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Original Research

Legal Liability for Damages Arising From Toxin Formation and Pesticide Use in Agricultural Products in Türkiye

Yavuz Guloglu[1,*]

[1]Department of Public Administration, Faculty of Economic and Administrative Sciences, Kastamonu University, 37150 Kastamonu, Türkiye
*Correspondence: yavuzguloglu@kastamonu.edu.tr (Yavuz Guloglu)

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Abstract

Background: Advances in modern production techniques have given rise to new production models, which, in turn, have led to a range of food-borne challenges. Despite numerous legal regulations in Türkiye designed to strengthen food inspection, pesticide use within legally permissible limits has not been reduced to a level considered reliably safe. The obligations of the state include: protecting plants from infectious and widespread diseases and safeguarding the conditions necessary for a healthy social environment; supervising the production and marketing of all foodstuffs to prevent harm to human health and the environment; establishing hygiene conditions and standards from a public health perspective; preventing the sale and consumption of products containing pesticide residues in excess of normal limits; in brief, ensuring food safety. This study examines legal liability under Turkish law for harm arising from the use of plant protection products that are prohibited or applied in quantities exceeding legal thresholds. **Methods**: This study draws on domestic and international literature on the effects of pesticide use—whether prohibited or exceeding established thresholds—on food safety and the environment in Türkiye, as well as on the legal liabilities arising from such practices. This study further analyzes finalized judicial and administrative decisions retrieved from relevant legal databases and the official websites of the high courts, as well as judgments of the European Court of Human Rights. **Results**: Agricultural pesticides that pose risks to human health and the environment are widely used, and the administrative sanctions and criminal penalties imposed for the misuse of these substances appear inadequate. Farmers frequently purchase pesticides indiscriminately; agrochemical dealers often sell these products without sufficient oversight; agricultural commodities are routinely made available to consumers in retail settings without prior analytical testing. Collectively, these systemic shortcomings undermine public health protection, environmental stewardship, and regulatory compliance. **Conclusions**: The existing administrative sanctions and criminal penalties for harmful pesticide applications are inadequate and should be strengthened. To deter prohibited practices, agricultural products should not be released for consumer sale before the results of accredited laboratory analyses are available. The manufacture and importation of hazardous agricultural pesticides must be prohibited. Comprehensive training programs should be implemented to ensure that farmers apply pesticides in accordance with best practices and legal requirements. Licenses for agrochemical dealerships should be issued exclusively to individuals who have completed certified training. Additionally, a barcode-based traceability system should be established to require the dispensing of plant protection products through secure digital prescriptions. Collectively, these measures would enhance regulatory compliance, protect public health, and improve environmental stewardship.

Keywords: pesticide; plant protection; public order; law enforcement forces; damages

1. Introduction

Under the Universal Declaration of Human Rights, access to food at an adequate level for oneself and one's family is a fundamental human right. With the global population trending upward, increasing consumption drives demand for food and places mounting pressure on agricultural production [1–3]. Given scarce resources, only the use of modern agricultural techniques and inputs can achieve higher yields and quality. Increases in agricultural mechanization and developments in plant protection methods contribute to greater yields per unit area [4,5].

Even today, many suffer from hunger; in the face of ever-shrinking arable land, feeding a continuously growing population in the future compels humanity to resort to pesticide use [6,7]. Today, sufficient quantity and quality of production is nearly impossible without supportive agricultural inputs [8].

From production to delivery to consumers, agriculture requires that drying, storage, packaging, transport, and similar stages be conducted under healthy conditions. Producers generally prefer plant protection products or chemical control methods because they are the most effective against pests and diseases [9]. In terms of human health, measures must be taken not only against direct risks posed by agricultural and food products but also against unforeseen risks [10].

The study seeks to answer the question of to what extent Türkiye's current legal framework prevents harms to human health and the environment arising from the use of pesticides that are either prohibited in agricultural production or applied in quantities exceeding legal limits. To this end, it examines—within the scope of Turkish law—the legal responsibility for damages caused by the use of plant protection products that are banned or used above statutory thresholds.

Moving beyond a merely descriptive summary of applicable legislation and case law in the existing food law literature, the study offers a critical, holistic, and practice-oriented contribution. First, by addressing administrative, civil, and criminal liability regimes together in the context of pesticide-related harms in Türkiye, it systematically identifies normative discontinuities across these regimes and reveals shortcomings in the effectiveness and deterrent capacity of sanctions.

