 6 - Downstream ripple effect.

Activity	*Downstream effect*
Soft wheat	3
Durum wheat	3.02
Straw	0.0087
Free flours	0.29
Wholemeal flour	0.20
Semolina	0.077
Bran	0.016

wheat by 2.17 units for the production of soft wheat flours and 0.42 units for other agri-food industries. For durum wheat, the input supply for the production of semolina and durum wheat flour is 2.3 units, and 0.38 units for other agri-food industry products.

For straw and bran, which are used as livestock feed, an increase in livestock activity will induce a rise in demand for straw by 8.7% and 1.6% units for bran.

The flours are further processed and used in the production of pasta, biscuits, and other products. An increase in this activity will generate additional demand for flours with the following proportions: 29% for free flours, 20% for durum wheat flour, and 7.7% for semolina.

3.3. *The Multiplier Matrix*

Production multipliers measure the impact of a unit change in a sector on its production (direct effect) and on the production of other sectors in the national economy (indirect effect). They help determine the impact of a change in the final demand for a given product on the economy's production.

3.3.1. *Production Multipliers*

For cereals, soft wheat and durum wheat have effects of 2.66 and 2.6, respectively, on production activities.

Analyzing the distribution of these effects across different economic sectors reveals that an injection into one of the activities, namely soft wheat and durum wheat, induces a greater increase in the production of that activity itself compared to other sectors, achieving significant direct effects. An injection of 1 billion DH into the soft wheat production activity would result in an additional increase of 2.66 billion DH in the production of all activity sectors, including 0.84 billion DH for the soft wheat activity itself. For durum wheat, an injection of 1 billion DH into this activity would result in an additional increase of 0.75 billion DH.

An injection into these two products leads to a significant increase in the primary wheat processing industry much more than in other agri-food industries, with 0.33 as the effect for soft wheat and 0.25 for durum wheat. The direct effects of processed products are more significant, with 1.19 for free flours, 1.06 for FNBT, 1.14 for durum wheat flour, and 1.03 for semolina. Table 7 presents the direct and indirect effects of

Table 7 - Multiplier effects on sectors of activity

		Soft wheat	*Durum wheat*	*Free flours*	*FNBT*	*Wholemeal flour*	*Semolina*
Cereals	Soft wheat	0,847	0,182	0,638	0,721	0,179	0,186
	Durum wheat	0,17	0,75	0,165	0,174	0,625	0,669
Other agricultural activities		0,123	0,122	0,133	0,132	0,128	0,128
Cereal processing industry	Free flours	0,248	0,237	1,191	0,259	0,235	0,246
	FNBT	0,081	0,074	0,073	1,063	0,07	0,074
	Wholemeal flour	0,19	0,18	0,184	0,195	1,145	0,185
	Semolina	0,073	0,069	0,07	0,075	0,067	1,033
Others Agri foof industry		0,149	0,148	0,162	0,16	0,156	0,155
Other sectors		1,05	1,076	1,07	1,065	1,08	1,12
Total		2,66	2,6	3,7	3,84	3,7	3,8

Table 8 - Multiplier effect on added value.

	Agricultural products		*Agri-food products*			
	Soft wheat	*Durum wheat*	*Free flours*	*FNBT*	*Wholemeal flour*	*Semolina*
Effect on Land Rent	0,05	0,038	-			
Effect on Labor	0,046	0,043	0,27	0,28	0,26	0,27
Effect on Capital	0,07	0,058	0,68	0,59	0,63	0,57
Effect on VA	0,16	0,13	0,95	0,87	0,89	0,84

investment in unprocessed and processed wheat products.

3.3.2. *Value Added Multipliers*

Similar to production multipliers, value added multipliers measure the impact of a unit change in a sector on the value added.

The increase in agricultural value added primarily affects agricultural capital. Similarly, in the wheat processing industry, the increase in non-agricultural value added has a greater impact on non-agricultural capital, followed by non-agricultural labor.

These multipliers indicate that an additional unit injection would create an additional wealth of 16% in the case of soft wheat, with 7% for capital and 4.6% for wages, and an increase of 13% in value added for durum wheat, with 5.7% for capital.

The value added of the primary wheat processing industry will see an increase of 3.55 units after the injection of an additional unit into this activity.

3.4. *Income Distribution Multipliers*

For soft wheat and durum wheat, the effects of an injection on household income are 0.26 and 0.22, respectively. For these two crops, the income effects benefit rural households much more than urban households.

The effects that primarily concern urban households are those from injections into wheat-based processed products, with a greater effect seen with FNBT injections, followed by free flours, durum wheat flour, and semolina.

4. Conclusion

The disaggregated SAM for soft wheat and durum wheat has highlighted their significance in agriculture and the primary processing industry, revealing interdependencies between activities and the multiplier effects of monetary injections on activities, value added, and household income.

The value added from soft wheat represents 13.7% of agricultural value added and 2% of national value added. Of this, 76% compensates

Table 9 - Multiplier effects on income distribution.

	Effects on rural households	*Effects on urban households*	*Effects on households*
Soft wheat	0,17	0,09	0,26
Durum wheat	0,15	0,07	0,22
Free flours	0,22	0,27	0,49
FNBT	0,28	0,24	0,52
Wholemeal flour	0,21	0,26	0,47
Semolina	0,22	0,27	0,49

capital, 18% compensates land, and 5.7% compensates labor. For durum wheat, its share of agricultural value added is 7.13%, with 81% compensating capital, 13% land rent, and 5.6% labor. These two crops generate 10.4% and 5.33% of agricultural wages and 11.3% and 6.25% of agricultural capital, respectively.

Regarding the primary wheat processing industry, it accounts for only 5% of the total value added in the agri-food sector, with free flours generating the highest value added. The milling sector, with its various products, generates 4.3% of the labor created by the agri-food sector and 5% of the sector's capital.

Based on multiplier effects, soft wheat and durum wheat have effects of 2.66 and 2.6, respectively, on production activities. An additional unit injection would lead to an 84% increase in soft wheat production and a 16% increase in the value added of the activity, while for durum wheat, production increases by 75% with a 13% increase in value added.

The multiplier effect is most significant when injected into FNBT, followed by free flours, semolina, and finally durum wheat flour.

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Improving agricultural policies to enhance food security in Tunisia: A retrospective and prospective analysis

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Abstract

This paper explores the evolution and future perspectives of agricultural policies in Tunisia, focusing on their role in enhancing food security. The agricultural sector, while contributing around 9% to GDP and employing 16% of the active population, faces numerous challenges including water scarcity, climate change, and economic pressures from international trade. The study identifies that despite economic diversification, agriculture remains crucial for rural livelihoods and food security. Also, the paper critiques existing policies, particularly the inefficiencies in subsidies and the complexity of administrative procedures, which disadvantage small farmers. The analysis underscores the need for policy reforms aimed at improving farmers' incomes, reducing policy costs, and enhancing efficiency. Recommendations include developing infrastructure, promoting modern agricultural technologies, and adjusting trade policies to better balance export promotion with import substitution. The study concludes that a dynamic and transparent agricultural policy, responsive to international changes and inclusive of all farmer categories, is essential for sustainable agricultural development and food security in Tunisia.

***Keywords**: Agricultural policy, Food security, Retrospective and prospective analysis, Tunisia.*

1. Introduction

The agricultural sector in Tunisia plays a vital role in the country's economy, despite its relatively small contribution to GDP compared to other sectors. Indeed, agriculture contributed around 9% to GDP during the period 2019-2023, with an additional 3.2% coming from the agri-food industry (AFI). However, the share of the agri-food sector in the GDP has decreased from about 16 to 9 percent in between 1996 and 2023 (ONAGRI). Despite the diversification observed in the Tunisian economy, the agricultural sector remains economically and socially important for its contribution to the achievement of national objectives as regards to food security and employment. Agriculture represents 10% of total investments and employs 16% of active population, with half working in the cereals sub-sector (ITES, 2017).

The agricultural sector is made up of three main sub-sectors: crop production, animal production, and fisheries/aquaculture production.

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Crop production represents 64% of total output, while the rest is split between animal and fisheries production at an average of 28% and 8% respectively. Domestic production is estimated to fulfill nearly 50% of the nation's cereal needs, all livestock product needs, and more than 80% of its oil needs (ONAGRI, 2020).

According to FAOSTAT, Tunisia has about 10 million hectares of agricultural land, with around 4 million hectares utilized, 90% of which is rain-fed. Irrigated agriculture, the biggest water consumer, uses 82% of the available resources (World Bank, 2020). Primary crops by area include olives (49%), wheat (17%), barley (13%), almonds (5%), and dates (2%), and by production quantity: tomatoes (15%), wheat (14%), olives (12%), barley (6%), watermelon (6%), potatoes (5%), and chilies& pepper (5%).

In terms of foreign trade, the food balance made up 12% of Tunisia's overall trade balance between 2019 and 2023. Agricultural and agri-food products constitute 9.6% of total imports and 10.8% of total exports. Key imports include durum wheat, bread wheat, maize, and soya cake, with wheat alone accounting for over 51% of food imports. On the export side, major agri-food products include olive oil, fishery products, dates, and citrus. The food balance coverage rate was around 75% between 2010 and 2023 (ONAGRI, 2023).

However, Tunisia's agricultural sector faces challenges such as water scarcity (357 m^3/capita/year), climate change, soil degradation. Indeed, the majority of farms are small. Around 75% of farmers manage less than 5 hectares (ONAGRI, 2020). This can make modernization and mechanization of farming difficult. The lack of storage and transport infrastructure can also cause problems for product marketing. The Tunisian agricultural sector has also faced significant exogenous shocks, challenging its openness to external markets and highlighting the importance of food security. Notably, these include the COVID-19 health crisis and the war in Ukraine.

This paper provides a retrospective analysis of the Tunisian agri-food policies. It also identifies the new challenges and future perspectives of these policies for improving the agricultural sector's performance and promoting food security in Tunisia.

2. Main features of the Tunisian agriculture sector

2.1. *Importance of agricultural sector*

Agricultural sector in Tunisia is a fundamental source of economic growth. Despite the change and diversification observed in the Tunisian economy (industrialization, growth of service sector and expansion of tourism), the agricultural sector remains important for its contribution to food security, economic and social development. The importance of agriculture to the country's economy is highlighted also by its contribution to supporting rural livelihoods and controlling urban migration as it employs about a quarter of the Tunisian workforce (Touayi, 2004).

Over recent decades, most indicators show that the relative importance of Tunisian agricultural sector in the overall economy has been declining. The share of agriculture in Tunisia's Gross Domestic Product (GDP) has been significant changes over the decades, reflecting the country's economic transformations. Historically, agriculture was a major pillar of the Tunisian economy. However, with the development of the industrial and service sectors, the relative share of agriculture in GDP has declined. From the 1960s to 1970s, agriculture made up over 20% of Tunisia's GDP, with the economy being largely agricultural and the population predominantly rural. Since the 1980s, the share of agriculture in GDP began to decline due to economic diversification and the growth of industrial and service sectors, yet it still contributed around 15-20%. In the 1990s and 2000s, this share further decreased to about 12-15%, then to around 10-12%, as economic reforms and the rise of tourism and ICT became more prominent. By the 2010s, the agricultural share stabilized at 8-10%, continuing to be important for rural employment and food security. Between 2017 and 2022, agriculture accounted for approximately 10% of GDP, remaining vital for rural communities and significant for exports like olive oil, dates, citrus, and seafood (Boudiche *et al*., 2022). This evolution, economic diversification and the growth of industrial and service sectors reduced reliance on agriculture.

Table 1 - Indicators of agriculture sector in Tunisia.

	2011	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*Avreage 2017-2022*
Share of agriculture GDP in total GDP	8	9	8	9	10	10	10	10	11	10
Share of agriculture in total investment %	7.5	7.8	7	7	7	6	6	5	6	6
Share of agriculture employment in total %	16.4	14.9	14.8	14.8	14.3	14.3	14.4	14.5	14	14.4
Share of agriculture exports in total %	7	7	13	8	8	11	11	10	8	9
Share of agriculture imports in total %	6	9	9	8	8	9	11	9	8	9
Covering rate in food balance %	75	98	72	71	91	75	85	70	67.4	77

Source: BCT, 2023.

The major challenge facing the agricultural sector, in addition to climate change and limited production resources, is the competition from imported products, which can reduce the price of local produce. Traditional farming practices and the use of chemical fertilizers can also exacerbate the degradation of soil and water quality.

2.2. *Main agricultural commodities*

Agriculture in Tunisia is characterized by a wide diversity of crops, including cereals (wheat, barley), fruits and vegetables (olives, dates, citrus), dairy products, and meat. The country's land, spanning approximately 16 million hectares, is classified into three primary types: one-third arable land, one-third forests and rangeland, and the remaining third as desert. The arable land, of about 5 million hectares, is typically allocated to three main activities: one third to cereals, one third to olive trees and the rest to everything else. The irrigable areas in this country has increased from 200 thousands ha to 420 thousands ha in 2020. The heads (numbers) is declining over last decade due to low productivity and profitability.

The major crops grown in Tunisia are cereals, food legumes, forages and trees crops. This later covers 2 million ha, with the dominating activity being olive production (3/4). Regarding the livestock activities, the heads (numbers) is declining over last decade due to low productivity and profitability.

Table 2 - Total land use.

