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The Link Between Sustainable Development Goals and Agricultural Production Systems: Türkiye Analysis

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ABSTRACT

Technological developments are taking place at an incredible pace in the world and in Türkiye. As with all other sectors, the agricultural sector and therefore agricultural production systems are also affected by this process very quickly. Smart agricultural applications, artificial intelligence technologies, fertilization and spraying with drones, electric agricultural equipment, autonomous systems are among the main concepts and topics that are discussed and applied in the public. However, it is crucial to address these technological advancements within the framework of sustainability and ensure the balanced use of limited natural resources. This study aims to explore the relationship between the Sustainable Development Goals (SDGs) and agricultural systems in Türkiye, offering a fresh perspective on this crucial area. By utilizing the "Food Systems Summit Analysis" data tool from the FAO Data Laboratory, the study evaluates Türkiye's performance in achieving the SDGs. The findings reveal that while Türkiye has made significant progress in certain areas, substantial challenges persist in achieving sustainable agricultural production systems. The study contributes to the literature in two key ways. First, it identifies Türkiye's policy priorities and areas of success in transforming its agricultural systems within the SDG framework. Second, it develops a novel analytical framework to assess the interaction between sustainability and agricultural systems. This approach not only provides a roadmap for Türkiye but also serves as a valuable reference for other countries with similar development and sustainability objectives.

1. INTRODUCTION

Especially in the last 20 years, there have been significant changes and transformation processes in agricultural production systems as well as in all sectoral ecosystems. While this rapid change process is taking place, the concepts of efficiency and optimization are on the agenda as much as possible, and it is accepted by all segments that preventing the exploitation of existing natural resources worldwide and achieving balanced and sustainable development goals are now among the main policy targets.

Sufficient and balanced nutrition of the world population within the scope of the Sustainable Development Goals is one of the most important issues. In order to develop appropriate policy instruments to establish food security on a global scale, a good understanding of all motivational tools is necessary (Van Dijk et al., 2021).

Schneider et al. (2023) analyzed a food system indicator framework and holistic monitoring architecture developed to track food system transformation towards health, global development, and sustainability goals. The study focused on five main axes: (1) diets, nutrition and health; (2) environment, natural resources and production; (3) livelihoods, poverty and equity; (4) governance; and (5) resilience. Each main axis is divided into three to five indicator areas, and the indicators were selected to reflect each area through a good evaluation process. A total of 50 indicators were selected, with at least one indicator in each area. The data comprising these 50 indicators attempted to provide a basic assessment of the world food systems. As a result, while positive findings were obtained in some parts of each country's food systems, it was determined that no country had the highest values in all areas. In addition, it is claimed that some indicators are independent of national income, and that each of the indicators emphasizes a healthy, sustainable and equitable aspiration.

There are many activities and tests that may result in the damage and destruction of the multidimensional vital resources of the world, where living life continues, in the development and development process. Such negative activities can occur intentionally or unintentionally. For this reason, it is stated that there are many measures that need to be taken in order to prepare the planet for the future and to guarantee sustainable results in agriculture-food systems, and these should be taken quickly. In this context, the Food and Agriculture Organization (FAO) Strategic Framework 2022-31 has been developed. This process has been increasingly developed during the many negativities caused by the COVID-19 pandemic, and a global crisis that has been experienced worldwide and is thought to continue, although its intensity has decreased, FAO has the main mission of developing policies to establish functioning and sustainable agriculture-food systems that allow for sufficient and balanced food production and consumption (FAO, 2024a).

When the Covid-19 pandemic began to shake the world deeply in 2020, it became clear that non-traditional data sources and new methods that could improve coverage and provide rapid insights into specific issues were essential. On the other hand, there were already some efforts in this direction. For example, at the end of 2019, the Food and Agriculture Organization of the United Nations (FAO) established the "Data Lab for Statistical Innovation" with the aim of modernizing the Organization's statistical data collection and classification work, finding ways to fill and improve official data gaps. This can be explained as improving the timing and level of detail of data collection, providing automated analysis, and capturing early warning signals. The Covid-19 process has somehow accelerated the transformation and made efforts to do so even more prioritized (Fabi et al., 2022).

FAO's Data Laboratory was used in this study (FAO, 2024b). The Data Lab for Statistical Innovation employs cutting-edge methodologies to uncover hitherto undiscovered information pertinent to food security, nutrition, and food systems transformation. By extracting data from non-conventional sources and combining it with cutting-edge technologies, including web scraping, text mining, geo-spatial data analysis, and artificial intelligence, we address gaps in official statistics. Furthermore, we construct and sustain diverse databases to furnish timely, potentially real-time, data obtained from unconventional sources, thereby facilitating data analysis and evidence-based policymaking.