Second, in line with the jurisprudence of the European Court of Human Rights, the study assesses high court decisions from a comparative perspective and makes visible the practical shortcomings of Turkish law with regard to the State's positive obligations arising from the Constitution and the European Convention on Human Rights—particularly in relation to the right to life, the right to live in a healthy environment, and food safety. In this respect, the article conceptualizes food safety not merely as a technical matter of inspection and control, but as a field of legal responsibility that must also be evaluated through the lens of fundamental rights.

Finally, focusing on the implementation dimension often neglected in the literature, the study develops concrete and normatively grounded policy proposals, including mandatory laboratory analysis requirements, a digital prescription and barcode-based traceability system, and strengthened licensing and training mechanisms. Accordingly, the research not only explains why the current legal framework remains inadequate, but also provides an original roadmap for how a preventive and deterrent liability regime in the field of food law can be constructed, thereby offering a forward-looking contribution to the literature.

2. The Impact of Agricultural Spraying and Mycotoxins on Human Health

Pesticide residues used in agricultural production cause various adverse effects on human and environmental health—including cancer [11]. Using pesticides at doses above recommendations, applying them at improper times, or preferring products containing banned ingredients increases residues. In addition, when products are dried, stored, packaged, or transported under unsuitable conditions, toxic molds such as mycotoxins can develop. These substances have been shown—through both experimental and clinical evidence—to cause carcinogenic, immunological, neurotoxic, and visceral toxic effects, as well as serious adverse impacts on reproductive health [12,13].

Pesticide poisonings constitute a significant public health issue, particularly in developing countries and agricultural regions [14]. Although some pesticide poisonings worldwide are intentional (suicidal), it is reported that approximately three million severe acute pesticide poisonings occur annually, with more than 220,000 resulting in death [15]. Certain pesticide residues can be transmitted to humans not only through consuming the treated fruit or vegetable but also via transfer to grasses that are eaten by animals, leading residues to accumulate in animal fat tissue and pass through meat, milk, or dairy products. It has been noted that pesticide residue levels in agricultural products periodically decrease during the time from production to consumption with extended freezing or storage [16].

2.1 Definitions of Pesticides and Mycotoxins

Pesticides are chemical substances used to mitigate the adverse effects of living forms such as insects, rodents, weeds, and fungi that cause harm during the production, storage, and consumption of food sources or reduce their nutritional value, and that live on or around humans, animals, and plants [15].

To qualify as a pesticide, a chemical must be biologically active, sufficiently stable and effective; safe for users and livestock; and should not cause adverse effects on the environment, wildlife, or beneficial organisms. However, due to low cost, some banned pesticides are still used in Türkiye [17].

Mycotoxins rank among the most significant natural toxins threatening human and animal health. These toxic compounds are secondary metabolites produced by certain microscopic fungi known as toxigenic fungi that are not essential for their life [18]. Under appropriate environmental conditions, such fungi can grow and cause mycotoxin accumulation in food and feed. Due to their chemical structures and biological activities, mycotoxins pose serious risks to both humans and animals [19,20].

2.2 Reasons for Pesticide Use in Agricultural Production

Climate change disrupts the life cycles of pests and their natural enemies; increased temperatures prolong pest reproduction cycles and accelerate their proliferation [21]. This leads farmers to spray excessively or at inappropriate times to prevent yield losses. Consequently, excessive pesticide use leads to the accumulation of residues in vegetables and fruits, drinking and domestic waters, soil, and sediments [22].

The additional costs required to ensure proper drying, storage, transportation, and packaging conditions that prevent mycotoxin formation make it difficult for economically weaker producers to bear these expenses. Accordingly, the desire to bring products quickly to market drives farmers further toward pesticide use.

Moreover, due to labor shortages, cultural measures such as collecting and destroying diseased plants and leaves, root and pruning residues, are not adequately implemented in many regions. In addition, some agricultural chemical dealers—motivated by commercial gain—recommend unnecessary pesticide use, encouraging excessive spraying among farmers [23].