	Average (ha) (2017-2022)
Cereal	1,154,828
Driedbeans and legumes	87,570
Root crops	23,237
Nuts	9,196
Freshvegetables	144,264
Total fruit products	340,934
Citrus fruits	21,444
Grapps	26,576
Total Olive	1,675,554
Dates	43,477
Total industrial plants	15,636
Raw tobacco	1,976
Feedirrigated	429,701

Source: Elaborated from MARHP, 2022.

Tunisian farm structures are dominated by small farmers. Fam sizes of less 5 hectares are increasing in numbers while large ones are declining. This is indication of the increasing agricultural land fragmentation process that is taking place in the country, which represents a major constraint to the agricultural development in the country.

Table 3 - The most important agricultural products (1000 t).

	Before-revolution	*Post-revolution*	*Current*
Products	*Average 2010-2011*	*Average 2012-2017*	*Average 2018-2022*
Total cereals	1,133.5	1,400	1,843
Durum weat	700.5	840	1,109
Bread wheat	169.5	141	127
Barley	245.5	390	582
Olive oil	1.350	933	1,238
Grapes	180.1	177.3	178.3
Dates	310.1	351	358
Citrus	403	351	363
Apples	135.3	131	138
Potatoes	443.5	422	424
Tomatoes	1,553.5	1,238	1,297
Meats	237.1	233.6	237.7
Milk	1,370.4	1,332	1,341
Fishery products	101.4	129	149

Source: Elaborated from ONAGRI, 2022.

2.3. *Agricultural products trade*

The most exported agricultural products in Tunisia are olive oil, dates, citrus and fish. In fact, olive oil, dates and fish exports represent together about 50 percent of the value of Tunisian agricultural exports (Table 2). A major share of all exports of agricultural commodities goes to traditional markets of the UE. Tunisians pattern of exports is dominated by olive oil. The other large products of exports are the fishery products and the dates.

Among the typical products that are imported, the cereals are evidently at the top, represented about 50% percent in value of its agricultural imports.

The Annual Performance Project (MARHP, 2022) report highlights that family farming is

Table 4 - Structure of agricultural exports (%).

	Before-revolution	*Post-revolution*	*Current*
	Average 2010-2011	*Average 2012-2017*	*Average 2018-2022*
Exports	100	100	100
Olive oil	23	33	40
Fishery products	12	10	11
Dates	16	16	15
Citrus	1	1	0
Cereal preparations	9	7	6
Vegetable and fruit preparations	5	4	3
Fresh vegetables and legumes	5	4	5
Other products	30	24	19
Coverage ratio %	75	72	78

Source: Elaborated from INS and FAO data.

Table 5 - Structure of agricultural imports (%).

	Before-revolution	*Post-revolution*	*Current*
	Average 2010-2011	*Average 2012-2017*	*Average 2018-2022*
Imports	100	100	100
Durum wheat	13	13	11
Soft wheat	16	13	16
Barley	5	6	9
Corn	13	12	10
Total cereals	47	44	46
Milk and derivatives	2	2	2
Vegetable oils	18	14	10
Potatoes	1	1	1
Tea and coffee	3	4	4
Sugar	15	11	7
Other products	13	25	30

Source: Elaborated from MARHP, 2023.

predominant in the Tunisian agricultural sector, with 75% of farmland being under 10 hectares in size. Approximately 15% of the workforce is engaged in agriculture, along with a significant portion in seasonal roles. This sector offers stable income to about 470.000 farmers, contributing to rural population stability, with women comprising 35% of the agricultural workforce.

3. Retrospective analysis of past and current agricultural policies in Tunisia

Since independence, Tunisia's economic policy has focused on four main objectives: I) achieving food self-sufficiency, which has evolved into the broader concept of "food security"; II) promoting agricultural exports such as olive oil by subsidizing vegetable oils to preserve more olive oil for export; III) conserving natural resources (water and soil); and IV) enhancing the competitiveness of agricultural products in international markets (Laajimi *et al*., 2012; Boudiche *et al*., 2022).

To achieve these objectives, various economic instruments have been employed at different stages of the agri-food chains. Internal price policies, border protection, input use subsidies, financial and fiscal incentives and trade policies are the main tools used by public authorities to support agricultural producers.

3.1. *Price policies*

Regarding price policy, public intervention distinguishes three regulatory regimes. For the first regime (cereals and milk), the state sets a guaranteed minimum production price at the beginning of each agricultural season. This aims to provide farmers with a signal of future market prices to help them make optimal production and resource allocation decisions. The set prices are those that farmers are assured of receiving when they sell their produce. For a long time, these prices were higher than world prices, but they fell below world prices following the 2007-2008 food crisis. This downward trend accelerated with the depreciation of the Tunisian currency. Between 2012 and 2022, the Tunisian dinar depreciated by 34.5% against the Euro and 38% against the US Dollar. Since 2016, this depreciation has had increasingly severe impacts on farmers' incomes and the expenses of the compensation fund, widening the gap between domestic production prices and global prices for several basic agricultural products.

The milk production price administration policy showed its limits for the first time in 2015 and especially in 2016 due to a decline in local demand and dairy product exports, which severely affected the capacity of industries to absorb milk production despite state subsidies. For the sec-

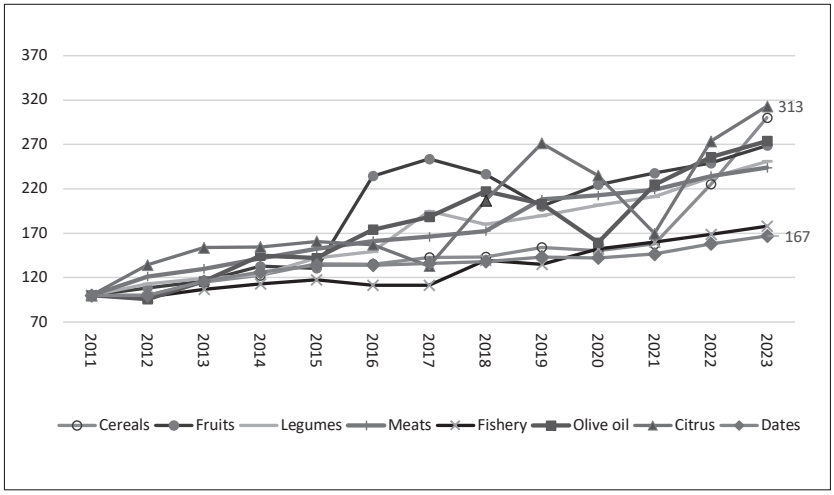

Figure 1 - Average price indices of agricultural products (2011=100).

Source: Elaborated from BCT, 2023.

ond regime (sugar beet and raw tobacco), prices are also fixed, but the state intervenes directly through a public body that regulates domestic prices by releasing the necessary product quantities to absorb any excess demand that would drive prices up, thereby aligning the market price with the pre-set institutional price. This policy requires the government to maintain sufficient stocks. Guaranteeing a minimum production price ensures a certain level of remuneration for producers and protects them against global price fluctuations.

Lastly, for vegetables and meat prices, which are supposed to be governed by market mechanisms, public intervention has been heavily criticized for its economic rationality. When national production is limited for a given product, prices naturally tend to rise. Public authorities intervene whenever these prices reach a level deemed too high by setting a ceiling price without compensating producers or even by prohibiting exports. Conversely, when prices are very low due to abundant national production, no measures are taken to safeguard producers' incomes. This type of intervention, aimed at controlling inflation at the expense of certain categories of farmers, has significantly affected their incomes and the overall development of the agricultural sector in recent years.

The figure illustrates the trend of various food production price indices from 2011 to 2023. All food production prices show an increasing trend over the years, with some categories like Fruits and Citrus exhibiting more variability than others. This general upward trend indicates growth or an increase in these categories' prices from a base index of 100 in 2011 to 2023. Cereals prices (represented in blue) start around 100 in 2011 and show a steady increase, reaching approximately 167 by 2023. Fruits prices display a more variable trend, peaking at about 270 in 2018, and then reaching their highest point of around 313 in 2023.

Index price of fishery exhibits a gradual and steady rise over the years, reaching around 200 by 2023. Index price of olive oil experiences moderate fluctuations, peaking around 2017 and 2018, and stabilizing at around 200 by 2023. Legumes price demonstrates a steady increase from around 100 in 2011 to approximately 200 in 2023. Meats also show a consistent upward trend to about 230 in 2023. Citrus has the most variability price peaking sharply at about 320 in 2018, then fluctuating significantly before stabilizing at around 250 in 2023. Finally, index of Dates prices shows moderate fluctuations but an overall increase from around 80% between 2011 and 2023.

3.2. *Input use subsidies*

In addition to controlling product prices, the government intervenes in input prices to support farmers' incomes and enhance the inten-

sification of agricultural activities by encouraging irrigation and increased use of industrial inputs (fertilizers, pesticides, machinery, higher-yield varieties, animal feed, etc.). Almost all these inputs have been "officially" provided to farmers at prices below their respective market prices. However, in realty, subsidized inputs were available in very limited quantities and often sold through parallel channels at much higher prices than those set by the government. This systematic intervention, in effect during the 1970s and the first part of the 1980s, aimed to maximize production without optimizing input use and without considering farmers' potential reactions to these incentives or other related environmental issues. Consequently, progress towards achieving quantitative objectives was modest (Elloumi *et al*., 2012). Since the mid-2000s, this policy, instead of controlling production costs in certain agricultural activities, has led to accelerated transfer of rents to few importers and input distributors (Laajimi *et al*., 2012; La Rovere *et al*., 2010). This situation has worsened since 2016, with even millers no longer supplying animal feed to agricultural cooperatives, despite the entire supply chain being controlled and subsidized at every level. These products are now sold on the black market at nearly double the administered prices.

Regarding irrigation, the government has implemented further measures to boost the irrigated areas and water efficiency improvement. The State programs involve subsidies of modern irrigation equipment (drip) up to 60% of total investment costs and irrigation water pricing at lower price mainly for cereal crops.

3.3. *Institutional framework*

The institutional framework plays a crucial role in economic development and has a significant impact on agricultural performance. The state can influence, either directly or indirectly, agriculture's contribution to various development goals through series of measures and price interventions, facilitated by different institutions. For example, the Office of Cereals regulates cereal transport and once held a near-monopoly on collection and importation. However, since 2005, with the liberalization of competitive commercial activities, the participation of private collectors has steadily increased, rising from 0.7% in 2005 to 42% in 2010 and 60% in 2023.

The Office of Commerce holds a monopoly on importing sugar and several other food products such as potatoes, coffee, and tea. The National Oil Office imports edible oils and exports olive oil. It is the sole exporter under agreements with the EU for bulk olive oil, which has a fixed quota of 56,700 tons per year. Private actors are allowed to export under this quota only when the quantity collected by the National Oil Office is below the allocated amount. Furthermore, the quota allocation process is ambiguous and can lack transparency.

Serious questions arise about the effectiveness of these offices, which are increasingly criticized for their impact on the agricultural sector's development. Issues such as prolonged olive oil export crises, grain quality evaluation procedures for price setting, the efficiency of monopoly-controlled agricultural product imports, and the rise of black markets for various products, particularly livestock feed, underscore the need for profound institutional reforms. These institutions no longer meet the new demands of supporting and developing the sector in a highly competitive global environment that presents both opportunities and risks. They appear incapable of playing a pioneering role in the sector's modernization and transformation. Only through modernization and genuine adaptation of the sector can Tunisia hope for a more significant contribution from agriculture to the country's economic and social development.

3.4. *Financial and fiscal policies*

As for other transfers to producers, they are granted with the approval of the Agricultural Investment Promotion Agency (APIA), established in 1983. These measures primarily take the form of direct investment grants and tax benefits for farmers. The new investment code distinguishes between two categories of investment grants

based on the total investment amount: 30% and 15% for smaller and larger investments, respectively. Additionally, any investment component deemed to improve farm competitiveness receives a 50% grant. This includes, among other things, agricultural mechanization and irrigation equipment. However, there is a significant gap between goals and reality, as subsidies are now almost exclusively directed to large enterprises, which are very few in number. Small and medium-sized farms are nearly excluded from the new subsidy administration system, which has become much more complicated in terms of procedures and limits subsidy payments to the realization of 40% of the planned investments. This new code and its implementation regulations represent the greatest danger to the Tunisian agricultural sector, as they fail to consider the characteristics of Tunisian agriculture, which is predominantly based on small farms that produce almost all of the country's dairy, meat, and vegetable output.

Even the Tunisian tax system, which allows for VAT exemption and suspension on certain agricultural equipment, remains difficult to implement and very costly for both farmers and the tax administration itself. Two measures are effectively in place. The first suspends VAT on two lists of agricultural equipment, specific equipment parts, insecticides, and fungicides. The second authorizes specific exemptions (fuel tax exemption) under the investment code. However, over the past few years, restrictions on VAT exemption and suspension have been gradually introduced. To benefit from VAT exemption on inputs and equipment, a "local origin" standard is now required, covering an extensive list of products. These restrictions are costly for the agricultural sector as they force farmers to source from local suppliers, who often provide inferior quality products or sell at relatively higher prices. In practice, these measures effectively grant local producers a competitive advantage equivalent to the VAT rate on a list of products whose selection and annual revision are questionable. This VAT regulation is illegal considering Tunisia's commitments under various trade agreements, which specify that VAT should not be used as an equivalent to customs duties to discriminate against products based on their local or foreign origin. To circumvent this, the current regulation states that it is a suspension, not an exemption, of VAT.