Türkiye has implemented various policies and practices to support the transformation of sustainable agriculture and food systems. These efforts are aligned with FAO’s 2022–2031 Strategic Framework and the Sustainable Development Goals (SDGs). For instance, support has been provided for organic

farming and good agricultural practices in Türkiye (Türkan and Gürçam, 2020), and the Soil Protection and Land Use Law, enacted in 2005, has legally secured the protection of agricultural lands (Resmi Gazete, 2005). To promote the efficient use of water resources, modern irrigation methods such as drip and sprinkler irrigation have been encouraged, alongside the development of integrated management plans (TOB, 2021). The "Save Your Food" campaign, launched in collaboration with FAO to reduce food waste, has raised awareness and contributed to the development of logistics and cold chain infrastructure to prevent product losses (TOB, 2024a). Digital tools such as the Agricultural Monitoring and Information System (TARBİL) and the Geographic Information System (GIS) are employed to enhance agricultural planning and productivity (TOB, 2024b). Additionally, IPARD funds have been utilized to support rural development, while projects targeting women farmers have contributed to gender equality (TOB, 2024c). To adopt a climate-resilient agricultural production model, the use of renewable energy sources, particularly solar energy, in agriculture has been encouraged (İDB, 2024).

These policies reflect Türkiye's efforts to strengthen sustainable agriculture and food systems in alignment with the SDGs. However, there is a notable lack of comprehensive academic studies evaluating the effectiveness of such direct and indirect policies in achieving the desired SDG targets. This study examines the transformation of agriculture and food systems in Türkiye within the framework of the Sustainable Development Goals. Given the limited number of holistic studies addressing sustainability indicators in Türkiye, this research aims to fill a significant gap and is expected to serve as a crucial guide and reference for future studies.

2. MATERIAL and METHOD

The study was mainly created by using the "Food Systems Summit Analysis" data tool in the "Analysis of Documents" menu in the FAO Data Laboratory section. The data sources used by the FAO Data Lab are derived from internationally recognized institutions and reliable databases. For instance, FAO's own datasets, such as FAOSTAT, have long been a standard source of information on agriculture, food security, and environmental sustainability. The database used in this study was developed during the UN Food Systems Summit (FSS), held as part of the UN General Assembly in September 2021, which set the context for the global transformation of agricultural and food systems to achieve the SDGs. A total of 1643 country dialogues were reported during the Summit, with more than 109000 participants. This resulted in the formulation of 117 National Pathways, which aimed to define the agri-food system transformations needed at the country level. The Data Lab employed text mining tools to extract, summarize, organize, and categorize information on effective policy interventions proposed in these transformation pathways. This in-depth analysis aimed to identify the current priorities that countries have defined as the pillars of their food systems transformation and to identify commonalities across country programs (FAO, 2024b).

The UN Food Systems Summit (FSS), which took place during the UN General Assembly in September 2021, created an important building block for global agri-food systems transformation to achieve the Sustainable Development Goals. During the Summit, 1643 country dialogues were reported with more than 109000 participants, resulting in more than 117 National Pathways. The purpose of these dialogues is to identify the agri-food system transformations needed at country level. The Data Lab used text mining tools to extract, summarize, organize and categorize information on effective policy interventions proposed in these transformation pathways in order to highlight existing priorities that countries have identified as the foundations for food systems transformations. Mainly, text mining tools were used to classify policy documents and gain insights into Türkiye's current priorities and programs related to agri-food system transformations (FAO, 2024b).

In addition, the Sustainable Development Report website was also used in detail and data was extracted (SDR, 2024). Sustainable Development Goals consist of 17 indicators. (i) No poverty (ii) Zero hunger (iii) Good health and well-being (iv) Quality education (v) Gender equality (vi) Clean water and sanitation (vii) Affordable and clean energy (viii) Decent work and economic growth (ix) Industry, innovation and infrastructure (x) Reduced inequalities (xi) Sustainable cities and communities (xii) Responsible consumption and production (xiii) Climate action (xiv) Life below water (xv) Life on land (xvi) Peace, justice and strong institutions (xvii) Partnerships for the goals. The values and success status of the indicators are represented.