2.3 Detection of Pesticide and Toxin Residues and the Current Situation

In Türkiye, pesticide residue analyses are routinely conducted—particularly in public and private laborato-

ries accredited by the Turkish Accreditation Agency (TURKAK) [24]. Pesticide use is highest in the Mediterranean region due to crop diversity, the prevalence of greenhouses, and intense agricultural trade; the Black Sea region sees the least use [25]. Türkiye ranks 12th globally in pesticide use, accounting for 1.23% of world consumption. Official data indicate pesticide use of 2.2 kg per hectare in Türkiye [26].

Due to significant informality in agricultural sector records, the actual number of agricultural products containing mycotoxin and pesticide residues far exceeds official statements. Türkiye has introduced a "producer record book" application—albeit covering limited agricultural products—to control the use of pesticides and fertilizers. Considering the widespread nature of agricultural production and the high number of farmers across the country, and the Ministry of Agriculture and Forestry's limited personnel and other duties, it is virtually impossible to ensure controlled spraying to minimize yield losses; thus, many agricultural products reach the market without inspection. Yet pesticide controls must be conducted "from seed to table"—including pre-harvest, at harvest, in storage facilities, and at markets and retailers—with transparent publication of results. In a survey conducted in 2017 through face-to-face interviews with 75 randomly selected fruit growers in the Gürsu and Kestel districts of Bursa—a region of significant importance for Türkiye's fruit production and export—it was determined that the average number of pesticide applications per growing season was 18.3 for pears, 11.3 for apples, 10.0 for peaches, and 7.8 for quinces [27]. According to the Ministry of Agriculture and Forestry's Plant Health 2025 Implementation Program, under the Pre-Harvest Pesticide Inspection Program Implementation Instructions, a total of 21,762 samples were collected throughout the year, distributed as follows: 3061 in the first quarter (January-March), 4954 in the second (April-June), 5477 in the third (July-September), and 8270 in the final quarter (October-December). Considering that the number of producers registered in the Ministry's Farmer Registration System (ÇKS) reached 2,354,217 as of 2025, these figures indicate that not even 1% of the existing producers can be effectively inspected under the current program [28].

Pesticide use is exacerbated by spraying done unconsciously and without expertise by farmers or unauthorized individuals, and by timing applications too early or too late. The core problem in Türkiye is excessive pesticide use, especially in certain cities like Antalya. Among large pesticide markets, Türkiye has the highest positive growth in pesticide use. In the ten provinces with the highest output of vegetables, fruits, and greenhouse products, pesticide use per hectare is reported at 6.7 kg per hectare—approximately three times the world average—and reaches 9.5 kg per hectare when fallow areas are excluded; increasing health problems heighten public concern over food safety (as voiced in some media). Over the last five years, Türkiye's annual pesticide consumption averaged 54.2 thousand tons, peaking above the average at 57.8 thousand tons in 2023 [29].

According to inspections conducted by the Ministry of Agriculture and Forestry to prevent pesticide residue and toxin-related non-compliance in agricultural production, plant health inspections for export found non-compliance in 966 of 12,039 samples in 2022 and 2022 of 12,737 samples in 2023—i.e., approximately one in six products [30]. Given that the number of samples represents a very small portion of plant production trade and that samples are taken from export-bound products—likely from more residue-conscious producers seeking to avoid rejection at the border—non-compliance for products destined for domestic consumption may be much more serious. Despite implementation of a six-year Pesticide Residue Action Plan covering 2022–2027, test results indicate that the plan has not succeeded [13].

Although Türkiye ranks 6th among countries exporting agricultural products to the EU, it had the highest number of EU notifications in 2024, with a total of 492 [31]. The return or destruction of exported products abroad results in significant losses for the exporter—considering lost sales, domestic procurement, transportation, and other costs—reduces foreign exchange earnings due to unrealized exports, negatively affects the country's foreign trade balance and national income, and harms the country's reputation abroad.

It is implausible that products exported would encounter such non-compliance while products sold directly domestically would not; this suggests that pesticide residues in products sold domestically are at far more serious levels compared to export-bound products. Considering the presence of residues in products offered for domestic consumption, the issue has grave significance for citizens' health [13]. Public distrust persists regarding claims that products rejected at export—despite prohibitions—are resold domestically via illicit channels.