Viewed from one angle, such a measure might seem beneficial for the national economy. However, considering farmers' well-being, the picture changes as they are penalized and forced to buy local products, often with insignificant local added value, instead of accessing potentially more competitive and suitable imported products. In this context, such a policy also diverts the initial fiscal benefits intended to encourage agricultural investment by creating a captive market for local producers of inputs and equipment, disregarding the farmers' interests. Besides these system failures, the procedures required to benefit from these advantages are often very complicated and costly, preventing small farmers from taking advantage of them.

3.5. *Trade policy*

One of the main objectives assigned to the Tunisian economy is to ensure that agriculture contributes to improving the balance of payments. To achieve this, export promotion policies are implemented for products where Tunisia has a comparative advantage (olive oil, seafood, dates, citrus fruits). However, given the national goal of increasing food self-sufficiency, import substitution policies for food products that are socially and economically important, such as cereals, milk, and beef, are also implemented. Consequently, the current issue is finding an appropriate mix of export promotion and import substitution policies to improve the country's food security.

The majority of Tunisia's agricultural and agri-food trade is conducted with the European Union (EU). Overall, 70% of Tunisian agricultural and agri-food exports are sold on the EU market, and 40% of imports of these products come from the EU. However, the agricultural trade between Tunisia and the EU is currently governed by the provisions of the Association Agreement which, for these products, provides

a specific regime based on the exchange of reciprocal concessions (agricultural protocol).

The concessions granted for Tunisian agricultural exports depend on their nature and the sensitivity of the products for the European market as well. Four cases are provided: I) full exemption from customs duties, without restriction on the quantities traded neither on the export period; II) a total exemption from customs duties, with limitations regarding the export period; III) total exemption of customs duties for a certain quota, and IV) a partial reduction of tariffs, without any quantitative restrictions. In contrast, Tunisia has committed to provide the EU preferential access to its market for cereals, meat and dairy products and also consolidate its concessions according to the WTO agreements.

Negotiations on agricultural trade between Tunisia and the EU in the frame of the CDFTA should take into account the recent developments of the Tunisian economy and encompass a more global vision regarding the fact that the agricultural sector is supposed to play a role within the economic diversification strategy in addition to the improvement of social and economic performance, especially in the integration chain of regional and international values.

4. Emergence of new challenges

Tunisia's agricultural policy development must consider several forward-looking factors affecting agricultural production and trade: I) Anticipated impacts of climate change: Higher temperatures and more frequent extreme weather events will complicate resource management, leading to land and groundwater degradation. II) Effects of increased national and international demand for higher-quality agricultural and food products: This trend poses supply risks for Tunisia but also offers export opportunities. III) Fluctuating international agricultural prices: Price spikes may encourage greater production, yet market volatility raises investment risks. IV) Expected rises in energy and agricultural input costs, influencing production and marketing expenses. V) Global conflicts and geostrategic issues (e.g., Ukrainian-Russian conflict, Palestine) that can disrupt food availability. VI) Challenges like pandemics, diseases, and crop pests exacerbated by climate change.

Actually, the agricultural sector faces a multitude of challenges and issues. At the agricultural investment level, the dominant approach to agricultural investment tends to favor large enterprises while largely neglecting small and medium-sized farms. Additionally, ineffective input subsidies and cumbersome administration contribute to the complexity of the situation. the reluctance of financial institutions, notably the national bank responsible for financing the agricultural sector, given the absence of land titles for the majority of agricultural operations and the status of farmers.

Moreover, in terms of marketing, an oligopoly exerts control over milk prices, and grain prices often fall below global standards. Similarly, the lack of transparency in the marketing system poses a significant obstacle to the sector's profitability. The presence of unfavorable logistics, coupled with a money laundering sector that increases agricultural production costs, exacerbates the difficulties faced by the sector. Agricultural incomes are declining, and the capacity for processing and adding value to agricultural products is low. Markets for agricultural equipment and inputs suffer from imperfect competition. The sector lacks a clear agricultural policy, faces continuously rising production costs, and has no credible commercial policy. Controlling the loss and wastage of agricultural along the entire value chain covers a large part of food deficits (FAO, 2022; Ben Becher, 2016).

The existence of significant regional imbalances has led to considerable exodus and migration of rural populations, with approximately one million people leaving rural areas over a six-year period. The inefficiency of natural resource management and governance policies for water and soil conservation, coupled with agricultural research disconnected from real development issues, exacerbates the situation, consequently threatening the sector's sustainability.

5. Prospective analysis of agricultural policies in Tunisia

The entire current policy for encouraging the agricultural sector has become unclear and should be reformed to ensure better efficiency in both spending and expected outcomes. This policy became obsolete when Tunisia started subsidizing imported products at the expense of locally produced ones, effectively imposing a new tax on the sector, leading to a continuous decline in agricultural incomes. This phenomenon began in 2008 but significantly increased in 2016 and especially during 2017-2019. This observation is particularly relevant to bovine milk, for which production and consumption prices are set by the government. Despite significant rises in production costs due to increased prices of concentrated feeds—most of which are imported—the government has repeatedly refused to raise the price paid to local producers. To address the milk supply shortage, the government imports milk at prices significantly higher than those received by local producers. In other words, the government opts to import milk at higher prices rather than raising consumer prices, hoping for a future decrease in global feed prices.

The reality is that the country lacks an effective agricultural policy, which should ideally achieve three main objectives: increase and diversify production, ensure sufficient profitability for producers, and preserve the country's main natural resources, especially water and land. Currently, these objectives are far from being achieved, and the sector is confronted with contradictory instruments resulting in decreased agricultural incomes, reduced productivity, and capacity to adjust, and above all, depletion of natural resources. Meanwhile, significant public expenditures continue to be allocated to the agricultural sector, albeit with very low efficiency. In Tunisia, the state budget allocated to the Ministry of Agriculture and its public enterprises reaches between 10 and 15% of agricultural value added, a substantial amount compared to other countries. Thus, the issue is not to increase spending but rather to better manage current resources for improved economic and social efficiency of the sector.

Even with the most favorable conditions for the development of the Tunisian agricultural sector, economic benefits remain limited due to the low capacity for reallocation and adjustment within Tunisian agriculture. It seems to possess a comparative advantage in arboriculture and its derivatives (specifically olives), but its production capacities are constrained by the very nature of this type of cultivation (which has a very long return on investment) and by the limitation of natural resources.

The reform of Tunisian agriculture will only bear fruit if it is accompanied by increased access to the European market for its export products as well as other markets. Within the framework of deepening its partnership with the EU, Tunisia would be entitled to demand such a counterpart since the liberalization of Tunisian agriculture significantly favors the EU. The main recommendations to improve performance of this sector are us follow:

Revise the investment code to facilitate procedures and ensure it contributes to achieving development goals.

- Review the process for granting drilling permits to better conserve water resources.
- Ensure more effective transmission of global prices to local prices for products with regulated prices.
- Revise the agricultural development strategy for better use of natural resources.
- Reassess the role of public offices and ensure greater private sector participation on competitive bases for supplying inputs and marketing agricultural products.
- Establish a foreign marketing strategy for agricultural products and develop a common commercial vision based on a national strategy.
- Simplify procedures for acquiring equipment.
- Reorganize wholesale markets.
- Promote better competition to facilitate the establishment of agricultural product processing units.
- Stop subsidizing inputs and favor a system of direct transfers according to objectives.
- Clarify the role of the Ministry of Agriculture, which should, in our opinion, protect farmers' incomes rather than "consumers."

- Encourage the formation of Mutual Agricultural Services Societies (SMSA). This would reduce transport costs and losses, subsequently lowering consumer prices, stimulating both consumption and production.
- Resolve the financial problems of small farmers who have been unable to meet their repayment commitments on previous loans.
- Modify the consumption model of Tunisians through appropriate policies to stimulate domestic production by changing consumer diets. For example, reduce the consumption of soft wheat (flour used to make bread, which is largely imported), vegetable oils, and sugar, which also pose public health issues and increasingly strain the state budget.

6. Conclusion and policy recommendations

Tunisia agricultural sector is facing new challenges such as water scarcity, climate change, soil degradation, land fragmentation, deterioration of farmers' income and consumers buying power. The present agricultural policies are not efficient to address these challenges. Hence, new policies for sustainable food system are needed. This comprehensive vision should take into account the following interventions:

- Improving the income of farmers in order to increase the role of agriculture in reducing the unemployment rate, fighting against poverty, and strengthening the balance between the different country regions. If it wants to achieve these objectives, Tunisia should abandon the indirect taxation policy in the agricultural sector now in place in favor of a policy which aims to improve the growth of farmers' income based on a greater level of transmission of world prices to local producer prices.
- Reducing the cost of agricultural policy and improving its efficiency, because actually the policy of controlling the prices for certain goods, such as cereals and dairy products, appears to be heavy and expensive whereas its impact remains limited. In general, there is an urgent need to assess the effectiveness of the agricultural policy in Tunisia and to find alternative mechanisms that has to be less expensive, but also more effective for the development of the sector and improvement of farmers' income.
- Shifting the efficiency of agricultural policy through the development of infrastructure (water, transport network, electricity, distribution channels...) instead of instruments of subsidies to the private direct investment currently into existence, which largely contributed to introduce heavy disturbance of the agricultural sector without taking into consideration the need to improve equal opportunities for different categories of farmers.
- Enhancing the transparency and adaptability of agricultural policy to effectively respond to international changes impacting the sector.
- Reforming the agricultural trade policy should be placed in the broader context of the profound reform of the Tunisian agricultural policy.
- Empowering programs focus on small farmers with access to affordable credit, technical training, and modern agricultural technologies.
- Enhancing sector efficiency and productivity through the adoption of smart agriculture using drones, sensors, and hydroponic techniques.
- Developing investments in the agro-industry and cold storage facilities to reduce post-harvest losses and improve agricultural product management. This helps create integrated value chains by processing raw materials locally, adding value, generating employment, and ensuring price stability for agricultural products.
- Promoting organic production to enhance the competitiveness of export products.
- Promoting reused water and improving water use efficiency by implementing high technologies such as hydroponics and smart irrigation.
- Adjusting cereal producer prices, especially to align with world prices.
- Enhancing the importance of insurance and the National Risk Fund.
- Promoting the roles of institutional structures like GDAs, SMSAs, and private companies.

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Agricultural and food business dynamics in the Mediterranean region: Identifying key indicators for sustainable supply chain systems originated by small-scale farming production

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Abstract

Fruit and vegetables play a crucial role in ensuring food and nutrition security, and developing more sustainable value chains in agriculture and the agri-food sector. To support a greater supply of fruit and vegetables, small farmers' production is fundamental and needs to be integrated into stable value chains to maintain market, logistics and quality conditions. This article develops a theoretical framework based on the conditions, strategies and performances of supply chain systems, combined with the elicitation of expert opinion, to identify key variables for the specific analysis of fruit and vegetable supply chains. Empirical data was retrieved from eight supply chains in five Mediterranean countries to identify the most relevant issues related to their conditions, strategies and performances. Three different types of supply chains were included: 1) Short food supply chains, 2) Green public procurement, and 3) Export-oriented supply chains. This research made it possible to identify key indicators for the analysis of fruit and vegetable supply chain system dynamics. The variables identified in this study may contribute to prospective research for the assessment of fruit and vegetable supply chain sustainability and to the development of policies that encourage the adoption of environmentally-friendly and socially-responsible practices, thus contributing to the long-term sustainability of Mediterranean fruit and vegetables supply chains.

Keywords*: Agriculture and food policies, Value chain organisation, Business models, Sustainable food systems.*

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1. Introduction

The problems associated with the global food crises make agri-food supply chains a critical component for achieving the Sustainable Development Goals and sustainable food systems (UN, 2015). The goals of ensuring a global sustainable food system, reducing food waste throughout the supply chain and ensuring food safety are recognised in the European "Farm-to-Fork" strategy, which is at the core of the European Green Deal strategy (European Commission, 2020). In the global agri-food system, the following challenges have been identified: (i) improving supply-chain sustainability; (ii) reducing food losses and waste; (iii) promoting a global dietary transition to a more sustainable diet. Within this framework, food categories such as fruit and vegetables are widely recognised as key foods for ensuring people's food and nutrition security (FAO, 2020). These foods are also considered to play a crucial role in the implementation and further development of more sustainable value chains in agriculture and the agri-food sector (Santacoloma *et al*., 2021).

Furthermore, a number of studies show the importance of smallholders in the global production of fruit and vegetables (e.g., FAO & CIRAD, 2021; Santacoloma *et al*., 2021), with small-scale farmers known to produce between 50% and 75% of the calories consumed annually worldwide (IFPRI, 2019; Ricciardi *et al*., 2018). They greatly diversify food systems and improve consumer access to fresh and diverse food (Galli *et al*., 2020), and their role is crucial in ensuring food security and social-ecological resilience (Guarín *et al*., 2020; Guiomar *et al*., 2018). Smallholdings are known to have very heterogeneous characteristics (Darnhofer, 2014; Guiomar *et al*., 2018, 2021; Palmioli *et al*., 2020; Rivera *et al*., 2020), including different organisational and business models (Prosperi *et al*., 2023), and they can therefore be integrated into different supply chain systems, from short food supply chains to export-oriented supply chains (Grando *et al*., 2020). Previous studies have highlighted the complex diversity created by business models for smallholdings within local, national and global food systems, as well as the associated multi-scale resilience capacities of small farms vis-à-vis farming system challenges (Winter & Lobley, 2016), including in the Mediterranean area (Prosperi *et al*., 2023).

