

## CARBON ACCOUNTING APPLICATION IN THE AGRICULTURAL PRODUCTS SECTOR WITHIN THE SCOPE OF CLIMATE CHANGE, SUSTAINABILITY AND ACCOUNTING STANDARDS

Cenk Kiritoglu, page 165-193

### ABSTRACT

A series of ecological and environmental problems driven by global warming has become an issue that individuals must confront, while for businesses it represents a significant source of risk and cost. In the face of the global climate crisis, the agricultural sector is both a major source of greenhouse gas emissions and a strategic sector with considerable carbon sequestration potential, which is instrumental in combating climate change. Accordingly, the implementation of accurate, transparent, and reliable carbon accounting practices has become imperative in the agricultural products sector. This article comprehensively addresses the theoretical foundations, implementation methodologies, and reporting requirements of carbon accounting in the agricultural products sector, within the context of climate change, sustainability, and accounting standards. Through a sustainability report and a carbon accounting case study, the article provides guidance to investors in the agricultural sector concerning costs and risks. In Turkey, the Turkish Sustainability Reporting Standards (TSRS), which entered into force on December 29, 2023, have made the reporting of sustainability and climate-related information mandatory for enterprises meeting certain criteria. Accordingly, agricultural enterprises are required to account for their carbon emissions in line with the Turkish Accounting Standard 41 (TAS 41) – Agriculture and to carry out integrated reporting in compliance with TSRS 2 – Climate-Related Disclosures. The research revealed that particularly small enterprises in the agricultural sector are not adequately prepared for the implementation of sustainability standards and carbon accounting practices due to deficiencies of capital, technology, infrastructure, and capacity. Deficiencies observed in carbon emission calculations, inconsistencies between Tax Accounting and TAS 41, and the lack of necessary accounts for carbon accounting in the Uniform Chart of Accounts indicate that comprehensive regulations in accounting and tax systems are needed to ensure the successful implementation of the process initiated by the Climate Law No. 7552.

**Keywords:** Carbon accounting, Agriculture sector, Sustainability reporting, TMS 41, TSRS 2, Climate change

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## 1. INTRODUCTION

Carbon accounting, climate reporting, and data collection requirements for the Turkish agricultural sector have been detailed within the framework of the 2025 Climate Law and related regulations. The objective is to monitor greenhouse gas emissions, establish verifiable databases, and ensure compliance in enterprises trading with the European Union.

Carbon and Climate Reporting Requirements in Agriculture within the Current Legislative Framework:

1. **Monitoring of Greenhouse Gas Emissions:** Recording and tracking of land use, fertilizer applications, energy and fuel consumption, irrigation, and livestock-related methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions at field, barn, and enterprise levels is mandatory.
2. **Data Collection at Product and Enterprise Levels:** Annual creation of emission inventories at enterprise and product levels (e.g., wheat, corn, milk, cattle) and electronic entry of collected data into the national database is mandatory.
3. **Registration in the National MRV System:** Agricultural sector enterprises must be fully integrated into the Monitoring, Reporting, and Verification (MRV) system, with regular data transmission in standard format.
4. **Soil, Fertilizer, and Livestock-Specific Modules:** Soil carbon stock, fertilizer management, methane/nitrogen emissions based on feed and animal numbers, and CO<sub>2</sub> emissions from irrigation and energy consumption must be declared separately.
5. **Sink Area/Pasture Management:** Preparation of carbon capacity reports once a year for pastures, forests, and wetlands is mandatory for the protection of agricultural sinks and carbon stocks.
6. **Audit through Verification:** Reported data will be verified for accuracy through systems, with administrative sanctions for false, incomplete, or misleading declarations.
7. **Differentiation by Agricultural Enterprise Size:** Large enterprises, cooperatives, and associations will conduct detailed reporting, while simplified templates will be applied for small family farms.
8. **Integration with National Greenhouse Gas Inventory:** Collected emission data will be transferred to the central database of the Ministry of

Agriculture and Forestry/Ministry of Environment and will constitute the primary input for the national greenhouse gas inventory.

9. EU and Export-Specific Requirements: Agricultural firms exporting to the EU will be required to prove product-specific carbon footprints separately in the Carbon Border Adjustment Mechanism (CBAM) process; certified and verified data presentation will be a prerequisite, and export of products not produced in this manner will be prohibited.

Within this scope, the period for collecting and reporting greenhouse gas emission data in the agricultural sector, compatible with EU standards, electronically and verifiably, began with the 2025 law, and its complete implementation became a legal obligation by the end of 2027.

#### Strategic Importance of Agricultural Carbon Accounting

In the face of the global climate crisis, the agricultural sector is both a significant source of greenhouse gas emissions and a strategic sector with carbon sequestration potential (Öncar Şentürk, Gök & Koçyiğit, 2023; QSI Cert, 2025). While agricultural activities account for approximately 10-12% of global greenhouse gas emissions, they are in an effective position in combating climate change through their capacity to sequester carbon from the atmosphere via soil and vegetation (Öztürk, 2024).