Under the Regulation on the Organization of Agricultural Extension and Consultancy Services in Türkiye, agricultural consultants must visit the farmers they advise at least 12 times per year and should ensure that farmers' pesticide use remains within limits by providing guidance throughout all production stages. Especially in regions with intensive agricultural production and exports, consultants specializing in toxins and pesticide residues should be employed; consultants should be assigned legal and criminal liability to ensure that products intended for domestic and foreign markets comply with residue limits, thereby assuring both domestic consumers and exporters that the products they purchase are free of toxin and pesticide residues. If the agricultural consultancy system functions poorly, Türkiye may receive fewer rural development grants, which are also provided to EU candidate countries.

2.4 Knowledge Levels of Farmers Engaged in Chemical Spraying

Spraying is conducted at inappropriate times and by farmers themselves or by unauthorized, untrained individuals. Most farmers rely on pesticide dealers (from whom they purchase) as their primary information source; they sometimes consult other farmers and, without obtaining technically expert advice, they choose pesticides "blindly", make incorrect decisions regarding areas, timing, and dosage, and assume that pesticides have no harmful environmental effects. Farmers often lack sufficient knowledge regarding how and in what manner pesticide residues can spread to living organisms in nature and often fail to use protective equipment while spraying. Many farmers decide to apply pesticides only once disease symptoms appear and prefer low-cost pesticides [32]. A large majority believe that residues will be washed away by rain and/or washing the products, leaving no residue on the product.

2.5 Practices Worldwide and in the European Union

Rules establishing regulations in the food field are known as food codes [33]. The Codex Alimentarius Commission, headquartered in Rome, was established in 1963 under the United Nations by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). Although the Commission's regulations are not binding standards for states, countries use them as references when drafting national standards for safe food production. In alignment with WTO standards, food codes are set to ensure global safety standards in international trade of food and agricultural products and to protect consumer health [34].

EU Member States are required to establish systems for delivering consultancy services to farmers. Under the GLOBALG.A.P. protocol (the Good Agricultural Practices Protocol developed by the European Retailers Working Group for Agricultural Products), EU retailers guarantee and assure customers that products on their shelves are not harmful [35].

The Rapid Alert System for Food and Feed (RASFF)—developed by the European Commission—is a centralized online database used by EU Member States to collect and exchange information related to food safety, using criteria such as date, country, type (food, feed), product (category), risk status, reference number, and notification subject. The system aims to design a fair, healthy, and environmentally friendly "farm-to-fork" food system that can prevent many food safety risks before they cause harm by enabling notifications of risky situations in food and feed, whether marketed domestically or imported. Depending on risk level, measures can include banning entry into EU borders or ordering market withdrawals [36,37]. Notifications arise from laboratory analysis results of samples taken from foods and feeds suspected of posing risks at markets or border points [38,39]. This practice is not limited to the EU; non-EU countries also conduct inspections based on their own criteria and permit agricultural imports after necessary checks.

In RASFF notifications regarding Türkiye between 2009–2016, out of a total of 2083 notifications, the leading hazard groups were mycotoxins (993) and pesticide residues (468). In 2024, mycotoxins again topped the list for Türkiye with 208 of 492 notifications, mostly aflatoxins and ochratoxins; moreover, residues of harmful substances containing chlorpyrifos—an active ingredient of a plant protection product banned for sale or use in Türkiye—were also detected [40].

3. Materials and Methods

The study draws on the existing literature regarding legal liability in Turkish law for damages arising from the use of plant protection products that are prohibited or exceed permissible thresholds. Because factors negatively affecting food safety are not limited to the use of banned pesticides and their residues, the study also addresses their environmental impacts. The review was conducted using data obtained from online publications in search engines such as Google Scholar, Web of Science, and Scopus, as well as from databases of judicial decisions. The keywords "pesticide", "plant protection", "public order", "police powers", and "damage" were used for searching. The reference lists of relevant articles were manually screened, and all cited studies were examined and analyzed together with the initially identified relevant works. In determining the inclusion criteria, attention was paid to whether the studies were published in English or Turkish, and whether the court decisions were directly related to the subject and were final high court decisions.

In Türkiye, with certain exceptions, appeals against administrative fines, as well as judicial fines and prison sentences, are generally subject to the jurisdiction of the judicial courts. Conversely, lawsuits for the annulment of administrative acts and certain general regulatory proceedings concerning the environment are subject to judicial review by the administrative courts, with the Council of State serving as the supreme authority in this field. In the search for jurisprudence regarding pesticides, finalized judgments were prioritized that have undergone the scrutiny of the Court of Cassation, he highest judicial authority, following the initial appellate review of the decisions rendered by the courts of first instance. Since sanctions regarding the use of prohibited pesticides or those exceeding legal limits are regulated by the Turkish Penal Code No. 5237 (adopted in 2005) and the Law on Veterinary Services, Plant Health, Food and Feed No. 5996 (adopted in 2010), the selection of cases was specifically limited to Court of Cassation rulings issued after 2005 concerning violations of these particular statutes.