However, smallholders, who typically farm on small plots and rely on traditional farming methods, can face various sustainability challenges that impact both the environment and their livelihoods (FAO and CIRAD, 2021; Rivera *et al*., 2020). They often lack access to key resources such as land, water and capital (Kapari *et al*., 2023) countries from this region have the responsibility to reduce green gas emissions and adapt to the changing climate in the agricultural sector through such measures as climate-smart agriculture (CSA). This limits their ability to adopt sustainable agricultural practices or invest in modern technologies that could improve their efficiency and reduce their environmental impact (Dhillon and Moncur, 2023). Limited access to modern pest control methods and the use of chemical pesticides can lead to pollution and damage ecosystems (Diemer *et al*., 2020) an increasing number of smallholder farmers in low- and middle-income countries are using conventional pesticides. Adopting safer pest management requires farmers to obtain new information. However, little is known how farmers develop an information need, seek, and use pest management related information, and whether this process differs for organic and conventional pest management strategies. In this qualitative study, we investigated pest-related information behavior in depth, from farmers' own perspective. Using an ethnographic approach, we conducted 46 semi-structured interviews, 15 on-farm observations and 302 structured questionnaire interviews with farmers in Wakiso District, Uganda, in 2017. Our results indicated that farmers develop information needs when adopting new farming practices, or when presented with disruptive information (e.g. when new pests emerged). Smallholders may not know about or have access to alternative pest control strategies that are less harmful to the environment (Diemer *et al*., 2020) an increasing number of smallholder farmers in low- and middle-income countries are using conventional pesticides. Adopting safer pest management requires farmers to obtain

new information. However, little is known how farmers develop an information need, seek, and use pest management related information, and whether this process differs for organic and conventional pest management strategies. In this qualitative study, we investigated pest-related information behavior in depth, from farmers' own perspective. Using an ethnographic approach, we conducted 46 semi-structured interviews, 15 on-farm observations and 302 structured questionnaire interviews with farmers in Wakiso District, Uganda, in 2017. Our results indicated that farmers develop information needs when adopting new farming practices, or when presented with disruptive information (e.g. when new pests emerged. In addition, inadequate infrastructure such as roads and storage facilities can lead to post-harvest losses and reduce the economic viability of sustainable practices (Bisheko and Rejikumar, 2023). Smallholders may struggle to transport and store their produce efficiently, which can impact both their income and the overall sustainability of their operations.

Various attempts have been made in different regions to propose general frameworks for analysing the sustainability of agri-food systems, by identifying relevant key indicators for specific products or at a regional level (Krishnan *et al*., 2022; Norde *et al*., 2022). Many research efforts focus on the Mediterranean Basin (Allen and Prosperi, 2016; Allen *et al*., 2019; Bôto *et al*., 2022) due to its specificities in terms of climate, nutrition and cultural heritage, which have raised specific questions concerning the agri-food systems of this region.

In addition, the sustainability of the agri-food system in the Mediterranean area is threatened by climate change, population growth, water scarcity, food insecurity, unsustainable agricultural practises, and the low profitability of smallholders (Casini *et al*., 2019; Antonelli *et al*., 2022). More recently, the Covid-19 pandemic disrupted the movement of goods between countries, which had a strong impact on the producer price index for fresh and perishable products (Gray, 2020). Furthermore, the disruption to agricultural labour entry at European borders during the Covid-19 pandemic led to labour shortages in the fruit and vegetable sector in the Mediterranean area, which resulted in an inevitable increase in the price of fruit and certain fresh vegetables (Coldiretti, 2020), thus highlighting the essential vulnerability of this sector in Europe and the Mediterranean region.

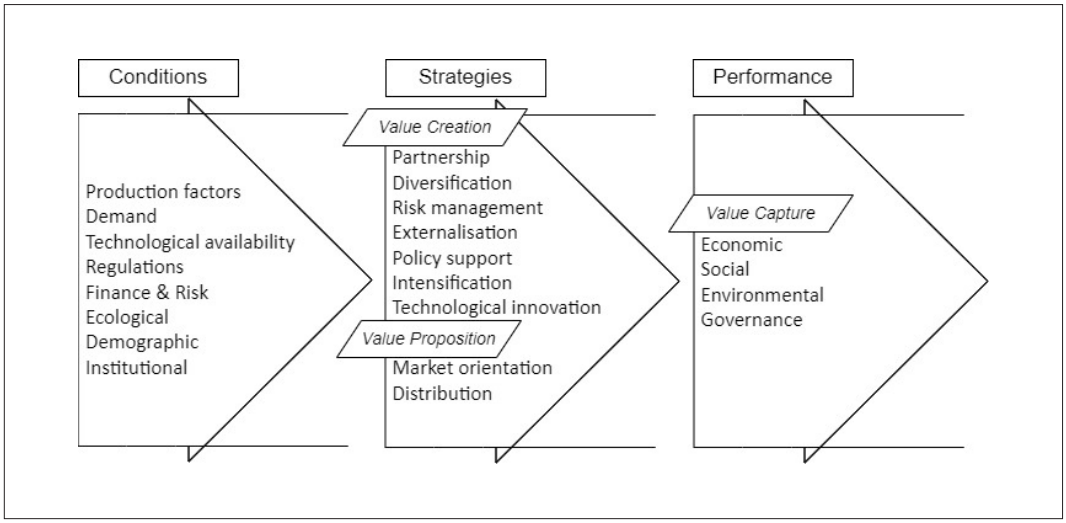
Analysing sustainability in the heterogeneous context of the Mediterranean agri-food sector, especially when it comes to small-scale producers and supply chains actors, has become complex and deserves further investigation. Therefore, this paper aims to identify key variables for the assessment of the sustainability of small farm-based fruit and vegetable supply chain systems (F&V SCS) in the Mediterranean region by addressing the conditions related to their business environment, strategical solutions and sustainability performance.

A theoretical background of the model is presented in Section 2. The analysis covers three types of F&V SCS (Section 2.1). As part of the project, eight clusters of firms from the F&V SC sector were selected as case studies throughout the Mediterranean area (Table 2). Each of the three supply chains analysed in this paper are covered by at least one case study. In Section 3, the geographical and economic boundaries of the clusters are defined and delimited. The key issues and opportunities of local supply chains are defined through stakeholder and expert elicitation. The results of the interviews with experts on the subject are presented in Section 4, along with the selected relevant variables for assessing the multi-dimensional drivers of supply chain systems, their strategic choices and competitiveness performance

2. Theoretical background

An agri-food supply chain is defined as a series of complex networks between the agricultural production sector, the food processing industry and the distribution sector, that create pathways from farm to consumer. Food systems take a broader view by considering the interactions between and within the bio-geophysical and human environments, a range of activities (from production to consumption) and the outcomes of the activities (Ericksen, 2008). In this work, we use the term "supply chain system"

Figure 1 - Value-Management CSP Model of supply chain systems' causal dynamics.



(SCS) to emphasise the linkages and relationships between the stakeholders involved in the production and trade of food while considering the external factors that influence their strategies and the outcomes of their activities.

This paper presents an original theoretical framework that assumes that supply chain actors employ strategies to overcome the constraints, obstacles and risks imposed by their socio-economic, biophysical and institutional environments. The outcomes of the strategies are translated into performance and unintended consequences. Performance in turn influences the characteristics of actors as well as their conditions, etc. These interrelationships are mapped and inventoried using the *Conditions-Strategies-Performances* (CSP) model adopted by Grando *et al*. (2020), and originally from Porter's (1981) *Structure-Conduct-Performance* framework in the field of economics and the management of industrial organizations (Figure 1). The CSP model is a proven and rational approach that is useful not only for strategic planning and the implementation of plans, but also for maintaining the results achieved. This methodology helps to focus on clear and understandable goals that are linked to specific performance metrics and aligned with ongoing strategic initiatives and value measures (Grando *et al*., 2020).

Several studies have already employed a variant of this model to analyse agri-food supply chain systems. Klint & Sjöberg (2003) proposed an analysis model which comprised three levels: individuals, companies, and networks. De Figueirêdo *et al*. (2017) put forward a framework which focused on a segment of a value chain in a territory, which includes firms and their network. They introduced shocks into the model (i.e., significant events that can change the way those interactions take place) (De Figueirêdo Junior *et al*., 2014).

The causal dynamics that shape the functioning of a supply chain system according to the adapted CSP framework are closely linked to value management in the supply chain system itself. External and internal conditions influence the factors and resources that can be applied for developing strategies in terms of production, distribution, marketing, consumption, institutional arrangements and organisational partnerships. According to the CSP framework, the strategic management of value creation and value proposition has implications for the multidimensional aspects of performance and influences how value is finally captured.

Value creation consists of structural, operational, and relational activities that enable a SCS to produce and to provide services and products (Richardson, 2008). It reflects the re-

source organisation required to carry out the activities that provide value to customers and stakeholders. Value proposition is what a supply chain system offers potential customers and target markets (Richardson, 2008), and it reflects the ability to articulate business relationships and make customers and stakeholders aware of the value created. Value capture is what the investment should return (Morris *et al*., 2005) in economic, as well as social and environmental terms, and it reflects the ability to actually obtain and retain the value initially "created" and then "proposed". The principles of value management are thus integrated into the CSP causal model (Figure 1) to capture relevant issues for F&V supply chain systems.

The CSP framework can also be useful for analysing small-scale farms, as they play an important role in food security and global food chains (Grando et al., 2020; Moreno-Pérez *et al*., 2024)focusing on the small farms' role and dynamics within the evolving food system. Assessing small farmers' actual and potential contribution to the change towards a sustainable food and nutrition security requires a deep understanding of their strategic decision-making processes. These processes take place in a context highly conditioned by internal and external conditions, including the complex relations between farm and household, which are mapped and described. Building on an adaptation of Porter's model (Porter, 1990. A performance measurement framework can be a valuable tool for addressing the complexity of smallholder systems and offers a holistic approach to the optimisation of efficiency, resilience and sustainability (Hervani *et al*., 2022). Smallholders are particularly vulnerable to external influences such as weather fluctuations, market demand and regulatory changes. The CSP framework can provide a structured methodology for understanding these conditions and their impact across the supply chain, thus enabling farmers and stakeholders to proactively respond to challenges and seize opportunities (Nakano and Lau, 2020). The strategies within the CSP framework encompass a spectrum of decisions and actions taken by farmers, suppliers and traders to optimise resource allocation, mitigate risk and increase overall efficiency. By applying the framework, smallholders can tailor strategies to their specific needs, promote adaptability and ensure the sustainable growth of their businesses.

2.1. *Three types of supply chain systems*

In general, supply and distribution channels can be sorted into a typology of "short" and "long" supply chains (Malak-Rawlikowska *et al*., 2019) based on the number of intermediaries between producers and consumers. Supply chains with no or a limited number of intermediaries are counted as short food supply chains and the higher numbers are classified as long food supply chains (European Parliament, 2013). Based on new institutional economics, the cooperation of actors in a supply chain can be categorised into a spectrum between spot markets and vertical integration (Williamson, 1991). Various degrees of concentration can be observed in the form of different governance systems for the supply chain (Swinnen, 2020). The largest and most complex forms of organisation between actors are usually observed in international trading systems. In contrast, the simplest supply chain is that of producers selling on spot markets. Various forms of interaction and coordination take place in between.

This study examines three different SCS for fruit and vegetables in the Mediterranean region. The first covers exported fruit and vegetables. The second concerns the short supply chains for selling fruit and vegetables on the local market. In addition to these two widely studied types of supply chains, public procurement was selected because of its particular governance system, in which local government organisations play an important role as purchasers of fruit and vegetable products.

These three types of F&V supply chain systems differ in the number of stakeholders involved in the supply chains, the agreement made between them, and the spatial flow of the goods exchanged. These general characteristics are presented in Table 1, followed by further explanations for the three F&V SCS selected.

Table 1 - The three types of supply chain systems of the study and their general characteristics.

Supply chain systems (SCS)	*Stakeholders involved*	*Institutional arrangements*	*Scale*
Short Food Supply Chain	• Local producers • Limited number of intermediaries • Organised consumer networks, Producer organisations	• Direct selling to consumers (e.g., farmers' markets) and to intermediaries (e.g., local shops)	Local
Green Public Procurement	• Local and regional producers • Municipalities, Local and regional governments • Certification bodies	• Tendering • Horizontal coordination	Local Regional National
Export Oriented Supply Chain	• Coordinated small-scale producers • International logistics • Export agents • Certification bodies	• Label based contracts • Horizontal & vertical coordination	International

(Source: authors)

2.2. *Short food supply chains*

In accordance with Article 2 of Regulation No. 1305/2013 of the European Parliament (2013), we defined Short Food Supply Chains (SFSC) as supply chains "*involving a limited number of economic operators, committed to cooperation, local economic development, and close geographical and social relations between producers, processors and consumers"* (European Parliament, 2013). The key stakeholders in SFSC are farmers and consumers. Supply chains with no more than one intermediary between farmers and consumers are included in this category (European Commission, 2014). Intermediaries can include shops, retailers, restaurants, school canteens and groups of consumers who enable producers to access markets (European Commission, 2014).