Therefore, the accurate, transparent, and reliable implementation of carbon accounting in the agricultural products sector has become mandatory (Bora Kılınçarslan, Poroy Arsoy & Kardeş Selimoğlu, 2022). In Turkey, the Turkish Sustainability Reporting Standards (TSRS), which entered into force on December 29, 2023, made the reporting of sustainability and climate information mandatory for enterprises meeting certain criteria (Kamu Gözetimi, Muhasebe ve Denetim Standartları Kurumu, 2023a). With these regulations, agricultural enterprises are required to account for their carbon emissions within the framework of TAS 41 Agricultural Activities standard and report them in accordance with TSRS 2 Climate-Related Disclosures standard (Kamu Gözetimi, Muhasebe ve Denetim Standartları Kurumu, 2023b; QSI Cert, 2025).

#### Implementation of Sustainability Standards and Reporting

The implementation of sustainability standards and sustainability reporting will be realized through the systematic implementation of technical, environmental, and social criteria for enterprises. Sustainability standards are determined by technical, economic, and environmental criteria aimed at managing the impact of an enterprise's activities on

society, the environment, and the economy. Implementation stages include:

- a) Resource Efficiency: Optimizing the use of inputs such as energy, water, and raw materials and preventing waste.
- b) Assessment of Direct & Indirect Energy Use: Determining the amounts of energy consumed in electricity, fossil fuels, and related production processes (e.g., MJ/ha, GJ/t).
- c) Monitoring of Greenhouse Gas and Other Emissions: Calculating and reporting environmental indicators such as CO<sub>2</sub>, NO<sub>2</sub>, SO<sub>2</sub>.
- d) Sustainable Agriculture/Food Production: Requiring the adoption of appropriate fertilizer use, energy-efficient machinery, and environmentally friendly methods.

"Energy efficiency is the goal of efforts to reduce the amount of energy required to provide products and services. In agricultural production, energy is used directly through fuel and electricity consumption and indirectly due to energy consumption in the production processes of agricultural machinery, fertilizers, and agricultural pesticides" (Mutlu, 2020, p. 293).

This article provides a multidimensional evaluation of the legal legislation, implementation standards, and effects on companies within the scope of this transformation. The research revealed that the agricultural sector, particularly small enterprises, is not prepared for sustainability standards and carbon accounting practices due to deficiencies in capital, infrastructure, and capacity (Tursun & Durmuş, 2025). It was determined that the accounts necessary for carbon accounting have not yet been fully established in the Uniform Chart of Accounts, and comprehensive regulations in accounting and tax systems are needed for the successful implementation of the process initiated by Climate Law No. 7552 (Kaya & Alkan, 2024).

## **2. LITERATURE REVIEW**

Yılmaz (2022) in his study titled "Accounting for Carbon Emissions within the Scope of Turkish Accounting Standards" examines how greenhouse gas emissions subject to trading in carbon markets can be accounted for within the framework of Turkish Accounting Standards (TAS). Accounting methods through the IFRIC 3 approach, net liability approach, and asset-liability model have been evaluated. The research

proposes a framework for transferring carbon information to financial statements in an accurate, transparent, and reliable manner.

Korkmaz (2023) in his article titled "Carbon Footprint in Agriculture and Its Impact on Climate Change" examined the impact of agricultural activities in Turkey on greenhouse gas emissions and carbon footprint. The research focused on soil organic matter levels, water use, and the carbon sink function of agricultural lands. The findings indicate that increasing the carbon storage potential of agricultural lands is an important element in combating climate change.

Ayyıldız (2025) in his study titled "Reduction of Agricultural Carbon Footprint within the Framework of the Paris Climate Agreement" comparatively addresses carbon emissions from agricultural sources in Turkey and the EU, evaluating the effectiveness of farm-based emission reduction policies in line with the goals of the Paris Agreement. Policy compliance, carbon tax effects, and emission-reducing agricultural practices have been discussed.

Christensen (2024) in his article titled "Accounting for Sustainability and Climate Change" examines the role of the accounting profession in sustainability reporting. The study discusses the development of climate change-related accounting standards and the integration of carbon accounting into financial reporting processes.

OECD (2025) in its report titled "Measuring Carbon Footprints of Agri-Food Products" analyzes the application of international standards and ISSB-based sustainability disclosure rules in measuring the carbon footprint of agricultural and food products. The report emphasizes the importance of the product life cycle approach in greenhouse gas calculations.

Farmonaut (2025) in its article titled "Carbon Accounting Tools in Sustainable Farming: 2025 Perspective" introduces digital carbon accounting tools developed in the agricultural sector as of 2025. The contribution of these tools in terms of emission monitoring, access to the carbon market, and sustainable practices has been evaluated. The study emphasizes the impact of carbon accounting technologies on farm-level decision-making processes.

Arslan (2024) in his book titled "Greenhouse Gas Emissions and Carbon Footprint Management in Agricultural Production" explains the process of creating a greenhouse gas inventory and carbon footprint management in agricultural production. He provides recommendations for agricultural

enterprises in Turkey within the context of the ISO 14064 standard and TSRS 2 "Climate-Related Disclosures" standard.