3. RESULTS and DISCUSSIONS

Basically, within the framework of the SDGs in Türkiye, within the scope of pathway analysis, studies are carried out under 42 topics in 5 main areas. The distribution of these is presented below. The first action area, "Nourish All People," aims to ensure that all segments of society benefit from sufficient, healthy, and sustainable food systems. In this context, themes such as social protection mechanisms, reducing food loss and waste, supporting family farming, and promoting healthy diets for children are highlighted. The second action area, "Boost Nature-Based Solutions," focuses on minimizing the adverse environmental impacts of agricultural production. This area emphasizes themes such as nature-positive innovations, sustainable production methods, agroecological practices, soil health, and efficient water management. The third action area, "Advance Equitable Livelihoods and Empowered Communities," focuses on promoting social equity in agricultural systems and improving the economic and social conditions of disadvantaged groups. This includes increasing the participation of women and youth in the agricultural sector, ensuring fair income opportunities, and fostering rural development. The fourth action area, "Build Resilient Food Systems," aims to make agriculture and food systems more resistant to climate change, health crises, and other environmental or economic shocks. Key themes here include resilient supply chains and climate- and disaster-resilient development pathways. The fifth and final action area, "Means of Implementation," encompasses the supporting mechanisms necessary for implementing sustainable food systems. These include governance, financing, innovative knowledge and technologies, policy regulations, and infrastructure investments (Table 1).

Table 1. Action area and themes based using pathway analysis in Türkiye

Action area	Theme
1: Nourish All People	Social Protection for Food Systems Transformation Food Loss and Waste Family Farming Achieving Zero Hunger Healthy Diets from Sustainable Food Systems for Children & All Food Quality and Safety The True Value of Food Sustainable Consumption Social Protection for Food Systems Transformation Food Loss and Waste
2: Boost Nature-Based Solutions of Production	Nature-Positive Innovation Land Halting Deforestation & Conversion from Agricultural Commodities Water Sustainable Productivity Growth Agrobiodiversity Agroecology Sustainable Livestock Soil Health
3: Advance Equitable Livelihoods and Decent Work and Empowered Communities	Vulnerable Peoples Food Systems Urban Food Systems Youth Food Systems Equitable Livelihoods Food Systems for Women and Girls Decent Work and Living Incomes and Wages for All Food Systems Workers Indigenous Peoples Food Systems
4: Build Resilience to Vulnerabilities and Shocks and Stresses	Resilience to Stress and Vulnerabilities Resilient Food Supply Chains Resilience to Health Crises Resilience to Shocks and Violent Conflicts and Food Crisis Climate and Disasters Resilient Development Pathways (CRDP)
5: Means of Implementation	Governance for Sustainable Food Systems Finance and Investment Human Rights Policy and Regulation Digital Trade

	Human Resource Capacities
	Innovation and Knowledge
	Public Information
	Partnerships
	Better Data
	Infrastructure

Source: FAO, 2024b.

At this stage of the study, it was attempted to determine the extent to which the sub-indicators determined within the scope of SDGs were complied with. By evaluating the contributions of these success indicators to the SDGs as a whole, it was attempted to reveal the possible contributions and effects of these related indicators and communications on the transformation of agricultural production systems in Türkiye (Table 2).

When examining areas of success, notable achievements are observed in reducing poverty, access to clean drinking water, and indicators related to childhood nutrition. Under SDG 1 (No Poverty), the rate of extreme poverty has dropped to remarkably low levels. The reduction of the population living on less than $2.15 per day to a minimal level highlights the effectiveness of Türkiye's policies in this area. Similarly, under SDG 2 (Zero Hunger), the prevalence of stunting in children has decreased to a low rate of 5.5%, reflecting the success of Türkiye's nutrition programs. Access to clean water and sanitation services under SDG 6 (Clean Water and Sanitation) remains high, exceeding 97%, which is above global averages. These indicators showcase the progress Türkiye has made in social and basic infrastructure services (Table 2).

However, some areas of underperformance pose significant challenges to achieving sustainable development goals. Under SDG 13 (Climate Action), the per capita carbon emissions stand at a high level of 5.28 tons, indicating the need for Türkiye to adopt stronger sustainability policies in its energy and agricultural production systems. Similarly, SDG 15 (Life on Land) indicators reveal serious deficiencies in protecting biodiversity and ensuring the sustainable use of terrestrial ecosystems. Additionally, under SDG 12 (Responsible Consumption and Production), limited progress has been observed in waste management and recycling practices. These indicators emphasize the need for comprehensive policies to achieve environmental sustainability goals (Table 2).

In certain areas, mixed results are observed. For instance, under SDG 3 (Good Health and Well-being), Türkiye has made notable progress in general health indicators, but obesity rates remain high at 32.1%. This underscores the need for health policies that incorporate both preventive and curative approaches. In the context of SDG 5 (Gender Equality), significant issues persist, such as the low representation of women in parliament (17.33%) and disparities in female labor force participation. These findings highlight the necessity of addressing gender equality policies comprehensively (Table 2).