2.3. *Export-oriented supply chains*

Export-oriented supply chains (EOSC) are international supply chains that commercialise the produce on foreign markets. This highly institutionalised way of commercialising F&V requires sophisticated arrangements between the actors of the SCS. Global food supply chains are increasingly dominated by large multinational food companies, and trade is increasingly regulated through standards (Maertens *et al*., 2012; Camanzi *et al*., 2019). The sustainability standards in global agri-food supply chains typically cover environmental issues and labour conditions (Meemken *et al*., 2021).

2.4. *Green public procurement*

Green public procurement (GPP) is defined by the European Commission as "*a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured*" (European Commission, 2008). Concerning European countries, the criteria defined by the European Commission (2019) for GPP varies between schemes in different European cities according to the type of food products (i.e., organic produce, processing and packaging) and service provision (i.e., waste management, menu planning and transport) (Neto, 2020).

3. Methodology

In this research, a combination of eight case studies composed of the three supply chains were selected from among five Mediterranean countries as part of the project. This composition is presented in Table 2.

The methodology of this research is founded on two rounds of consultations with key in-

Table 2 - Composition of the eight case studies.

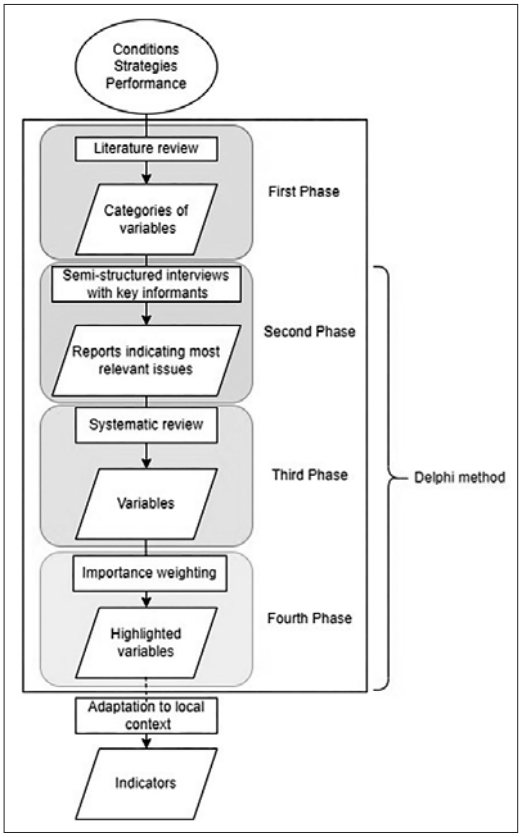
Type of Supply Chain System	*Product*	*Country*
SFSC	Oranges	Egypt
SFSC	Vegetables	Greece
SFSC	Fruit & vegetables	Italy
SFSC	Apples	Morocco
EOSC	Medicinal & aromatic plants	Egypt
EOSC	Cherries	Greece
EOSC	Vegetables	Italy
GPP	Fruit & vegetables	France

formants of supply chains in five Mediterranean countries using the Delphi technique. This technique follows an iterative approach in which experts are asked to respond to at least two waves of questionnaires, called "rounds" (Antonelli *et al*., 2022). It consists of a group decision-making process on a specific topic with the objective of gathering expert opinion and reaching a consensus (Allen *et al*., 2019; Miller *et al*., 2020). This approach involves iterated questionnaires being presented anonymously to experts (Turoff & Linstone, 2002). In this study, the first round consisted in selecting the most significant variables in the supply chains, and the second round sought to attribute a level of importance to the selected variables (Figure 2). Figure 2 represents the methodology of the work schematically. The section included in the large box represents the flow of activities carried out in this research.

In the first round, in order to identify the key variables of a sustainable F&V SCS, we benefited from the CSP framework illustrated in Figure 1. A set of categories of variables of conditions, strategies, and performance of F&V SCS were adapted from previous studies in this field (Grando *et al*., 2020; De Figueirêdo *et al*., 2017), and semi-structured interviews of supply chain experts provided information on the most relevant variables to consider for a holistic illustration of the dynamics of each specific fruit and vegetable supply chain system. A questionnaire was designed based on a set of 21 categories of variables (Appendix).

The questionnaire was addressed to key informants of supply chains who were asked to identify the most important issues in their supply chain relative to the categories of variables. Semi-structured interviews were conducted with at least 2 key expert informants per supply chain. Experts were invited to participate in the variable identification process as institutional representatives of supply chain actors, with the objective of

Figure 2 - The flow of activities.



including those who have a high degree of social representativeness and scientific competence in the structural deliberative process of defining variables (Rondinella *et al*., 2017).

Overall, 18 experts participated in the first round and 14 experts in the second round of interviews conducted in the 5 countries. The majority of them were representatives of Producers' Organizations or associations (respectively 7 and 5 experts were interviewed in the first and second rounds) along with experts from technical advisory services (6 in the first round and 4 in the second round). Other experts from the academia and research centres (3 experts) and from the private sector (2 experts) took part in the consultation.

The results of the interviews were structured into reports with identical templates in which the conditions, strategies and performances of each supply chain were illustrated. Subsequently, to identify the most significant variables, a systematic review method called Qualitative Evidence Synthesis (QES) (Flemming & Noyes, 2021) was employed. In this method, qualitative data gathered through open-ended questionnaires are reviewed using text analysis procedures. This approach highlights trends related to the occurrence of words which are similar or have proximately the same meaning. In this study, data was managed using Word processing and a spreadsheet software.

In the second Delphi round, the opinion of experts was investigated to further narrow down the set of the most significant variables which address the sustainability of F&V SCS in the Mediterranean region. The issues raised – and translated into variables – in the first round were weighted by experts based on their importance in each supply chain using a Likert scale. The same experts of the first round were asked to attribute a number between 1 and 5 designating the importance of each specific variable, with 1 indicating the highest importance and 5 denoting no importance.

4. Results

Following the two-step Delphi method, the results were obtained in two rounds. At first, the semi-structured interviews raised issues relative to the sustainability of F&V SCS. Through a systematic review of the reports, building on the QES method, the key variables of F&V SCS sustainability were deduced from these discussions, and synthesis tables were produced (Section 4.1) in which the points highlighted by the experts were presented. In the second round, the experts were requested to react to the key variables which had emerged from the previous round (Section 4.2).

The issues raised in the first round were translated into variables to be evaluated based on their importance using the Delphi method. The mean weight of importance attributed to each variable was calculated at this stage. In addition, the standard deviations between the average responses of countries were computed to see whether there was a large difference between the different cases in the Mediterranean region (see the Appendix).

Based on the interviews with the experts in the five countries, the structure and functioning characteristics of the firm clusters were described in Table 3. These clusters fulfil the role of samples representing the whole supply chain. The eight clusters were described based on their geographical and social context, their composition and their functioning.

4.1. *Conditions, strategies and performance of sustainable Fruit & Vegetable Supply Chain Systems*

The outcome of the interviews carried out in the first round with the key informants of the supply chains was provided in a descriptive way using a predefined report template. The reports were analysed based on the QES method. A synthesis of the main points of those results is given in Tables 5, 6 and 7 which correspond to the conditions, strategies and performances of the respective supply chains. Each table is followed by a comparative analysis which discusses the issues in more details.

4.1.1. *Conditions*

Conditions in this work consist of both external and internal factors to the actors of the supply chain. Table 4 presents the categories of external and internal conditions and the issues that were raised by at least one of the interviewed experts

Table 3 - The cluster of firms studied as cases of F&V SCS.

Products, type of SCS and country	*Geographical location*	*Main actors of the supply chain system*	*Main forms of coordination & flows of products*
Orange SFSC – Egypt	Nile Delta region, an area of 70 thousand hectares of orange orchards	Small and medium producers competing with large companies who own thousands of hectares of orange orchards, and also large packaging Co.	SMEs sell to packaging and processing (orange juice) companies supported by NGOs' coordination
Medicinal and aromatic plant (MAPs) EOSC – Egypt	Beni-Suef governorate, which produces 25% of Egyptian MAPs	Mainly medium-sized farms (0.8-5 ha) cultivating MAPs as a source of income beside subsistence products	Small holders have contracts with large farms which in turn are connected with processing & marketing companies exporting mainly to EU
Fruit and vegetable GPP – France	Mediterranean Occitania Region, mainly around Montpellier agglomeration	Farmers with an average farm size of 7 hectares, Producer organisation (PO)[1], Montpellier wholesale market (MIN)	The PO functions as a hub for selling the local products to restaurants, shops and public entities, while taking care of the processing according to customer orders and benefiting from the logistics available at the MIN.
Vegetable SFSC – Greece	Central Macedonia region, City of Katernini	Small-scale farms	The farmers commercialise their products at Katerini's farmers' market [2]
Cherry EOSC – Greece	Central Macedonia region	Small-scale farms, Agricultural cooperative	An agricultural cooperative sells to European markets based on contracts with exporters
Fruit and vegetable SFSC – Italy	Lazio region, City of Latina	Small-scale farms, Large farms using crop rotation (set-aside), Campanga Amica Foundation, Coldiretti Farm Union	Farmers sell seasonal products at the farmers' market in Latina according to the prescription of the "Campagna Amica Foundation"
Vegetable EOSC – Italy	Lazio region, Province of Latina, An area specialised in vegetable production	Family farm enterprises, Producer organisation, Export enterprises	Cooperatives collect the products, process, package and arrange contracts with trade agencies active in the European market
Apple SFSC – Morocco	Ait Illhoussan, Zaïda, Province of Midelt, Drâa-Tafilalet Region	Apple producers gathered as an economic interest group consisting of 3 cooperatives, packagers, distributors and retailers	The economic interest group provides its members with means of transports and other logistic facilities, and supplies supermarkets and wholesalers

(Source: Authors' elaboration

[1] For the sake of consistency, in this work the discussion was developed using the term "Producer Organisation" (PO) for all cases that cover a wide range of institutions such as cooperatives, associations, federations and unions.

[2] Beside the main form of commercialisation mentioned in the fourth column of Table 4, other forms of commercialisation are available to the members of the clusters. For instance, the members of the cooperative in Greece also sell their cherries at the local market. Nevertheless, the study focuses only on the supply chain mentioned in the study.

in the first round of the survey. External factors involve situations that influence the decisions of stakeholders but which they individually cannot control or affect. The categories of regulation and policy, demand, financial risk and environmental factors belong to external factors. As far as internal factors are concerned, the characteristics of the stakeholders and the facilities availa-

Table 4 - Issues relative to conditions of fruit & vegetable supply chains raised by experts.

Category of variables	*Fruit & vegetables supply chain systems*		
	SFSC	*EOSC*	*GPP*
Regulation and policy	Mandatory regulations on food safety to be followed; State support and subsidies under rural development policies and funds	Regulations in destination countries; Encouraging environment for expanding farm size; Regulations regarding safety at work and traceability	Increasing the share of certified products in tenders; Allotment of calls for bids into more specific groups of products
Demand	Fruit & vegetables represent a large part of farmers' market produce; Stability of market due to strong supplier-client bonds	Low demand elasticity; Low bargaining power of POs; Increasing demand for organic products; Severe quality requirements	Raised awareness of health and environmental issues
Technological availability	Predominance of traditional practices; Development of an e-commerce platform; Agreements for mutual transportation services	Search for new F&V varieties; Increasing area under greenhouse cultivation; Use of traceability systems; Assistance of field technicians	Function of wholesale market and producer organisation as a hub
Production factors	Family members as the main farm labour force; High demand for extra labour in the summertime; Water scarcity; Fragmentation of farms	Large farms; High cost of skilled workers; Shortage of good quality seeds; High land rental rates; Water availability and application of drip-irrigation technology	Low soil quality
Finance and risk	Market continuity ensured by producer organizations (POs); Large farms benefitting from insurance	Use of income stabilization tools; Credits for production inputs; Funding for greenhouse and drip-irrigation	European Unionnational and regional financial supports
Socio-demographic	Ageing farmers; Cultural obstacles to farmers diversifying their activity; Limited development of organic farms due to neighbouring conventional farms	Development of production areas; Rise in issues relative to social conditions of workers; Low educational level of workers	Declining number of farmers; Lack of intergenerational renewal within farms
Environmental	Expansion of sustainable agricultural practices; Weather conditions	Favourable climate for early harvests; Climate change	High biodiversity in the region
Socio-institutional	Administrative and organisational support of POs; No criminality and corruption observed	Involvement of multinational institutions; Limited number of exporting agents; Presence of civil society organizations	Close collaboration with Municipality

(Source: authors' elaboration based on interviews with experts and key informants).

ble to them are considered, such as technological and production factors, as well as demographic and institutional factors.

4.1.2. *Strategies*

The strategies that are formed among the stakeholders of F&V SCS are categorised into two main groups of value creation and value proposition (Table 5). The key informants of the supply chains responded to the semi-structured questionnaire and their responses were synthesised in Table 6, followed by some explanations.

Issues brought up by experts regarding value creation strategies mostly concern product differentiation through the adoption of organic and environmentally-friendly methods (Moroccan apples), the multi-functionality of farming practices through the preservation of biodiversity, natural landscape and local culture (Italian SFSC), and respecting the organic farming criterion which offers higher chances to reach the public market in the case of the French GPP. In addition, the post-harvest treatments of products (i.e. storage, processing and packaging) are issues which gain importance when talking about value creation. For instance, increasing added value is sought by Italian SFSC stakeholders in marketing fourth range products (F&V ready for consumption).