A search conducted on the official Court of Cassation database (https://karararama.yargitay.gov.tr/) using the keyword "pestisit" (pesticide) for the period following 2005 yielded a total of 611 decisions. From this pool, deci-

Table 1. Criteria of the selection of Court of Cassation decisions on pesticide-related offences.

Stage	Process description	Number of decisions (n)	Reason for exclusion
Identification	Search conducted on "https://kararama.yargitay.gov.tr/" using the keyword "pesticide" for decisions issued after 2005	611	The decisions made after the adoption of the Turkish Penal Code in 2005, which regulates exceeding limits and the use of prohibited pesticides, have been evaluated
Initial screening	Removal of duplicate and substantially similar decisions	248	363 duplicate/substantially similar decisions excluded
Eligibility assessment	Exclusion of decisions falling outside Articles 185 and 186 of the Turkish Penal Code	64	184 decisions not related to the relevant offence types
Full-text review	Exclusion of decisions not clearly discussing both the basic and aggravated forms of the offences	18	46 decisions excluded due to insufficient substantive analysis
Included decisions	Final selection of decisions under Articles 185/1, 185/2, 186/1, and 186/2 (two decisions per offence type)	8	—

sions with repetitive or substantially similar content were excluded. To ensure a comprehensive legal analysis, two specific decisions were selected for each type of offence regulated under Articles 185(1), 185(2), 186(1), and 186(2) of the Turkish Penal Code, covering both the basic forms of these crimes and their aggravated (qualified) forms. These selected precedents are cited throughout the relevant sections of this study, with full references to their respective case numbers and dates of adjudication.

Table 1 presents the PRISMA-based selection process of Court of Cassation decisions concerning pesticide-related offences. From an initial pool of 611 decisions identified through keyword search, a multi-stage screening process resulted in the inclusion of eight finalized decisions. For each offence type regulated under Articles 185 and 186 of the Turkish Penal Code, two representative decisions were selected to ensure balanced doctrinal and jurisprudential analysis.

4. Results

4.1 The Role of the Administration in Ensuring Food Safety

Because all administrative activities are considered public services, the law enforcement forces—bound by strict rules and procedures—must also be considered a public service [41]. Public order is defined as the state of individuals living in a healthy, safe, and peaceful manner and serves as the basis for many duties and responsibilities assigned to the administration to maintain the environment of peace that enables people to live together securely. In modern understanding, beyond classic public order, public aesthetics, public morals, human dignity, and even protecting individuals against themselves are considered elements of public order [42,43].

General health—an element of public order—is used interchangeably with "public health" and "community health" in the literature, defined as the situation in which all members of society can continue their lives under healthy conditions [33]. Public health encompasses the supervision of food production and marketing in terms of health and the determination of hygiene conditions and standards for community health [44]. In this context, general health includes protecting society, animals, and plants from contagious and widespread diseases; ensuring a healthy social environment; supervising the production and marketing of foodstuffs to prevent harm to human health; and establishing hygiene standards—in other words, ensuring food safety.

General health is a state in which individuals are fully well in body and mind. In this sense, while pesticide use to protect plants from infectious diseases may be required by public order, it is also necessary—again from the perspective of public order—to prevent the production and marketing of plant and food products that, through pesticide use exceeding normal limits, become harmful to human health.

Health-related public order includes environmental health, food safety [45], the safety of medicines and medical products, animal and plant health, tobacco [46], and combating stimulants and narcotics [47,48] including hazards scientifically determined to possess disruptive potential. Accordingly, inspection and control services carried out in slaughterhouses and meat-cutting facilities to ensure food safety are part of administrative police functions [49].

One of the administration's main tools for ensuring public order and public health is the police power. Police power emerges when police authorities exercise regulatory powers in areas where they are tasked with protecting public order. The purpose of police activities is to preserve public order; therefore, any administrative action aimed at achieving and safeguarding public order is lawful [42]. Police services aimed at protecting health and well-being enhance trust among individuals and contribute to a more peaceful society [50].