Kamu Gözetimi, Muhasebe ve Denetim Standartları Kurumu (KGK) (2025) according to the report "Greenhouse Gas Disclosures Compatible with Turkish Sustainability Reporting Standards (TSRS)": This report, prepared in accordance with TSRS 1 and TSRS 2 standards, explains how climate-related financial information should be disclosed and its effects on the agricultural sector. According to the report, agricultural enterprises must disclose carbon footprint information in their sustainability reports as a mandatory requirement.

When these sources are evaluated together, it is observed that carbon accounting in the agricultural products sector is strongly associated with global climate goals and the Turkish Sustainability Reporting Standards (TSRS). In recent years, publications on these topics have rapidly increased in the literature.

### **3. CARBON ACCOUNTING, SUSTAINABILITY REPORTING AND AUDITING WITHIN THE FRAMEWORK OF THE CLIMATE LAW**

In Turkey, sustainability reporting is transforming from a voluntary practice to a legally mandated and audited obligation with the Climate Law No. 7552 and national and international regulations. Under the headings of Climate Law, Emissions Trading System (ETS), Turkish Sustainability Reporting Standards (TSRS), and mandatory assurance audits, sustainability is becoming a strategic activity centered on companies' risk management, corporate competitiveness, and long-term value creation. With the deepening of the global climate crisis and the implementation of the European Green Deal, sustainability and climate risks have become not only an ethical responsibility but also a commercial and legal obligation for organizations in Turkey. In particular, the Climate Law No. 7552, which entered into force on July 9, 2025, and the Turkish Sustainability Reporting Standards, which entered into force in 2023, have initiated a new era in sustainability reporting and auditing (Çevre İklim Bakanlığı, 2025; KGK, 2023).

#### **1. Climate Law No. 7552 and Legal Framework**

Climate Law No. 7552 is Turkey's first comprehensive climate legislation and legally guarantees the country's net-zero target. The law envisages a comprehensive policy set aimed at reducing greenhouse gas emissions, green transformation, and ensuring adaptation to climate risks. With this

law, the infrastructure of the Emissions Trading System (ETS), carbon pricing, and cap allocation for companies have been finalized, and verified emission reporting and annual allowance delivery have been made mandatory. Severe administrative fines and commercial activity bans are envisaged in case of non-compliance with the law.

## **2. Turkish Sustainability Reporting Standards (TSRS)**

TSRS, which entered into force in early 2024, is compatible with international ISSB IFRS S1 and S2 standards. Sustainability reporting has now become mandatory for enterprises exceeding certain size thresholds (500 million TL total assets, 1 billion TL sales volume, 250+ employees) or operating in the financial sector and companies traded in the capital market. TSRS is based on the principles of financial materiality, stakeholder focus, and comparability, thus enabling enterprises to strengthen transparency and competitiveness in both national and international markets.

## **3. Emissions Trading System (ETS)**

ETS is a market mechanism based on setting a cap on carbon emissions and allocating and trading carbon rights. The pilot application will begin in 2026-2027, and from 2028 onwards, it will be implemented in full scope in all regulated facilities and sectors. Emission measurement, reporting, and financial management of emission permits are mandatory for companies within the scope of ETS. The purpose of ETS is to make carbon costs visible and encourage reduction investments.

## **4. Mandatory Assurance Audit**

The reliability of sustainability reports prepared within the scope of TSRS will be subject to limited/reasonable assurance audits by independent auditors authorized by KGK. The main objective of sustainability auditing is to confirm the compliance of reported information with TSRS under the guidance of international auditing standards. The authorization of audit firms, the qualitative and technical competencies of auditors, and the standard format of audit reports are regulated by KGK.

## **5. Financial Reporting and Carbon Accounting**

Carbon allocations, emission liabilities, and carbon credits are reported as financial assets/liabilities under TAS 38, TAS 20, and TAS 37. With new implementation guides, how Emissions Trading System assets/liabilities will be accounted for within the Uniform Chart of Accounts is defined in

detail. The impact of greenhouse gas emissions on enterprise financials must be disclosed in annual activity reports in a detailed and comparable manner.

## **6. European Green Deal and International Compliance**

TSRS and Turkey's new climate legislation are largely compatible with the EU's Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS). Compliant reporting by companies trading with the EU in the 2025-2028 period is mandatory for competitive power and commercial access. Compliance with the Carbon Border Adjustment Mechanism (CBAM) and joint reporting enable Turkish companies to participate in European supply chains.

## **7. Strategic Consequences for Companies**

The new regulations in the field of sustainability and carbon accounting in Turkey are fundamentally transforming companies' financial, operational, strategic, and governance processes. Sustainability performance is becoming prominent in investor relations, and ESG scores are becoming an important criterion for green financing opportunities. Reporting, transparency, and audit obligations encourage the reduction of greenwashing practices and companies' long-term value creation.

Turkey's new legal architecture in sustainability and climate change combating offers an important opportunity window in terms of business model innovation, operational efficiency, and competitive advantage in international markets, going beyond compliance with legislation. Companies need to adopt this new structure on the path to strategic risk management and long-term value creation without being limited to legislation.

## **4. CARBON ACCOUNTING IN AGRICULTURAL ENTERPRISES AND AN APPLICATION EXAMPLE**

Turkey's agriculture and food sector has a significant share in the country's total exports, and according to 2023 data, agricultural product exports worth \$55 billion were realized. Agricultural product exports to the EU market constitute approximately 35% of total agricultural exports. For a sector of this magnitude, the obligations brought by the Climate Law and TSRS are of strategic importance not only for legal compliance but also for global competitiveness.