Table 2. Achievement of indicators of Sustainable Development Goals in Türkiye

Sustainable Development Goals	Value	Calculated by	Year	Achievement of SDG
SDG 1. No poverty				Challenges remain, on track or maintaining SDG achievement
-Poverty headcount ratio at $2,15/day	0.76	2017 PPP*, %	2023	Achieved, on track or maintaining SDG achievement
-Poverty headcount ratio at $3,65/day	1.39	2017 PPP*, %	2023	Achieved, on track or maintaining SDG achievement
-Poverty rate after taxes and transfers	15.00	%	2019	Significant challenges remain, on track or maintaining SDG achievement
SDG 2. Zero hunger				Significant challenges remain, score stagnating or increasing at less than 50% of required rate
-Prevalence of undernourishment	2.20	%	2020	Achieved, on track or maintaining SDG achievement
-Prevalence of stunting in children under 5 years of age	5.50	%	2022	Achieved, on track or maintaining SDG achievement
-Prevalence of wasting in children under 5 years of age	1.70	%	2018	Achieved, trend information unavailable
-Prevalence of obesity, BMI** ≥ 30	32.10	% of adult population	2016	Major challenges remain, score decreasing
-Human Trophic Level	2.25	best 2-3 words	2017	Challenges remain, score moderately improving, insufficient to attain goal
-Cereal yield	2.92	tonnes per hectare of harvested land	2021	Achieved, score stagnating or increasing at less than 50% of required rate
-Sustainable Nitrogen Management Index	0.64	best 0-1.41 worst	2018	Significant challenges remain, score decreasing
-Yield gap closure	Unavailable	% of potential yield	Unavailable	Information unavailable, trend information unavailable
-Exports of hazardous pesticides	3.80	tonnes per million population	2020	Challenges remain, trend information unavailable
SDG 3. Good health and well-being				Significant challenges remain, score moderately improving, insufficient to attain goal
-Maternal mortality rate	17.33	per 100000 live births	2020	Achieved, on track or maintaining SDG achievement
-Neonatal mortality rate	4.72	per 1000 live births	2021	Achieved, on track or maintaining SDG achievement
-Mortality rate, under-5	8.98	per 1000 live births	2021	Achieved, on track or maintaining SDG achievement
-Incidence of tuberculosis	18.00	per 100000 population	2021	Challenges remain, score stagnating or increasing at less than 50% of required rate
-New HIV infections	Unavailable	per 1000 uninfected population	Unavailable	Information unavailable, trend information unavailable
-Age standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30-70 years	15.63	%	2019	Challenges remain, on track or maintaining SDG achievement
-Age standardized death rate attributable to household air pollution and ambient air pollution	45.50	per 100000 population	2019	Challenges remain, trend information unavailable
-Traffic deaths	6.68	per 100000 population	2019	Achieved, on track or maintaining SDG achievement
-Life expectancy at birth	78.62	years	2019	Challenges remain, on track or maintaining SDG achievement
-Adolescent fertility rate	14.70	births per 1000 females aged 15 to 19	2020	Achieved, on track or maintaining SDG achievement
-Births attended by skilled health personnel	97.00	%	2019	Challenges remain, score decreasing
-Surviving infants who received 2 WHO-recommended vaccines	95.00	%	2021	Achieved, score stagnating or increasing at less than 50% of required rate
-Universal health coverage (UHC) index of service coverage	79.00	worst 0-100 best	2019	Challenges remain, on track or maintaining SDG achievement