Increasing farm size is a progressive value creation strategy that is especially chosen in the case of EOSC, which requires the critical mass of products to be competitive at an international level. Likewise, POs, such as French POs, tend to increase their size by accepting more members. This allows the POs to benefit from economies of scale by applying common production management and marketing strategies for their members. The economic agents in the fruit and vegetable supply chain often have recourse to POs to foster their competitive behaviour in the market (Camanzi *et al*., 2011).

Valorising the environmental functions of farming activities is an emerging strategy underlined in all three supply chains. Certifying the quality of the products is the most common strategy in this regard. In addition to that, in the cases of SFSC and GPP, the low environmental impact due to the proximity of production to the market is also emphasized. To prove the freshness of F&V, local production is valorised through traceability mechanisms.

In EOSC, the role of POs is remarkable in the distribution of F&V. They take care of the logistics throughout the supply chain and search for new markets. In the case of GPP, POs facilitate participation in calls for tenders by aggregating the products and communicating the origin of the products. As for the Italian SFSC, even in the absence of formal POs, collaboration between F&V producers at the farmers' market can be observed.

4.1.3. *Performance - value capture*

The outcomes of the strategies experimented were investigated and classified into four categories, i.e., economic, social, environmental and governance performances, as showed in Table 6.

The overall income generated by the sale of F&V is an umbrella issue which covers other aspects of economic performance such as the elements generating that income. These elements consist of productivity levels, the management of post-harvest losses, mechanised harvesting, and the efficiency of distribution channels. In addition, trading higher added-value products, either due to further processing or the selection of better varieties, influences the total income. These value captures can be associated to better consistency with market demand.

A number of issues considered as social outcomes of the supply chains are directly connected with job conditions. This is particularly the case for EOSC in which a high number of seasonal workers are employed during the harvesting season. In the case of European countries, most of the workers involved are immigrants. The concentration of farms in specialised areas also engages (directly or indirectly) a large part of the local community in the supply chain. Subjective well-being issues are also considered, especially in the case of SFSC. In the case of GPP, experts have noted the benefits that collective catering and food distribution bring to the less privileged and to society overall.

The reduction in the supply chains' environmental footprints is highlighted as their environmental outcomes. However, each focuses on

Table 5 - Strategies adopted by the three fruit & vegetable supply chains.

Category of variables	*Fruit & vegetable supply chains*		
	SFSC	*EOSC*	*GPP*
Value Creation			
Partnership	Practicing a collective code of farming; PO's support regarding agronomic practices; Mutual aid between farmers; Pooling logistics	Second grade POs intermediating for export; Vertical integration of producers and export agents; Producer-processor partnership	Aggregating in producer organization
Diversification	Selling fresh and local products; Adding value by producing 4th range products; Packaging and wrapping; Organising promotional events; Numerous possibilities of marketing strategies (open farm days; agro-tourism or catering activities)	Specialising in sustainable agricultural practices; Processing; Introducing new varieties; Modifying the crop calendar; Improving packaging	Diversity of product varieties; Quality certifications
Risk management	POs' support and inspection of practices; Eliminating production risks caused by water scarcity	Emerging collaborative logistics; Stabilising relationships between trading companies and local distributors	Planning the production of vegetables through long-term contracts
Externalisation	Financial accounting managed by POs; POs organise farmers' markets	Employing external workforce; Prevailing third party logistics; Promoting the products through distributors; Developing advising systems	Municipal wholesale markets providing sales and storage logistics
Policy support	Searching for funds and support from the EU Common Agricultural Policy; Recourse to the technical support of advisors and agronomists	Seed certification initiative	Participating in promotional campaigns organised by the municipality
Intensification and Upscaling	Common management through POs	Pursuing scale economies via larger farms; Enhancing productivity	Collective marketing strategy through POs
Technological innovation	Developing greenhouse production	Promoting agroforestry; Cultivating new varieties; Applying micro-irrigation and fertigation	Processing fruit and vegetables; Developing a virtual platform for tenders
Value proposition			
Distribution	Collective marketing strategy; Collaborations between farmers at farmers' markets	Technical assistance and support of POs for mandatory certifications; Aggregating and marketing the products through cooperatives	Aggregating products; Communicating the origin of the products
Market orientation	Valorising territorial proximity; Benefitting from quality certifications; Adopting sustainable agricultural practices	Developing organic production	Valorising local products

(Source: authors' elaboration based on interviews with experts and key informants).

Table 6 - The performances of the three fruit & vegetable supply chains.

Category of variables	*Fruit & vegetable supply chain systems*		
	SFSC	*EOSC*	*GPP*
Economic	High profits for farmers; Financial stability of farms; Productivity growth; Quality improvement; Survival of small-scale farms; Lack of financial resources; Considerably high production costs; Slow modernization process; Rare cases of risk mitigation plans	Cost management; Certified quality; Efficiency of distribution channels; High prices due to early harvest; Reduced harvesting costs due to machinery; Low post-harvest losses; Improved productivity; Further processing and resale by international customers	Cost reduction in marketing; Production more consistent with market demand
Social	Promotion of local tradition and culture; Removal of informational asymmetries between consumers and producers; Higher self-esteem among family farms; Support of local/regional identity; Job creation for women	Fair remuneration of workers; Job creation for local communities and migrants; Fair working conditions & safety at work; Educational and sanitary facilities established for local communities by POs	Distribution of vegetables among underprivileged communities; A considerable number of families benefit from collective restaurants
Environmental	Reduction in negative environmental impacts induced by transport; Reduced food miles	Certification schemes for sustainable agricultural practices; Improved management of waste, water, pesticides and fertilizers	Food waste reduction; Waste management
Governance	High social capital among producers	High negotiation power; Inequalities between coop members	Establishment of procurement agreements with municipalities and charity organisations

Source: authors' elaboration based on interviews with experts and key informants.

a certain stage of the supply chain. SFSC have mainly raised environmental outcomes at distribution level, EOSC at production level, and GPP at post-production level.

The governance structure of supply chains leads to managerial outcomes. While the Italian producer union benefits from transparent management and a fair governance system, the cherry producers' cooperative in Greece faces inequality in decision-making power among the PO members, due to the absence of explicit mechanisms of governance control.

4.2. *Key variables of Mediterranean sustainable F&V SCS*

The results of the second round of Delphi revealed the most important variables of F&V SCS in the Mediterranean region. Three variables with the highest rankings were selected to be presented in Figure 3. The majority of these variables were ranked from "very important" to "important" by the experts interviewed. The standard deviations between the average of countries are also negligible for these variables, which

Table 8 - Variables which received the highest weights of importance in each F&V supply chain.

	Conditions	*Strategies*	*Performance*
SFSC	• Logistics • Internet-based platforms • Presence of technicians	• Pooling logistics • Tracing the products • Certifying quality	• Quality products • Consumer-producer bonds • Food miles
EOSC	• Mandatory or voluntary regulations • Climate related early harvest • Presence of large farms	• Coalition of producer organisations • Long term contracts • Certifying quality	• Job creation • Working conditions • Sustainable agricultural practices
GPP	• Transport costs • Labour costs • Precipitation	• Procuring external workforce • Coalition of producer organisations • Irrigation	• Production costs • Productivity • Job creation

Source: survey results.

shows that there is little difference in the perception of experts in the five Mediterranean countries regarding the importance of those variables.

The categories of variables which received the highest importance are different based on the supply chain system (Figure 3). While technological variables were highlighted as the most important conditions in SFSC, production conditions were designated as the most important in GPP, and issues related to trade were mostly highlighted in EOSC as conditions which hinder (or enable) the competitiveness of the supply chain.

As for the types of strategies, those that were most emphasised are partnership and diversification. All three supply chain systems seek economies of scale by strengthening their partnership. SFSC do that through better coordination of logistics among the members of POs, GPP by upscaling POs through a higher number of members, and EOSC through vertical coordination. Other strategies belong to the category of diversification by certifying quality. This value creation strategy is highlighted in both short and long food supply chains. Another strategy that deserves further discussion relates to creating trust. In SFSC, this objective is carried out by product tracing (either through digital tools in Morocco, or creating tighter consumer-producer bonds in the Italian case), and in EOSC through long-term contracts.

The performance categories highlighted by the experts of the supply chain systems covers the three pillars of sustainability. However, in two of the SCS the emphasis is put on one of the pillars of sustainability rather than on the two others. In the case of SFSC, we can see that the three axes of sustainability are covered by the "quality of F&V" which is weighted as the most important economic performance variable, the "consumer-producer relationship" as a social variable, and zero-KM food (food miles) as an environmental variable. EOSC experts put the emphasis more on social issues by associating the highest values of weight to "job creation" and "working conditions". Finally, GPP experts highlighted economic performance variables by weighting "production costs" and "productivity" with highest numbers.

5. Discussion

By reviewing the issues raised by supply chain experts regarding SCS conditions, strategies, and performance, we highlighted certain outstanding points in the Mediterranean F&V industry.

When comparing the three types of F&V SCS in the Mediterranean region, a logical correlation can be observed between the most highlighted conditions, strategies and performances (Figure 3). These relations were primarily observed between the highlighted strategies and conditions. It can be noted that the strategies for overcoming the most emphasised conditions are weighted most heavily. For instance, the highlighted strategies in EOSC (i.e., the coalition of producer organisations, long-term contracts and quality certification) aim to overcome trade regulations. Eventually, relevance can also be observed between the lead-

ing performance variables and the strategies and conditions mentioned. As observed in the case of EOSC, the importance of performance variables such as working conditions and sustainable agricultural practices arises from their obligation to follow the regulations (or their interest in doing so). This finding is in line with the literature in which regulatory and market pressures are seen as the main drivers for implementing sustainability practices (Hernández et al., 2021; Wijethilake and Upadhaya, 2020) (Saeed & Kersten, 2019). The fact that the main performance variable highlighted for GPP is aimed at the economic competitiveness of the supply chain shows the extent to which the public market is still price-oriented. As for SFSC, the emphasis on zero-KM food (i.e., food miles) shows the importance of logistics and of sharing logistics with POs. The importance that experts attach to the presence of technicians in the supply chain can also be attributed to the quality of the products and their certification.

5.1. *Socio-demographic conditions*

Various conditions were discussed with the experts regarding the context in which supply chain actors interact with each other. The demographic and social situation of the production area was reviewed. The ageing of farmers and the lack of intergenerational renewal may threaten the sustainability of small-scale agricultural production. Obviously, small-scale farms looking for labour outside the family context have difficulty finding seasonal workers and struggle economically to remunerate them. Therefore, small-scale farmers may be forced to switch to less labour-intensive crops, or adopt practices that require less labour but may not match the farm's traditional know-how or market demands. This shift can affect the overall diversity and sustainability of farming practices and limit the farm's resilience to changing conditions. Research by Wuepper et al. (2020) aligns with these findings and examines how small family farms influence the adoption of sustainable practices in Germany. Their study shows that small family farms have less temporal variability due to a lack of access to seasonal labour, leading to a prevalence of monocultures. In addition, these farms present more bare land and fewer cover crops in the winter season, which is contrary to the principles of sustainability.

Furthermore, the workforce in the supply chains has a relatively low level of education. In addition to the age of farmers, this factor inhibits the transformation of farms through technological innovations. In addition, precision farming tools and digital solutions are rarely used in this production environment. In line with this result, Dhillon and Moncur (2023) mentioned that a major obstacle for smallholders is a lack of awareness and access to educational resources. It is difficult for these farmers to keep up with the latest knowledge needed to adapt to the ever-changing agricultural landscape. This lack of knowledge and resources is a significant barrier to the success and sustainability of small-scale farms.

5.2. *Technical conditions*

In this context, the use of irrigation systems and greenhouse production are seen as factors that facilitate the adoption of traceability systems, in addition to the mitigation of weather conditions and climate change. However, the installation of irrigation systems and their maintenance represent an economic burden for producers. Efforts should be directed towards providing affordable and sustainable solutions to make these technologies more accessible, and to ensure that advances in traceability are comprehensive and beneficial in all areas of agricultural production. According to Mutambara *et al.* (2016) and Zobeidi *et al.* (2021), improper water management also leads to the inefficiency of this system among smallholders, ultimately leading to non-sustainable agriculture in the face of changing weather patterns and climate change. If these challenges are carefully managed, the integration of traceability systems with irrigation and greenhouse technologies has the potential to revolutionise agriculture and promote transparency, efficiency, and environmental sustainability. This point should be considered important in regions facing a water scarcity crisis, such as the countries we studied, i.e, Egypt and Morocco.

5.3. *Mandatory and voluntary regulations*

The importance of these conditions is relatively different for the three types of supply chains (Table 8). For instance, the quality standards for F&V appear to be more demanding for EOSC than for GPP and SFSC. These regulations are set either by official authorities or by private stakeholders in the supply chain, and are either mandatory or voluntary. Strict commitments regarding the environmental and social conditions under which production takes place are set by national authorities and major retailers in the target market. Producers targeting international markets, in addition to mandatory food safety regulations, must in many cases also provide a traceability procedure to ensure compliance with proper environmental and social practices. These standards cover various aspects, including pesticide residues, microbial contamination and compliance with specific packaging and labelling requirements (Lengai *et al.*, 2022). In this sense, some studies emphasised the strict quality requirements that the export markets impose, and stressed that these requirements must be met in order to gain access to the markets in question (Camanzi *et al.*, 2019; Yadav *et al.*, 2021; Yang *et al.*, 2023). However, this raises a challenge as to how the freshness of the products can be maintained for export markets, and how the processes of those involved in the supply chain can be coordinated (Ran and Chen, 2023).