### **4.1. Sustainability Reporting Framework for Agricultural Enterprises**

Agricultural enterprises falling within the scope of TSRS are required to conduct sustainability reporting if they meet certain size criteria:

\*Total assets: 500 million TL and above

\*Annual net sales revenue: 1 billion TL and above

\*Number of employees: 250 and above

Agricultural enterprises meeting these criteria are required to report in accordance with TSRS 1 (General Sustainability Disclosures) and TSRS 2 (Climate-Related Disclosures) standards.

#### **4.2. Scope Classification in Carbon (Greenhouse Gas) Accounting: Scope 1, 2, 3, and 4**

The most widely used standard worldwide for greenhouse gas accounting is the GHG Protocol (Greenhouse Gas Protocol) (GHG Protocol, 2004). This protocol was developed in 2001 by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) and enables enterprises to measure their greenhouse gas emissions in a systematic, consistent, and verifiable manner (Plana Earth, 2025). The GHG Protocol is based on five fundamental principles: relevance, completeness, consistency, transparency, and accuracy (GHG Protocol, 2004). These principles ensure that emission inventories are reliable and comparable.

##### Scope 1 (Direct Emissions)

Scope 1 emissions are greenhouse gas emissions directly generated from sources owned or controlled by the enterprise (GHG Protocol, 2004). These emissions occur within the physical boundaries of the enterprise and are directly under control, making this the scope most affected by reduction measures (Plana Earth, 2025).

##### Scope 1 Emission Sources

Scope 1 emissions are classified into four main categories (GHG Protocol, 2004):

- a) Stationary Combustion: Boilers, generators, turbines, furnaces, and dryers burning natural gas, fuel oil, or coal fall into this category.
- b) Mobile Combustion: Company vehicles (automobiles, trucks, buses), forklifts, work machinery, and agricultural machinery (tractors, combine harvesters) are included in this group.
- c) Process Emissions: Calcination of limestone in cement production, chemical reactions, and N<sub>2</sub>O emissions from nitrogen

fertilizer use in agriculture are examples of process emissions (T.C. Tarım ve Orman Bakanlığı, 2021).

d) Fugitive Emissions: HFC leaks from cooling systems, methane leaks from natural gas pipelines, and methane emissions from wastewater treatment plants are evaluated in this category.

#### Calculation Method

The basic formula for calculating Scope 1 emissions is as follows (Cormind, 2025):

Emission (kg CO<sub>2</sub>) = Fuel Consumption (unit) × Emission Factor (kg CO<sub>2</sub>/unit)

Example: 10,000 liters of diesel consumption × 2.68 kg CO<sub>2</sub>/liter (IPCC emission factor) = 26,800 kg CO<sub>2</sub>

In the agricultural sector, N<sub>2</sub>O emissions from nitrogen fertilizer use are an important component of Scope 1. According to IPCC Tier 1 methodology, 1% of the applied nitrogen amount is released into the atmosphere as N<sub>2</sub>O-N, and the global warming potential (GWP) of N<sub>2</sub>O is 298 times that of CO<sub>2</sub> (T.C. Tarım ve Orman Bakanlığı, 2021).

#### Scope 2 (Indirect Energy Emissions)

Scope 2 emissions are indirect emissions resulting from the consumption of purchased electricity, heat, steam, or cooling by the enterprise (GHG Protocol, 2015). These emissions occur at the energy production facility but are the responsibility of the enterprise due to its energy consumption.

#### Calculation Methods

The GHG Protocol Scope 2 Guidance (2015) offers two different calculation methods:

a) Location-Based Method: The average emission factor of the electricity grid is used. For Turkey, the 2024 grid emission factor is 0.396 kg CO<sub>2</sub>/kWh (Enerji ve Tabii Kaynaklar Bakanlığı, 2024).  
Emission (kg CO<sub>2</sub>) = Electricity Consumption (kWh) × Grid Emission Factor

b) Market-Based Method: The specific emission factor of contractually purchased electricity is used (GHG Protocol, 2015). Scope 2 emissions can be zeroed with renewable energy certificates.

#### Scope 3 (Other Indirect Emissions)

Scope 3 emissions are all indirect emissions that occur in the enterprise's value chain but cannot be directly controlled (GHG Protocol, 2011). Scope 3 is of critical importance for understanding climate impact as it typically constitutes 70-90% of total emissions (Plana Earth, 2025).

### **Category Classification**

The GHG Protocol Corporate Value Chain (Scope 3) Standard divides emissions into 15 categories (GHG Protocol, 2011):

#### **Upstream Categories:**

1. Purchased goods and services
2. Capital goods
3. Fuel and energy-related activities
4. Upstream transportation and distribution
5. Waste generated in operations
6. Business travel
7. Employee commuting
8. Leased assets (upstream)

#### **Downstream Categories:**

9. Downstream transportation and distribution
10. Processing of sold products
11. Use of sold products
12. End-of-life treatment of sold products
13. Leased assets (downstream)
14. Franchises
15. Investments

In the agricultural sector, Category 1 (fertilizer, seed, pesticide production) and Category 10 (milling of wheat) are the largest Scope 3 emission sources (Kamu G zetimi, Muhasebe ve Denetim Standartları Kurumu [KGK], 2025).