-Subjective well-being	5.10	average ladder score, worst 0-10 best	2022	Significant challenges remain, score decreasing
-Gap in life expectancy at birth among regions	4.50	years	2019	Challenges remain, on track or maintaining SDG achievement
-Gap in self-reported health status by income	8.10	percentage points	2020	Achieved, on track or maintaining SDG achievement
-Daily smokers	28.00	% of population aged 15 and over	2019	Significant challenges remain, score decreasing
SDG 4. Quality education				Significant challenges remain, on track or maintaining SDG achievement
-Participation rate in pre-primary organized learning	79.49	% of children aged 4 to 16	2020	Significant challenges remain, on track or maintaining SDG achievement
-Net primary enrollment rate	95.11	%	2020	Challenges remain, score stagnating or increasing at less than 50% of required rate
-Lower secondary completion rate	122.52	%	2020	Achieved, on track or maintaining SDG achievement
-Literacy rate	99.91	% of population aged 15 to 24	2019	Achieved, on track or maintaining SDG achievement
-Tertiary educational attainment	39.83	% of population aged 25 to 34	2021	Challenges remain, on track or maintaining SDG achievement
-PISA*** score	462.67	worst 0-600 best	2018	Challenges remain, on track or maintaining SDG achievement
-Variance in science performance explained by socio-economic status	10.99	%	2018	Challenges remain, score decreasing
-Underachievers in science	25.15	% of-15-year-olds	2018	Significant changes remain, on track or maintaining SDG achievement
SDG 5. Gender equality				Major challenges remain, score stagnating or increasing at less than 50% required rate
-Demand for family planning satisfied by modern methods	60.20	% of females aged by 15 to 49	2018	Significant changes remain, trend information unavailable
-Ratio of female-to-male mean years of education received	83.62	%	2021	Significant changes remain, score stagnating or increasing at less than 50% required rate
-Ratio of female-to-male labor force participation rate	48.04	%	2022	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Seats held by women in national parliament	17.33	%	2021	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Gender wage gap	9.98	% of male median wage	2018	Challenges remain, trend information unavailable
SDG 6. Clean water and sanitation				Significant challenges remain, score moderately improving, insufficient to attain goal
-Population using at least basic drinking water services	97.01	%	2020	Challenges remain, on track or maintaining SDG achievement
-Population using at least basic sanitation services	99.23	%	2020	Achieved, on track or maintaining SDG achievement
-Freshwater withdrawal	45.71	% of available freshwater resources	2019	Challenges remain, trend information unavailable
-Anthropogenic wastewater that receives treatment	30.53	%	2020	Significant challenges remain, trend information unavailable
-Scarce water consumption embodied in imports	974.31	m_3 H_20 eq/capita	2018	Achieved, trend information unavailable
-Population using safely managed water services	Unavailable	%	Unavailable	Information unavailable, trend information unavailable
-Population using safely managed sanitation services	78.43	%	2020	Challenges remain, score moderately improving, insufficient to attain goal
SDG 7. Affordable and clean energy				Challenges remain, score moderately improving, insufficient to attain goal
-Population with access to electricity	100.00	%	2020	Achieved, on track or maintaining SDG achievement
-Population with access to clean fuels and technology for cooking	95.20	%	2020	Achieved, on track or maintaining SDG achievement
-CO_2 emissions from fuel combustion per total electricity output	Unavailable	$MtCO_2$/TWh	Unavailable	Information unavailable, trend information unavailable
-Renewable energy share in total final energy consumption	14.10	%	2019	Significant challenges remain, score stagnating or increasing at less than 50% of required rate

SDG 8. Decent work and economic growth				Major challenges remain, score stagnating or increasing at less than 50% of required rate
-Adjusted GDP**** growth	-0.59	%	2021	Challenges remain, trend information unavailable
-Victims of modern slavery	6.50	per 1000 population	2018	Challenges remain, trend information unavailable
-Adults with an account at a bank or other financial institution or with a mobile-money-service provider	74.09	% of population aged 15 or over	2021	Challenges remain, on track or maintaining SDG achievement
-Unemployment rate	Unavailable	% of total labor force, ages 15+	Unavailable	Information unavailable
-Fundamental labor rights are effectively guaranteed	0.41	worst 0-1 best	2021	Major challenges remain, score decreasing
-Fatal work-related accidents embodied in imports	0.05	per 100000 population	2018	Achieved, on track or maintaining SDG achievement
-Victims of modern slavery embodied in imports	20.11	per 100000 population	2018	Challenges remain, trend information unavailable
-Employment-to-population ratio	50.25	%	2021	Significant challenges remain, score stagnating or increasing at less than 50% of required rate
-Youth not in employment, education or training (NEET)	28.69	% of population aged 15 to 29	2021	Major challenges remain, score stagnating or increasing at less than 50% of required rate
SDG 9. Industry, innovation and infrastructure				Major challenges remain, score moderately improving, insufficient to attain goal
-Rural population with access to all-season roads	95.87	%	2022	Achieved, trend information unavailable
-Population using the internet	81.41	%	2021	Achieved, on track or maintaining SDG achievement
-Mobile broadband subscriptions	82.61	per 100 population	2021	Achieved, on track or maintaining SDG achievement
-Logistics Performance Index: Quality of trade and transport-related infrastructure	3.21	worst 1-5 best	2018	Achieved, score stagnating or increasing at less than 50% of required rate
-The Times Higher Education Universities Ranking: Average score of top 3 universities	40.45	worst 0-100 best	2022	Achieved, trend information unavailable
-Articles published in academic journals	0.74	per 1000 population	2021	Achieved, on track or maintaining SDG achievement
-Expenditure on research and development	1.09	% of GDP	2020	Significant challenges remain, on track or maintaining SDG achievement
-Researchers	5.65	per 1000 employed population	2020	Major challenges remain, on track or maintaining SDG achievement
-Triadic patent families filed	0.77	per million population	2020	Major challenges remain, score stagnating or increasing at less than 50% of required rate
-Gap in internet access by income	Unavailable	percentage points	Unavailable	Information unavailable, trend information unavailable
-Female share of graduates from STEM fields at the tertiary level	34.69	%	2014	Achieved, trend information unavailable
SDG 10. Reduced inequalities				Major challenges remain, score stagnating or increasing at less than 50% of required rate
-Gini coefficient	41.90	-	2019	Major challenges remain, score stagnating or increasing at less than 50% of required rate
-Palma ratio	2.01	-	2019	Major challenges remain, score decreasing
-Elderly poverty rate	13.70	% of population aged 66 or over	2019	Challenges remain, on track or maintaining SDG achievement
SDG 11. Sustainable cities and communities				Significant challenges remain, score stagnating or increasing at less than 50% of required rate
-Proportion of urban population living in slums	14.13	%	2018	Challenges remain, trend information unavailable
-Annual mean concentration of particulate matter of less than 2.5 micron in diameter (PM 2.5)	45.21	$\mu g/m^3$	2019	Major challenges remain, score stagnating or increasing at less than 50% of required rate