However, in the case of GPP, an ever-growing share of F&V purchased by public entities needs to be procured from certified products. The inclusion of certified F&V in GPP sends a strong signal to the market. As public bodies make up a large proportion of consumers, their preferences can have a significant influence on market dynamics. This influence can incentivise producers and suppliers to invest in sustainable practices and become certified, thus triggering a domino effect throughout the supply chain (Molin *et al.*, 2021).

Nevertheless, favourable conditions for smallholders are created in this context. The allocation of tenders for affordable batches by small-scale farms is one of the main tools for creating a favourable environment for the participation of small, local producers in public tenders. In cases where farmers delegate responsibility to the POs, quality standards are also set to homogenise the process of supplying the market. In addition, farmers receive technical assistance and support from public and private institutions for the required certifications.

5.4. *Specialisation*

A comparison between the strategies of smallholders who commercialise their produce through SFSC, and those of farmers who produce for export reveals a difference in the level of specialisation. Farmers in SFSC have a larger range of activities besides selling at the local market. Strategies such as organising open farm days, or agro-tourism and catering activities are possible for small-scale farms. Whereas producers in EOSC specialise in certain production types and concentrate their efforts and investment for further specialisation. In addition, post-harvest logistics, such as grading, packaging and storage are more pertinent in long supply chains. The different strategies of smallholders in SFSC and EOSC reflect the different requirements of local and international markets. While SFSC focus on community linkages and diversified activities, EOSC focus on specialisation and efficiency in a global context. Both approaches make a unique contribution to the agricultural landscape and demonstrate how adaptable and resilient farmers are when it comes to meeting different market demands. Distinct value-creation strategies have thus been identified for short and long F&V supply chains.

5.5. *Aggregation and coordination*

In the realm of value propositions, small-scale F&V producers find themselves contending within a landscape largely controlled by formidable corporations that possess extensive F&V production land, sometimes spanning thousands of hectares. Recognizing the substantial significance of this challenge, some studies have underlined the necessity for a transformative approach (Hernández *et al*., 2021; Rivera *et al*., 2020). One promising avenue involves re-

shaping regional and local agri-food systems, which would serve as a proactive response to the limitations posed by conventional agri-food systems (Cirone *et al*., 2023). This restructuring not only addresses existing issues but also serves as an essential survival strategy for small-scale farms. One strategy is to form alliances with fellow smallholders and establish cooperatives (Hernández *et al*., 2021; Sarkar *et al.*, 2023). As the FAO and CIRAD report emphasised, the establishment of a farmers' cooperative is of crucial importance for securing higher added value and access to the market for smallholdings (FAO and CIRAD, 2021). This approach enhances collective bargaining power and facilitates the pooling of resources. Additionally, collaborating on joint marketing initiatives can boost visibility and competitiveness in the market (Benedek *et al*., 2018).

In order to overcome the fragmentation of production and achieve a scale of business compatible with the competitive environment of the supply chain, various forms of stakeholder aggregation were observed in the Mediterranean case studies. In the Greek and Italian cases, the only intermediary in the SFSC was a PO that shared the same values and ambitions as the producers. In the three EOSC cases, several organisations were involved in the supply chain to get the product to the end consumer abroad. In a trade environment where grades and standards have become competitive tools in differentiated product markets, small firms and farms can partner with the public and non-profit sectors to create standards and certification systems that provide access to export markets and effect institutional change to non-tradable product markets (Reardon *et al*., 1999). Long-term relationships between the POs and trading companies stabilise trade by creating trust between supply chain actors. Creating an environment of trust can be seen as a strategy for all three supply chains, by enabling actors to plan production and processing.

5.6. *Overall performance*

The performance of supply chains depends largely on the conditions that actors may find. While in farmers' markets, as observed in the markets in the cities of Latina in Italy and Katerini in Greece, F&V prices are set by producers based on actual demand, the international supply chain for F&V is characterised by low elasticity of demand due to international competition. The high level of international supply has brought prices to a competitive level. Although in this environment, POs have limited bargaining power, they nevertheless act as intermediaries between farmers and the (public or private) market, thus facilitating price formation. In addition, POs join forces with other institutions, which leads to better financial stability and better functioning of the supply chain. With this in mind, Fałkowski and Ciaian (2016) examined existing research on this topic and explored how POs help to improve farmers' bargaining power and enable them to adapt to the dynamic changes in trade relations within the food supply chain. Research showed convincing evidence that the presence of agricultural knowledge and expertise positively influences farmers' bargaining power. Furthermore, farmers' bargaining power in the food chain is influenced by factors such as time, location, technology, sector, farm size and the availability of human and social capital. Therefore, in view of these factors, access to agricultural knowledge is of central importance in the Mediterranean region, where traditional agricultural practices often coexist with modern technologies. POs can facilitate the dissemination of information and best practices and equip smallholders with the knowledge they need to negotiate effectively in the marketplace.

6. Conclusions

In this research, the experts' opinion on the eight Mediterranean F&V SCSs have revealed important variables to be included in the analysis of the sustainable development of a F&V SCS. The CSP framework allowed us to capture a holistic view of the supply chains' dynamics. The results of this research on F&V SCS in the Mediterranean region have significant implications for understanding and promoting sustainable development in the sector while focusing on small-scale farmers.

As a first major result, the study underlines the central role of POs in F&V SCS in the Mediterranean region. As observed in previous research (Rivera *et al*., 2020; Prosperi *et al*., 2023) the POs are remarkably present in different stages of Mediterranean F&V SCS. The aggregation of producers in POs allows them to adopt collective marketing strategies concerning the pooling of logistics and distribution. In addition, POs facilitate the process of product certification (Prosperi *et al*., 2020; Widadie *et al*., 2022). These horizontal and vertical collaborations between the actors of F&V SCS offer a fertile environment for cooperative research and innovation activities involving businesses, researchers, and public authorities (Riccaboni *et al*., 2021). Recognizing the importance of horizontal and vertical collaboration between F&V SCS, stakeholders, including related companies, SMEs, researchers and public authorities, can leverage this collaborative environment for joint research and innovation activities. Policy-makers should consider supporting and promoting the formation of producer organisations to strengthen the sustainability and competitiveness of Mediterranean F&V supply chains.

As a second major result, in all of the eight supply chains analysed in this research, what stands out is the growing attention that the "quality" of fruit and vegetables is receiving to meet consumer demand and expectations. As in previous research (Tselempis *et al*., 2015), supplying quality products is deemed to be a widespread differentiation strategy. This is also in line with the findings of Kumar *et al*. (2022) in which "food quality" received the highest performance indicator in their proposed assessment for sustainable agri-food supply chains. Various certification schemes have been observed, ranging from informal, local to internationally recognized certifications. Certified products are promoted in all three supply chain systems, although with different "intensity" levels, to achieve higher levels of competitiveness. Policy-makers, companies and researchers should recognize the importance of quality certification as a key factor for the competitiveness of the F&V sector.

Overall, a concerted effort to promote environmentally-friendly and socially responsible practices is required. Collaboration between stakeholders, fostered by producer organisations and SMEs, creates a conducive environment for the implementation of sustainable initiatives. Policy-makers can look for ways to incentivise and support sustainable practices within supply chains by ensuring that environmental and social considerations are integrated into the decision-making processes of companies and producers. This could include the development of policies that encourage the adoption of environmentally-friendly and socially responsible practices, thus contributing to the long-term sustainability of Mediterranean F&V supply chains.

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Appendix

Proposed variables for each type of FV supply chain

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Conditions									
Regulation and policy	State subsidies for F&V production	2.8	1.0	Mandatory or voluntary regulations that facilitate or limit F&V export	1.3	0.3	Quality requirements for F&V set by state for public market	2	1.4
Demand	Sales of F&V in farmers' market	2.3	1.1	Price elasticity of demand for F&V	2	0.7	Demand for high quality F&V in public market	2	1.4
Technological availability	Availability of internet-based platforms	1.6	0.6	F&V production in greenhouses	2	0.4	Availability internet-based platforms	3.5	0.7
	Presence/activity of agricultural technicians	1.6	0.5	Presence/activity of agricultural technicians	1.7	0.8	Presence/activity of agricultural technicians	4	0.0
	Transport costs	1.9	1.0	F&V production of new varieties	1.9	0.3	Transport costs	1.5	0.7
	Logistic	1.5	0.3	Foreign investments in the logistics of supply chain	3	0.4	Logistic pooling	3	0.0
Production factors	Family farm members' engagement in the workforce	2.5	0.9	Farm size	1.7	0.8	Family farm members' engagement in the workforce	2	1.4
	Non-family labour cost	2.2	0.7	Cost of manual harvesting	2.1	1.5	Non-family labour cost	1.5	0.7
	Cost of land rentals	1.8	0.8				Cost of land rentals	2.5	0.7
Finance & risk	Subsidies as producers' income	3.7	0.8	Subsidies as producer income	2.6	1.3	Subsidies as producer income	3	1.4
	Insurance coverage of farms	2.5	1.1	Insurance coverage of farms	3.1	1.3	Insurance coverage of farms	4	0.0
Socio-demographic	Age of farmers	2.3	1.8	Age of farmers	2.3	1.1	Age of farmers	3	2.8
	Workers' education level in the F&V production	2.7	1.6	Workers' education level in the F&V production	2.1	0.9	Workers' education level in the F&V production	2	1.4
Ecological	Precipitation	2.3	1.6	Precipitation	4	1.2	Precipitation	1.5	0.7
	Economic cost of damages from climate change	1.8	0.7	Economic cost of damages from climate change	1.9	0.6	Economic cost of damages from climate change	2	0.0
				Advantage on harvest anticipation compared to international market	1.6	0.8			
Socio-Institutional	Size/activity of POs	2	0.7	Size/activity of POs	3.4	0.8	Size/activity of POs	3.5	0.7

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Strategies									
VALUE CREATION									
Diversification	Alternative channels of sales (agro-tourism, catering, etc.)	2	1.9	Diversification of F&V varieties	2.3	1.5	Organic or sustainable F&V production	3	0.0
	Organic or sustainable F&V production	2	1.0				F&V processing	3.5	0.7
	F&V processing	1.9	0.8						
	Ready for consumption packaging of fresh F&V	2.4	0.5						
Risk management	Water access improvement through water management	1.8	0.7	Commercialization of F&V through long term contracts	1.7	1.1	Commercialization of F&V through long term contracts	3.5	0.7
Externalisation	Procurement of workforce from outside farm	1.9	0.9	Procurement of workforce from outside farm	2.4	0.9	Procurement of workforce from outside farm	2.5	0.7
	F&V shipped by third party logistics/ distributors	2.1	0.6	F&V shipped by third party logistics/ distributors	2.4	0.8	F&V shipped by third party logistics/ distributors	3	0.0
Policy support	Adoption of technical advisory by farms	2	0.7	Adoption of technical advisory by farms	2.7	1.3	Adoption of technical advisory by farms	4	0.0
	Benefiting from state subsidies	2.2	1.4	Benefiting from state subsidies	2.9	1.5	Benefiting from state subsidies	3	1.4
Intensification and upscaling	Coalition of POs	2.4	1.0	Coalition of POs	1.4	0.5	Coalition of POs	2.5	0.7
	Farm size dynamics	2.4	1.3						
Technological innovation	Adoption of internet-based platforms for F&V commercialisation	1.8	0.5	Adoption of internet-based platforms for F&V commercialisation	2.6	0.5	Adoption of internet-based platforms for F&V commercialisation	3.5	0.7
	Production under greenhouse	3.8	0.7	Production under greenhouse	2.1	0.3	Production under greenhouse	3	1.4
	Implementation of irrigated cultivations	2.7	0.8	Implementation of irrigated cultivations	2.1	1.1	Implementation of irrigated cultivations	2	0.0
Partnership	F&V Farmers' participation in POs	2.2	1.4	Commercializing of F&V through POs	2.6	0.3	F&V Farmer participation in POs	3	1.4
	Commercialization of F&V through pooling logistics	1.3	0.3				Commercialization of F&V through pooling logistics	3	1.4
VALUE PROPOSITION									
Distribution	Commercialization of F&V through direct sale	1.9	1.5	Participation of POs as intermediaries in the distribution channel	1.6	0.3	Producer organisations' supply of F&V to public market	2	0.0
	Commercialization of F&V through one intermediary	2.6	0.8	Exporting destinations	1.7	1.0	Supply of F&V to public canteens directly by farmers	3	1.4
Market orientation	Participation in initiatives for food supply distance reduction	1.9	1.0	Adoption of quality labels	1.6	0.3	Participation in initiatives for food supply distance reduction	2.5	2.1
							Adoption of traceability systems	3	2.8
	Adoption of traceability systems	1.4	0.7				Adoption of quality labels	2.5	2.1
	Adoption of quality labels	1.7	0.6						