### **Calculation Method**

There are significant challenges in measuring Scope 3 emissions: difficulty in data collection, need for coordination with suppliers and customers, risk of duplication, and high uncertainty levels (GHG Protocol, 2011; Sweep, 2024). According to TSRS 2 standard in Turkey, enterprises have been exempted from reporting Scope 3 emissions in the first two reporting periods (KGK, 2025).

### **Scope 4 (Avoided Emissions)**

Scope 4 (Avoided Emissions) refers to greenhouse gas emissions prevented elsewhere through the use of an enterprise's products or services

(World Resources Institute [WRI], 2013; Plana Earth, 2024). Scope 4 is not an official GHG Protocol scope and does not require mandatory reporting (Atlas Copco, 2025; Net0, 2025).

### **Avoided Emission Mechanisms**

Avoided emissions occur through four main mechanisms (D-Carbonize, 2025; Global Climate Initiatives, 2025):

1. Energy Efficiency Improvements: Use of energy-efficient equipment instead of old equipment
2. Adoption of Low-Carbon Technology: Renewable energy systems and electric vehicles
3. Circular Economy Initiatives: Recycling and refurbishment services
4. Consumer Behavior Changes: Teleconferencing and digital services

#### **Calculation Method**

A result-oriented approach is used in calculating avoided emissions (Persefoni, 2024):

Avoided Emission = Reference Scenario Emission - Project Scenario Emission

Example: Solar energy system → Use of solar panel (50 g CO<sub>2</sub>/kWh) instead of coal-based electricity (950 g CO<sub>2</sub>/kWh) = 900 g CO<sub>2</sub>/kWh avoided emission.

Scope 4 emissions must be reported separately from Scopes 1, 2, and 3 and cannot be used in carbon neutralization claims (GHG Protocol, 2021; Sweep, 2024). Reference uncertainty, market penetration estimates, rebound effect, and greenwashing risk are the main challenges of Scope 4 reporting (Net0, 2025; Plana Earth, 2024).

In the agricultural sector, 20-30% nitrogen fertilizer savings can be achieved through precision agriculture technologies (IoT sensors, drone-based fertilizer application), and significant amounts of N<sub>2</sub>O emissions can be prevented (Yeşil Büyüme, 2025).

Scope 1 emissions typically constitute 5-20% of total corporate emissions, Scope 2 5-15%, and Scope 3 70-90% (Plana Earth, 2025). Analyses conducted in agricultural enterprises in Turkey determined that the share of Scope 3 emissions in the total is in the range of 66-70% (Türk Traktör, 2025).

## 5. HYPOTHETICAL CASE STUDY

Business Name: Büyük Tarım Anonim Şirketi (Hypothetical)

Location: Konya-Karaman-Ankara (Multiple locations)

Activity Area: Industrial-scale wheat production

Planted Area: 40,000 hectares (400,000 decare)

Production Capacity: 120,000 tons/year

Average Yield: 3 tons/hectare (300 kg/decare)

Legal Status: Joint-stock company, traded on Borsa İstanbul

TSRS Reporting: MANDATORY (exceeds threshold values)

Financial Magnitude (2024 Estimate):

1. Net Sales Revenue: 1,320,000,000 TRY (120,000 tons × 11,000 TRY/ton)
2. Total Assets: 3,500,000,000 TRY
3. Number of Employees: 850

· All TSRS Criteria Met → Mandatory Reporting

### 5.1. Data Collection and Calculation of Greenhouse Gas Emissions Based on Scope

#### Scope 1: Direct Emissions

##### A) Fuel Consumption Emissions

Fuel consumption for machinery and equipment (for 40,000 ha):

Plowing (heavy), harrowing, fertilizer spreading, spraying, harvesting with combine harvester, etc., estimated at 2,147,550 liters.

Fuel emissions: 5,755,434 kg CO<sub>2</sub> = 5,755.4 tons CO<sub>2</sub>

##### Scope 1 B - Nitrogen Fertilizer Use - N<sub>2</sub>O Emissions

Fertilization Program (for 40,000 ha wheat):

#### Table 1 Emission Calculation of Table

Application Time	Nitrogen Dose (kg N/ha)	Total Nitrogen (tons N)	Fertilizer Type
1. Sowing Fertilizer	50	2.000	Urea (%46 N) + DAP
2. Top Dressing (Tillering)	40	1.600	Urea (%46 N)
3. Top Dressing (Stem Elongation)	30	1.200	AN (%33 N)
TOTAL	120	4.800	

N<sub>2</sub>O Emission Calculation (IPCC Tier 1):

Step 1: Direct N<sub>2</sub>O-N Emissions

Step 2: Conversion of N<sub>2</sub>O-N to N<sub>2</sub>O

Step 3: Conversion of N<sub>2</sub>O to CO<sub>2</sub>e

**Scope 1B - Nitrogen Fertilizer N<sub>2</sub>O Emissions: 22,477,246 kg CO<sub>2</sub>e = 22,477.2 tons CO<sub>2</sub>e**

**Table 2 Summary of Scope 1 Emissions Table**

Emission Source	Emissions (tons CO <sub>2</sub> e)	Share in Total Scope 1 (%)
Fuel consumption	5,755.4	20.4%
Nitrogen fertilizer N <sub>2</sub> O	22,477.2	79.6%
Total Scope 1	28,232.6	100.0%

### **Scope 2: Indirect Energy Emissions**

Electricity consumption (for 40,000 ha): Total activity includes irrigation systems, lighting, ventilation, administrative buildings, and other items, with total electricity consumption of 43,182,000 kWh, resulting in total emissions of 17,102,072 kg CO<sub>2</sub>.