-Access to improved water source, piped	98.26	% of urban population	2020	Achieved, on track or maintaining SDG achievement
-Satisfaction with public transport	53.00	%	2022	Significant challenges remain, score decreasing
-Population with rent overburden	Unavailable	%	Unavailable	Information unavailable, trend information unavailable
-Proportion of population with access to points of interest with a 15 min walk	74.74	%	2022	Challenges remain, trend information unavailable
SDG 12. Responsible consumption and production				Significant challenges remain, score moderately improving, insufficient to attain goal
-Municipal solid waste	Unavailable	kg/capita/day	Unavailable	Information unavailable, trend information unavailable
-Electronic waste	10.20	kg/capita	2019	Major challenges remain, trend information unavailable
-Production-based SO_2 emissions	15.10	kg/capita	2018	Achieved, trend information unavailable
-SO_2 emissions embodied in imports	1.66	kg/capita	2018	Achieved, trend information unavailable
-Production-based nitrogen emissions	33.74	kg/capita	2018	Challenges remain, score stagnating or increasing at less than 50% required rate
-Nitrogen emissions embodied in imports	6.96	kg/capita	2018	Achieved, on track or maintaining SDG achievement
-Exports of plastic waste	0.17	kg/capita	2021	Achieved, on track or maintaining SDG achievement
-Non-recycled municipal solid waste	0.99	kg/capita/day	2020	Significant challenges remain, on track or maintaining SDG achievement
SDG 13. Climate action				Major challenges remain, score stagnating or increasing at less than 50% required rate
-CO_2 emissions from fossil fuel combustion and cement production	5.28	tCO_2/capita	2021	Major challenges remain, score decreasing
-CO_2 emissions embodied in imports	0.61	tCO_2/capita	2018	Challenges remain, on track or maintaining SDG achievement
-CO_2 emissions embodied in fossil fuel exports	1.30	kg/capita	2021	Achieved, trend information unavailable
-Carbon pricing Score at EUR60/tCO_2	23.61	%, worst 0-100 best	2018	Major challenges remain, score stagnating or increasing at less than 50% required rate
SDG 14. Life below water				Major challenges remain, score moderately improving, insufficient to attain goal
-Mean area that is protected in marine sites important to biodiversity	3.85	%	2022	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Ocean Health Index: Clean Waters score	70.71	worst 0-100 best	2022	Significant challenges remain, on track or maintaining SDG achievement
-Fish caught from overexploited or collapsed stocks	57.50	% of total catch	2018	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Fish caught by trawling or dredging	18.97	%	2019	Challenges remain, on track or maintaining SDG achievement
-Fish caught that are then discarded	5,38	%	2019	Challenges remain, on track or maintaining SDG achievement
-Marine biodiversity threats embodied in imports	0.01	per million population	2018	Achieved, trend information unavailable
SDG 15. Life on land				Major challenges remain, score stagnating or increasing at less than 50% required rate
-Mean area that is protected in terrestrial sites important to biodiversity	2.33	%	2022	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Mean area that is protected in freshwater sites important to biodiversity	4.17	%	2022	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Red List Index of species survival	0.88	worst 0-1 best	2023	Challenges remain, score stagnating or increasing at less than 50% required rate
-Permanent deforestation	0.01	% of forest area, 3-year average	2021	Achieved, score stagnating or increasing at less than 50% required rate
-Terrestrial and freshwater biodiversity threats embodied in imports	0.68	per million population	2018	Achieved, trend information unavailable
SDG 16. Peace, justice and strong institutions				Major challenges remain, score stagnating or increasing at less than 50% required rate
-Homicides	2.52	per 100000 population	2021	Challenges remain, score moderately improving, insufficient to attain goal