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Performance									
VALUE CAPTURE									
Economic	F&V Income of farmers	2	0.7	Total income generated by export of F&V	1.6	0.1	Income generated by supplying public collective restaurants	3.5	0.7
	F&V farming production costs	2	0.7	Production cost	1.3	0.3	F&V farming production costs	1	0.7
	F&V farming productivity	1.8	0.3	F&V farming productivity	1.3	0.3	F&V farming productivity	1.5	0.7
	Expansion of F&V market	1.9	1.0	Export of F&V high added value products	1.3	0.3	Organic F&V supplied to public market	3.5	1.4
	Access to financial resources	1.6	0.8	Post-harvest losses	1.9	0.9	Local and fresh F&V supplied to public market	3.5	0.0
	Farming risk mitigation plans	2.6	1.1	Efficiency of distribution channels	1.6	0.8	Coherence of local production with the demand of public market	2	0.7
	Quality of F&V	1.1	0.3	Harvesting method (manual or mechanised)	1.7	1.1	F&V area under cultivation	2	0.0
Social	Employment in the supply chain	2.2	0.5	Job creation	1.1	0.3	Job creation	1.5	0.7
	Consumer-producer relationships	1.5	0.8	Working conditions of the supply chain workers	1.6	0.8	Population benefiting from public canteens	3.5	0.7
	Self-esteem among family farms	2	0.7	Fair remuneration of supply chain workers	1.7	0.6	Food charities supplied by the cluster	3.5	0.7
	Employment stability of small-scale farmers	1.7	0.9	Employment of women	1.9	0.8			
	Promotion of local/ regional identity	1.7	0.8	Employment of immigrants	3.4	0.8			
Environmental	Food miles	1.6	0.6	Waste management	1.7	0.6	Waste management	3	1.4
	Quantity/volume of organic F&V	2	0.9	Sustainable agricultural practices' certification schemes	1.6	0.3	Reduction of food waste in the supply chain	2	0.0
	Environmental footprint	2.2	1.3	Efficiency of water use	1.6	1.2			
	Area under organic farming	2.4	1.4	Pesticides and fertilizers used	1.7	0.8			
Governance	Size of POs	2.6	0.7	Size of POs	2.9	0.9	Size of POs	3	1.4
	Decision-making equality among the members of POs	2.1	0.8	Running farm business by immigrants and women	3	0.4	Conventions and contracts between small-scale farmers and the municipality	2.5	0.7
				Decision-making equality among the members of POs	2.6	0.4	Decision-making equality among the members of POs	2.5	0.7
				Bargaining power of POs	2.7	0.8			

Source: Survey results.

Methodological note

The reader may note that certain variables indicated in the table above are repeated in two or even three sections of the table. This is the case of the "size of POs". This particular variable, which was considered as a part of conditions (in the socio-institutional category), while also as a strategy (in the up-scaling and intensification category) and eventually even as a performance (in the governance category) is a good example as to how a variable can function simultaneously in different stages of a dynamic system. It demonstrates how a dynamic loop connects a condition to strategies, how strategies shape performance, and ultimately how a performance functions as an possible condition. Concerning the theoretical framework, we may thus conclude that when evaluating a supply chain by considering the conditions in which it is developed, its functionality and performance require a holistic view of F&V SCSs. Omitting one aspect would present an incomplete representation of the dynamics of the supply chain system, which may lead to wrong managerial decisions for further improvements.

Sustainable food systems. Change of route in the Mediterranean

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The Mediterranean region is facing growing intertwined challenges, within a complex and rapidly changing Mediterranean scenario, including water scarcity, land degradation, climate change, the rise of non-communicable diseases, social and economic discrepancies and immigrations, impacting food security, health, nutrition, and sustainability, and the livelihoods of all Mediterranean people.

The Mediterranean is historically the meeting area of ancient millenary civilizations, characterized by a multiplicity of countries with marked environmental, cultural, social, economic and political differences. Located at the crossroads between Africa, Asia and Europe, today the Mediterranean is a region where growing interdependent challenges are undermining the sustainability of food systems, and negatively impacting on their populations and natural resources.

Population growth with demographic changes, urbanization, and globalization, are all driving increased food demand and influencing food choices, which have resulted in profound changes in food production/processing patterns, in food consumption patterns and lifestyles.

The Mediterranean is marked by the heterogeneity among, and within, its countries and a growing gap between the advanced economies in the Northern shores and the less developed ones in the Southern/Eastern ones. Across the Mediterranean region, there is an "*inegalitarian drift*" in the current relations between Northern Mediterranean countries and Southern-Eastern ones, where many difficulties are encountered due to the existing economic, social/cultural disparities and conflicts, with an ever-growing gap between developed economies and those that are less so.

The GDP (Gross Domestic Product)/per capita highlights a profound difference between Mediterranean economies which inevitably has repercussions on the social, environmental, and social dimensions of people livelihoods.

The region is marked by a "nutrition transition state" in which the prevalence of undernutrition (wasting, stunting, underweight) and micronutrient deficiencies are overshadowed by the prevalence of overweight, obesity and diet-related chronic non-communicable dis-

eases with undesirable impacts on the health and related public expenditure. The growing erosion of the Mediterranean diet heritage, by the loss of its adherence among Mediterranean populations, is alarming as it has undesirable impacts not only on health and nutrition, but also on social, cultural, economic and environmental sustainability dimensions in Mediterranean countries.

Accelerated climate change has further exacerbated existing environmental problems in the region that are caused by the combination of changes in drought and desertification processes, increasing pollution and declining biodiversity.

Disruptions of imports from Ukraine and Russia has further exposed Mediterranean countries to food shortfalls with increasing in prices, with combined effects on production cuts, export restrictions, energy prices and difficulties in logistics with negative impacts on both producers and consumers, worsening food insecurity in the region.

A change of route

The book *Sustainable Food Systems. Change of Route in the Mediterranean*, edited by Sandro Dernini and Roberto Capone and published in 2024 by CIHEAM Bari, offers a unique multi-perspective, with multiple trajectories, essential for comprehensively tackling these pressing challenges, integral to Mediterranean food systems. Coping with these interdependent challenges is crucial with a Mediterranean Sustainable Food System (SFS-MED) vision oriented towards accelerating in the region the United Nations Agenda 2030, by aligning global and local objectives and expediting the Agenda at the country level.

The book presents 21 original contributions from different perspectives by leading experts, who participated as moderators of thematic sessions at the Third World Conference on the Revitalization of the Mediterranean Diet, entitled *A Change of Route Towards More Sustainable and Resilient Food Systems in the Mediterranean Countries. The Mediterranean Diet as a Strategic Resource for Accelerating the Agenda 2030 in the Region*, organized at the CIHEAM Bari Institute in September 2022. It also represents the continuation of an intense collaboration that has lasted for several years with these authors.

The book addresses together the sustainability of the whole food system, from production to consumption, and acknowledging inter-relationships ecosystem-dependent and inter-dependencies of different sectors, with local specificities as well as regional and global complexities impacting Med food systems and diets.

Tackling food systems transformation in the Mediterranean region requires considering sustainable food systems as a whole, rather than their separate parts, and going beyond disciplinary approaches and silos.

There is a need to take into consideration a web of interconnected and interdependent components within a decision-making environment concerning food systems that is very fragmented, and where there is a wide range of voices from different interest groups and agendas, with diverse institutional and agroecological constraints in countries and territories on all shores of the Mediterranean.

The book advocates for a change in the mainstreaming narrative surrounding the Mediterranean diet, positioning it not just as a healthy dietary pattern but also as sustainable diet model, a strategic sustainable lever for accelerating the achievement of the 2030 Agenda for Sustainable Development in Mediterranean countries. It highlights the need of a change

of perception on the Mediterranean diet as a strategic resource of sustainable development for Mediterranean countries by linking together sustainable food consumption and sustainable food production. The book offers SFS-MED innovative approaches and operational proposals for fostering synergies across sectors and providing guidance for decision-makers and stakeholders interested in advancing economic, environmental, and social sustainability in the region.

The book advocates for a "Change of Route", requiring a new transdisciplinary rethinking, a change in the mindset overcoming silos of disciplines, different levels of specialization, and fragmented sectoral approaches. It highlights the need to bring together sciences and humanities and connecting the peoples, through transdisciplinary cross-cutting research on overlapping areas and multistakeholder initiatives such as SFS-MED Platform and living labs for enabling necessary conditions for an effective SFS-MED shift at country and regional levels.

The centrality of the Mediterranean consumer and of the so called "food environment" is highlighted in the book within this "Change of route" by taking into high consideration existing inequalities between Northern and Eastern Med countries, and differences in terms of food consumption, marked by different abilities to consume, and especially in large urban agglomerations.

The book as a "*white paper*", as a foresight exercise, provides useful food policy operational proposals, integrating different agriculture, environmental, economic, health/nutrition and cultural Med dimensions, with a focus towards improving food systems towards sustainability in the Med countries, with attention of offering economic and social opportunities, particularly for small-scale farmers, fishermen, youth, and women in areas highly affected by migration.

Building-up an SFS-MED CIHEAM Vision 2030

The CIHEAM Secretary-General Teodoro Miano within his opening address "Moving Forward" to the book chapter "Challenges and Solutions: From Theory to Action" outlines an innovative SFS-MED vision by presenting a holistic conceptual model based on the connections of food systems with two large biological entities, on the one hand Nature and on the other hand Human Beings, in a complex equation through which to link food production and consumption in a sustainable manner.

The complexity of the relationship stems from two main factors: Firstly, food production is intricately linked within various domains. Secondly, consumption extends beyond individual acts, encompassing socio-economic factors inherent to its environment. The conventional model of connection between fundamental or applied research on one side and private businesses on the other side has shown clearly a very limited utility in producing growing and empowering steps for the benefit of local and regional communities.

The importance of strengthening the SFS-MED platform, which brings together the CIHEAM, the FAO, the Union for the Mediterranean and the Prima Foundation, under the umbrella of the United Nations Program for Sustainable Food Systems One Planet Network, is highlighted in the CIHEAM vision for more inclusive multi-stakeholder collaboration as a fundamental element for coping with the complex scenario facing Mediterranean countries by liaising all interested stakeholders, from policymakers and researchers to pro-

ducers and consumers, towards a sustainable transformation of food systems and diets in the region, to drive to the SDGs achievement in the Mediterranean countries, refreshing the concepts generated by the declaration of the Matera G20 meeting.

Increasing awareness and mobilizing action regarding the pivotal role of consumers in the transformation of SFS-MED is a challenging task within the framework of sustainable consumption and production (SCP). This necessitates the establishment of a new, innovative SFS-MED food environment as part of the implementation of actions within the SFS-MED Platform.

The SFS-MED Platform provides a collaborative space for discourse and knowledge exchange on various facets of food policies, regulatory frameworks, natural resource utilization and management, food production techniques, transformation processes for both food and non-food items, consumption patterns, and the facilitation of conducive conditions for business development. Moreover, it actively promotes trade relations and international partnerships while advocating for sustainable solutions across social, economic, and environmental dimensions within the Mediterranean countries and the broader region.

The need of a novel approach is highlighted for a different working environment in which all actors and stakeholders share various approaches, backgrounds and experiences and actively co-plan solution-based procedures and actions. Complexity should be faced with complex tools and methodologies.

The CIHEAM vision 2030 for Mediterranean sustainable food systems aims to encourage the transition from an exclusively agri-food production approach to sustainable food consumption by placing the Mediterranean diet (as a sustainable diet) at the center of this new dynamic.

Conventionally, the consumer is considered very important because, through his own choices, he plays a leading role in directing production, since it is the consumer who chooses the products based on different variables. (Origin, method of production or their producer, the way they buy, transport, store, cook and consume food, disposable income, socio-economic status, religion, culture, marketing, etc.). But what emerges from reading the book is that in the transition towards more sustainable food systems, the main protagonist is no longer the consumer, but the "Food Environment", i.e. mean: "the physical, economic, political and socio-cultural environment, in which consumers interact with the food system to make decisions regarding the acquisition, preparation and consumption of food".

Building-up the SFS-MED CIHEAM Vision 2030, by acting together on the "*Natural Resources*" and the "*Food Environment*" could be an important contribution for a food systems transformation towards sustainability in the region, as well as, in the countries and contributing, at the same time, to the revitalization" of the Mediterranean diet, as a model of sustainable and healthy eating for the 21st century.

NEW MEDIT

Scope

New Medit is an international open access journal published quarterly on behalf of the Italian Institute of CIHEAM of Bari.

The Journal seeks to act as a bridge between the relevant regional studies to enhance regional cooperation and sustainable development, by providing a platform for theoretical and empirical debate in the fields of social and economic sciences, regional development and environmental studies in the Mediterranean Region.

The main subjects of interest include the economic and social transformations in Mediterranean Countries in particular agro-food economics, rural development, environmental economics and sustainability issues around all Mediterranean region.

New Medit welcomes studies tackling the various problems characterising the economy and agribusiness of Mediterranean countries with a multi-disciplinary approach and from diverse theoretical perspectives.

Types of article

New Medit publishes *Research/Themes* papers and *Notes*/*Reports*. *Research/Themes papers* include original essays and cutting-edge research closely related to the aims and scope of the Journal. *Notes/Reports* include comments or studies on singles experiences which aim to facilitate the debate and dissemination of the real questions among the different territorial areas of the Mediterranean.

The journal operates with a double-blind peer review policy.

Papers are published in English or in French, with an abstract in English.

Guidelines

http://www.newmedit.iamb.it.

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