**Scope 2 - Electricity Emissions: 17,102,072 kg CO<sub>2</sub> = 17,102.1 tons CO<sub>2</sub>**

Note: Turkey's electricity grid emission factor for 2024 is assumed as 0.396 kg CO<sub>2</sub>/kWh.

### Scope 3: Supply Chain Emissions

#### Category 1: Purchased Goods and Services

**Table 3 Emissions from agricultural inputs Table**

Input Type	Quantity (tons)	Emission Factor (kg CO <sub>2</sub> e /kg)	Emission (tons CO <sub>2</sub> e )
Fertilizers			
Nitrogen fertilizer (urea 46% N)	4.800 N → 10.435 urea	3.80	39,652
Phosphorus fertilizer (TSP 46% P <sub>2</sub> O <sub>5</sub> )	2,000	1.20	2,400
Potassium fertilizer (K <sub>2</sub> O 60%)	1,000	0.85	850
Fertilizer Total	13,435		42,902
Pesticides			
Herbicide	60	16.5	990
Fungicide	25	18.2	455
Insecticide	15	19.0	285
Pesticide Total	100		1,730
Seeds			
Wheat germ (certified)	8,000	0.48	3,840
Other Ingredients			
Packaging material	2,500	1.80	4,500
Spare parts/equipment	-	-	12,500
Fuel and lubricants (supply)	2,148	0.42	902
<b>CATEGORY 1 TOTAL</b>			<b>66,374</b>

Total emissions are calculated as 66,374 kg CO<sub>2</sub>.

Overall Greenhouse Gas Inventory (2024)

**Table 4 Summary of Carbon Inventory for Büyük Tarım A.Ş**

Scope	Emission Source	Emissions (tons CO <sub>2</sub> e)	Share in Total (%)
Scope 1	Fuel consumption	5,755	3.7%
Scope 1	Nitrogen fertilizer N <sub>2</sub> O	22,477	14.5%
Scope 1 Total		28,233	18.2%
Scope 2	Electricity consumption	17,102	11.0%
Scope 2 Total		17,102	11.0%
Scope 3	Purchased goods	66,374	42.8%
Scope 3	Upstream transportation	373	0.2%
Scope 3	Downstream transportation	2,046	1.3%
Scope 3	Other categories	41,080	26.5%
Scope 3 Total		109,873	70.8%
<b>Grand Total</b>		<b>155,208</b>	<b>100.0%</b>

Carbon Intensity Analysis

Per Product:

· Emissions per unit of wheat:  $155,208 \text{ tons} / 120,000 \text{ tons} = 1.293 \text{ kg CO}_2\text{e/kg wheat}$

Per Area:

· Emissions per hectare:  $155,208 \text{ tons} / 40,000 \text{ ha} = 3.88 \text{ tons CO}_2\text{e/ha}$

Economic:

· Emissions per 1,000 TRY revenue: 155,208 tons / 1,320,000,000 TRY = 117.6 kg CO<sub>2</sub>e/1,000 TRY

## 5.2. TMS 41 Framework for Carbon Accounting Records

### 5.2.1. Valuation of Living Assets (Growing Wheat)

As of March 31, 2024 (Interim Period) - Wheat Growing in the Field:

Asset Status:

- Planted area: 40,000 hectares
- Growth stage: (%65 maturity)
- Accumulated cost: 580,000,000 TRY
- Fair value estimate: 725,000,000 TRY
- Estimated sale cost: 22,000,000 TRY
- Fair value minus sale cost: 703,000,000 TRY

Accounting Entry (TMS 41, Articles 12-13):

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**31.03.2024 (Interim Closing)**

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**158 FUTURE EXPENSES AND INCOME ACCRUALS 123,000,000**  
(Growing Wheat - Fair Value)

**604 LIVING ASSET VALUATION GAIN**

**123,000,000**

(Fair value increase of 40,000 ha growing

wheat: 703,000,000 - 580,000,000 TRY)

[TMS 41 Articles 12-13]

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Footnote Explanation:

"The business measures the living assets (growing wheat) as of 31.03.2024 using the fair value less costs to sell method under TMS 41.

The valuation considers market prices, expected yield, and market conditions."

### **5.2.2. Carbon Credit Project: No-Till Agriculture Application**

Project Scope:

- Draft Regulation on Carbon Credits and Offset Management (2025): Defines the technical and administrative details of the legal process.
- Regulations related to the Emission Trading System (ETS) and carbon markets under Law No. 7552 "Climate Law".