-Unsentenced detainees	15.76	% of prison population	2020	Achieved, score stagnating or increasing at less than 50% required rate
-Birth registrations with civil authority	98.40	% of children under age 5	2018	Achieved, trend information unavailable
-Corruption Perception Index	36.00	worst 0-100 best	2022	Major challenges remain, score decreasing
-Children involved in child labor	3.83	% of population aged 5 to 14	2019	Challenges remain, trend information unavailable
-Exports of major conventional weapons	0.30	TIV consultant million USD per 100000 population	2021	Achieved, trend information unavailable
-Press Freedom Index	33.97	worst 0-100 best	2023	Major challenges remain, score decreasing
-Access to and affordability of justice	0.55	worst 0-1 best	2021	Significant challenges remain, on track or maintaining SDG achievement
-Timeliness of administrative proceedings	0.37	worst 0-1 best	2021	Major challenges remain, score decreasing
-Expropriations are lawful and adequately compensated	0.46	worst 0-1 best	2021	Major challenges remain, score stagnating or increasing at less than 50% required rate
-Persons held in prison	317.63	per 100000 population	2020	Major challenges remain, score decreasing
SDG 17. Partnerships for the goals				Significant challenges remain, score stagnating or increasing at less than 50% required rate
-Government spending on health and education	7.00	% of GDP	2020	Significant challenges remain, score decreasing
-For high income and all OECD DAC countries: International concessional public finance, including official development assistance	Unavailable	% of GNI	Unavailable	Information unavailable, trend information unavailable
-Other countries: Government revenue excluding grants	30.37	% of GDP	2020	Achieved, score stagnating or increasing at less than 50% required rate
-Corporate Tax Haven Score	0.00 (imputed)	best 0-100 worst	2021	Achieved, trend information unavailable
-Financial Secrecy Score	61.13	best 0-100 worst	2022	Major challenges remain, score moderately improving, insufficient to attain goal
-Shifted profits of multinationals	5.73	US$ billion	2019	Achieved, on track or maintaining SDG achievement
-Statistical Performance Index	87.71	worst 0-100 best	2022	Achieved, on track or maintaining SDG achievement
Overall score	70.78/100		Rank	72/166
Spillover score	94.70/100		Spillover rank	75/166

* PPP: Purchasing Power Parity.
** BMI: Body Mass Index. BMI ranges between 18,5 and 24,9 – The level is defined as the 'healthy range'. between 25 and 29.9 – The level is identified as overweight. between 30 and 39.9 – The level is defined as obesity. 40 or over – The level is identified as severe obesity (NHLBI, 2024).
*** PISA is the OECD's Programme for International Student Assessment. PISA measures 15-year-olds' ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges (OECD, 2024).
**** GDP: Gross Domestic Product.
Source: SDR, 2024.

In summary, Türkiye's general situation for SDG indicators is given below. While the success level for the targets is 50%, a limited development of approximately 22-24% and a worsening situation of 25-26% have been determined (Figure 1).

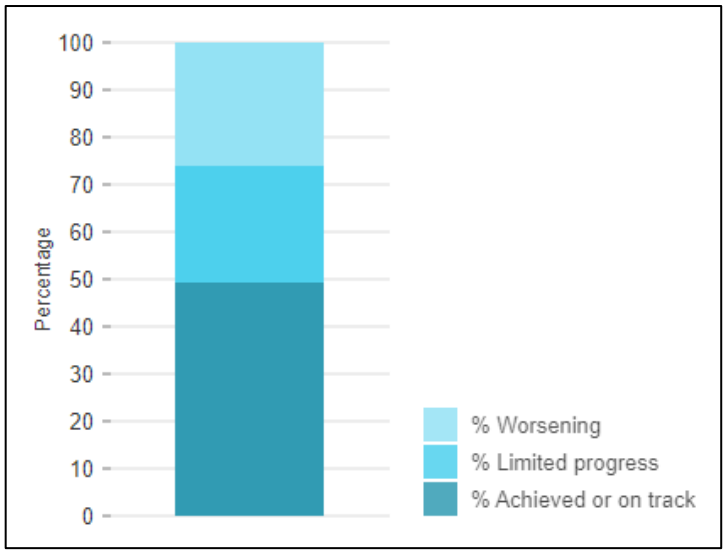

Figure 1. Status of SDG targets for Türkiye (% trend indicators) (SDR, 2024)