According to relevant regulations; when wheat producers or agricultural enterprises complete the registration, verification, and approval processes in accordance with national legislation; they can obtain an accredited carbon credit certificate and legally sell it in domestic and international markets. All documents must be complete and recorded during sales.

Büyük Tarım A.Ş. transitioned to no-till (zero tillage) farming on 5,000 hectares in 2024. No-till farming is a sustainable method where seeds are directly planted without soil tillage.

Carbon Sequestration Potential:

- Carbon sequestration per hectare: 1.2 tons CO<sub>2</sub>/ha/year
- Total carbon credits: 5,000 ha × 1.2 tons = 6,000 tons CO<sub>2</sub>

Certification:

- Standard: VCS (Verified Carbon Standard) + Gold Standard
- Certification date: 01.10.2024
- Voluntary carbon market price: 22 USD/ton CO<sub>2</sub>
- TL exchange rate: 32.50 TRY/USD
- Total value: 6,000 tons × 22 USD × 32.50 = 4,290,000 TRY

Accounting Entry 1: Initial Recognition of Carbon Credit

**01.10.2024 (Certification Date)**

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**260 RIGHTS 4,290,000**

(Carbon Credit Certificates - 6,000 tons CO<sub>2</sub>)

**649 OTHER ORDINARY INCOME**

**AND PROFITS 4,290,000**

(Recognition of 6,000 tons CO<sub>2</sub> carbon credits at fair value)

[TMS 38 / TMS 2, TDHP 260 Rights]

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### Financial Statement Presentation (31.12.2024):

#### Balance Sheet (Financial Position):

Current Assets	31.12.2024 (TRY)
Trade Inventories (Harvested Wheat)	85,000,000
Rights (Carbon Credit Certificates)	4,290,000
Other Current Assets	320,000,000
...	...

### 5.2.3. Sale of Carbon Credits - Accounting Entry 2

#### Sale Scenario (15.01.2025):

- Sale price: 26 USD/ton CO<sub>2</sub> (price increase)
- TL exchange rate: 33.00 TRY/USD
- Sale amount: 6,000 tons × 26 USD × 33.00 = 5,148,000 TRY
- Book value: 4,290,000 TRY
- Sale profit: 858,000 TRY

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**15.01.2025 (Sale Date)**

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**102 BANKS 5,148,000**

**260 RIGHTS 4,290,000**

**(Carbon Credit Certificates)**  
**649 OTHER ORDINARY INCOME AND PROFITS 858,000**  
**(Sale of 6,000 tons CO<sub>2</sub> carbon credits and realized value increase profit)**

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#### 5.2.4. Carbon Tax Scenario (Hypothetical - 2026)

Carbon Pricing in 2026:

- Turkey ETS coverage for agriculture: 75 TRY/ton CO<sub>2</sub>e
- Büyük Tarım A.Ş. Scope 1 emissions: 28,233 tons CO<sub>2</sub>e
- Annual carbon tax liability:  $28,233 \times 75 = 2,117,475$  TRY

Accounting Entry: Estimated Carbon Tax Accrual

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#### 31.12.2026 (Period End Accrual)

**770 GENERAL ADMINISTRATION EXPENSES 2,117,475**  
**(Carbon Tax Expense - 2026)**  
**360 PAYABLE TAXES AND FUNDS**  
**2,117,475**  
**(Carbon Tax Liability)**  
**(2026 Scope 1 emissions: 28,233 tons CO<sub>2</sub>e × 75 TRY/ton = 2,117,475 TRY)**

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Payment of Carbon Tax (within 2027):

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#### 30.04.2027 (Payment Date)

**360 PAYABLE TAXES AND FUNDS 2,117,475**  
**102 BANKS 2,117,475**  
**(Payment of 2026 carbon tax)**

### 5.2.5. Comprehensive Income Statement (2024)

#### Comprehensive Income Statement of Büyük Tarım A.Ş. (01.01.2024 - 31.12.2024):

Item	Amount (TRY)	Explanation
Gross Sales Revenue		
- Wheat sales (120,000 tons × 11,000 TRY)	1,320,000,000	<b>TMO + supports</b>
- Sales discounts (-)	(15,000,000)	
Net Sales Revenue	1,305,000,000	
Cost of Goods Sold (-)		
- <b>Seeds, fertilizers, pesticides</b>	<b>(420,000,000)</b>	
- Fuel and energy	(95,000,000)	
- Labor	(185,000,000)	
- Depreciation	(125,000,000)	
- Other production costs	(78,000,000)	
Gross Profit	402,000,000	
Operating Expenses (-)		
- General administrative expenses	(85,000,000)	
- Marketing expenses	(45,000,000)	
Other Income and Gains		
- Living asset valuation gains	123,000,000	TMS 41
- Carbon credit income	4,290,000	No-till project

- State supports	95,000,000	Payment difference
- Interest income	12,500,000	
Other Expenses and Losses (-)		
- Financing expenses	(65,000,000)	
- Exchange rate losses	(22,000,000)	
Profit Before Tax	419,790,000	
<b>Tax Expense (-)</b>		
- Corporate tax (%25)	(104,947,500)	
<b>Net Period Profit</b>	<b>314,842,500</b>	

**Profitability Ratios:**

- **Gross profit margin: %30.8**
- **Net profit margin: %24.1**
- **Contribution of carbon credits: 4,290,000 TRY (1.4% of net profit)**

**5.2.6. Financial Position Statement (Balance Sheet) - 31.12.2024**

**Assets (Summary):**

<b>Item</b>	<b>Amount (TRY)</b>
<b>CURRENT ASSETS</b>	
Cash and cash equivalents	425,000,000
Trade receivables	185,000,000
Stock (harvested wheat)	85,000,000
Rights (carbon credit certificates)	4,290,000
Other current assets	125,000,000
<b>Total Current Assets</b>	<b>824,290,000</b>

NON-CURRENT ASSETS	
Property, plant, and equipment (land, machinery)	2,450,000,000
Accumulated depreciation (-)	(385,000,000)
Net Property, Plant, and Equipment	2,065,000,000
Intangible assets	15,000,000
Total Non-Current Assets	2,080,000,000
<b>Total Assets</b>	<b>2,904,290,000</b>

## Notes to Financial Statements (According to TMS 41 and TSRS 2)

### Note 1: Living Assets and Agricultural Activities

"The business measures its living assets (growing wheat) as of 31.03.2024 using the fair value less costs to sell method under TMS 41. The wheat cultivated on 40,000 hectares is valued at 703,000,000 TRY, considering market prices, expected yield, and market conditions. Post-harvest products are evaluated according to TMS 2 Inventory standard."

### Note 2: Carbon Credits

"In 2024, the business adopted no-till (zero tillage) farming on 5,000 hectares and created 6,000 tons of CO<sub>2</sub> carbon credits, which are recorded at fair value (4,290,000 TRY) in the Rights account. All credits were sold voluntarily on 15.01.2025."

### Note 3: Climate Risks and Opportunities (TSRS 2)

"The business's total greenhouse gas emissions in 2024 are 155,208 tons CO<sub>2</sub>e (Scope 1: 28,233, Scope 2: 17,102, Scope 3: 109,873 tons CO<sub>2</sub>e). The carbon intensity per unit of wheat is 1.293 kg CO<sub>2</sub>e/kg. The company aims to reduce Scope 1+2 emissions by 25% by 2030. Climate risks include drought (high risk) and carbon pricing (medium risk)."

## 6. CONCLUSION AND RECOMMENDATIONS

### Research Findings

Large Agricultural JSC - 40,000 Hectare Wheat Production Carbon Accounting Summary:

- ✓ Total Greenhouse Gas Emission: 155,208 tons CO<sub>2</sub>e/year
- ✓ Carbon Intensity: 1.293 kg CO<sub>2</sub>e/kg wheat
- ✓ Largest Emission Source: Scope 3 (supply chain) - 70.8%
- ✓ Critical Reduction Point: Nitrogen fertilizer use (22,477 tons CO<sub>2</sub>e)
- ✓ Carbon Credit Income: 4,290,000 TL/year
- ✓ Potential Carbon Tax (2026): 2,117,475 TL/year
- ✓ TSRS Reporting: Mandatory (all criteria met)

This comprehensive example demonstrates how large-scale agricultural enterprises can implement carbon accounting and account for it within the framework of TAS 41 standards. The Large Agricultural JSC example (40,000 hectares wheat production) shows the practical application of scope classification in the agricultural sector. Of the enterprise's total 155,208 tons CO<sub>2</sub>e emissions, 18.2% originates from Scope 1, 11.0% from Scope 2, and 70.8% from Scope 3 sources. N<sub>2</sub>O emissions from nitrogen fertilizer use, at 22,477 tons CO<sub>2</sub>e, constitute the largest component of Scope 1 (Bora Kılınçarslan et al., 2022). Considering the 2024 TMO wheat purchase prices (11,000 TL/ton) and Turkey's average yield (3 tons/hectare), approximately 30,303 hectares of cultivated area is required for 1 billion TL worth of wheat sales (T.C. Tarım ve Orman Bakanlığı, Toprak Mahsulleri Ofisi, 2024; TÜİK, 2024). The research revealed that there are technical difficulties in measuring and calculating greenhouse gas (carbon) emissions in wheat farming, particularly in Scope 1 and Scope 2. Infrastructure deficiencies of agricultural enterprises emerged in this context. It was determined that existing financial reporting standards are inadequate in fully reflecting carbon emissions, and therefore legal gaps exist in the accounting of carbon liabilities, carbon credits, and reduction costs. In particular, within the scope of TAS 41, the carbon impact of biological assets and sustainability indicators should be reported together.

### **Key Recommendations**

#### **1. Harmonization between TAS 41 and Tax Laws:**

Within the scope of TAS 41, harmonization between countries' tax laws and international accounting standards is necessary for the carbon accounting of biological assets.

#### **2. Integrated Software Development:**

In addition to accounting software in agricultural enterprises, integrated corporate reporting software should be developed to track emission sources, carbon credit use, and other processes.

### 3. Alignment with IFRS S1 and S2:

The harmonization process between TAS/TFRS and IFRS S1 and IFRS S2 (Sustainability Disclosure Standards) is essential for agricultural enterprises.

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