In light of the Sustainable Development Goals (SDGs), understanding and addressing the multifaceted relationship between agricultural systems and sustainability indicators is crucial. The interaction between agricultural practices, resource management, and policy frameworks directly influences the progress toward these goals. Therefore, establishing a comprehensive integration strategy for agriculture becomes a key element in ensuring alignment with the overarching sustainability targets. In this context, when the findings of Table 2 are evaluated, it is evident that implementing sustainable agricultural practices is critically important for increasing productivity while protecting the environment and ensuring long-term ecological balance. These practices support the efficient use of existing resources and contribute to the preservation of natural ecosystems for future generations. As noted by FAO (2021), methods such as agroecology and precision farming have proven effective in increasing yields while preserving ecosystems. However, global hunger remains a pressing issue, affecting over 720 million people in 2020, a figure exacerbated by conflicts, climate change, and economic shocks. Agriculture plays a significant role in reducing rural poverty. Akhtar (2022) emphasizes that investments in rural infrastructure, microfinance, and improving farmers' access to markets can drive substantial progress in this area. For instance, India's PM-KISAN program, which provides direct income support to smallholder farmers, has demonstrated notable positive impacts in rural regions. At the same time, agriculture contributes approximately 23% of global greenhouse gas emissions and is both a driver of and vulnerable to climate change (IPCC, 2021). The adoption of climate-smart agriculture (CSA) strategies has proven effective in addressing this dual challenge by promoting both mitigation and adaptation. CSA projects in East Africa, for example, have enhanced resilience by incorporating drought-tolerant crops and improving water management while simultaneously reducing emissions. Furthermore, sustainable food systems are crucial for reducing waste and promoting responsible consumption. The United Nations (2023) has highlighted the necessity of transitioning to circular food systems. In this regard, countries such as Denmark and the Netherlands have achieved remarkable success in reducing food waste through effective policy frameworks and public-private partnerships. These examples demonstrate the transformative potential of agriculture and food systems in advancing sustainable development goals, showcasing their capacity to address critical challenges while contributing to global progress.

4. CONCLUSIONS

In this study, the status of the implementation of SDG indicators in Türkiye is examined and the possible direct or indirect impact and transformations of this situation on agricultural structure and production systems are evaluated. In this context, although it has been determined that many indicators regarding sustainability have been achieved at a significant level, it is observed that there are still significant inadequacies and deficiencies. While significant progress has been made in areas such as poverty reduction, access to clean water, and child nutrition, critical challenges persist in environmental

indicators such as high carbon emissions, biodiversity conservation, and waste management. In this context, adopting effective and integrated strategies is crucial to accelerate the transformation of agricultural production systems and achieve sustainable development goals.

Primarily, Türkiye must strengthen its climate policies and focus on renewable energy projects. Innovative solutions like solar-powered irrigation systems should be widely implemented in the agricultural sector to reduce carbon emissions. Similarly, programs supporting local ecosystems must be developed to conserve biodiversity, and the use of natural fertilizers in agriculture should be encouraged. Expanding smart agricultural practices can enhance agricultural productivity while optimizing the use of natural resources. Financial incentive mechanisms should be established to support small and medium-sized farmers in transitioning to sustainable production techniques. Promoting gender equality and increasing youth employment are also critical for strengthening the agricultural sector. Training and support programs should be organized to ensure greater participation of women in agriculture, and agricultural entrepreneurship projects should be launched to attract young people to the sector. Enhancing data infrastructure and establishing transparent monitoring mechanisms will facilitate more effective tracking of sustainability goals and policy development. Collaborating with international organizations such as FAO and adopting up-to-date, comprehensive data collection methods are essential. Additionally, awareness campaigns should be conducted to promote sustainable consumption habits in society, and policies aimed at preventing waste should be implemented. Finally, Türkiye should foster international collaborations to elevate its agricultural sector to global competitiveness. Increasing international funding and investments for sustainable agricultural projects can accelerate the transformation process in the sector. To enhance agriculture's resilience against global crises, insurance systems should be developed, and research on drought-resistant seed varieties should be prioritized.

Researchers' Contribution Rate Declaration Summary

The authors declare that they have contributed equally to the article.

Conflict of Interest Declaration

The authors declare that there is no conflict of interest between them.

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