Security means that individuals do not fear for their life and property, face no threats to their bodily integrity or possessions, and have confidence and belief that such dangers do not exist [51]. In modern understanding, protecting a person's own security and health even against himself is considered an element of public order. Even if the impact is below a level that would cause physical health problems, a person being forced to consume foods containing pesticides, despite being disturbed by them, may suffer psychologically and experience deterioration in mental health.

Environmental health seeks to protect both individuals' health and the elements within the environment, and to reduce such defects if they exist. When measures are not taken against environmental problems that can affect the right to life through different physiological causes, liability for compensation may arise along with the criminal liability of the relevant public official [52].

4.1.1 Food Control Authorities

Safe food is defined as food that is free from physical, chemical, and biological threats, and that retains its nutritional value and is unspoiled [53]. Foods should not harm human health at stages of processing, preparation, packaging, and transport; purity and physical or chemical identity must not be compromised by adulterants; foods should not resemble other foods in appearance, shape, or content; and should not be raw (unsafe) or spoiled [53,54]. Food control authorities are tasked with taking preventive measures to ensure healthy and safe food production, ensuring the implementation and enforcement of food regulations, and imposing sanctions in case of violations.

In the exercise of police functions, the administration can impose administrative sanctions without seeking a judicial decision, based on explicit statutory authority and using methods specific to administrative law [55]. Because food safety, animal health, and environmental health activities constitute a special part of health-related public order, sanctions imposed to protect them are regulatory penalties [56]. In relation to food, the administration has powers to prepare codes, set standards, conduct inspection and control, take samples and analyze, manage inspection, registration and approval procedures for food businesses, and license and supervise.

While "payment-at-source" and "polluter pays" principles apply in environmental police matters, the same principles cannot be applied in the same manner to food and animal health. In relation to human and animal health and food safety, the precautionary principle—recognized by the Rio Declaration and adopted by the Council of State (Council of State, 2022)—is accepted, requiring preventive measures against yet-to-be-realized and uncertain risks where scientific uncertainty and potential harm exist [57].

In Türkiye, authority to inspect and impose sanctions in food, animal, and tobacco control is legally vested primarily in the Ministry of Agriculture and Forestry. However, there is confusion in organizational structure, division of powers, and avenues of appeal related to food and health policing. Since licensing and inspection of food production facilities concern general public health, central administration has authority; municipal police should only act upon request by the relevant institutions. The Ministry of Health is competent to prohibit consumption of food causing contagious and epidemic diseases and, exceptionally, regarding waters. For waters with additives, regulatory authority belongs to the Ministry of Agriculture and Forestry; for natural mineral waters containing certain substances that are not considered "additives", the Ministry of Health is competent [58].

Article 14 of the Municipal Law requires municipalities to protect the environment and environmental health. Failure by the administration to perform this function at all or properly will entail liability. Under the Municipal Law, in cases of food violations detectable only by physical inspection without requiring special examination or laboratory analysis, municipal police may take necessary measures. Municipalities have the duty to inspect public places, production and sales points of food and drink and consumables, and drinking and spring waters from an environmental and public health standpoint, and to eliminate harmful effects. The Metropolitan Municipality Law No. 5216, the Special Provincial Administration Law No. 5302, and the Municipal Law No. 5393 impose duties on the administration regarding the subject.

Under Law No. 5302, special provincial administrations are authorized to confiscate substances prohibited for sale and use and destroy those harmful to health. If a reasonable likelihood exists that unsafe food may be placed on the market or remain in the market—pending conclusive scientific data—the Ministry is authorized to stop production, block placing on the market and consumption, order recalls, and take similar measures. A statutory provision exempting the Ministry from liability and prohibiting claims for compensation arising from such measures was annulled by the Constitutional Court.

4.1.2 Inter-Agency Authority Conflicts in the Field of Food Enforcement

The Ministry of Agriculture and Forestry is the principal authority responsible for the licensing, placing on the market, importation, and production of plant protection products, as well as for the official control of pesticide residues, sampling, laboratory analysis, and the imposition of administrative sanctions. Pesticide inspection is evaluated within the scope of "plant health and food safety", and the Ministry is therefore regarded as the central and primary competent authority in this domain.

Although the Ministry of Health does not have a direct mandate to inspect pesticides, its authority extends to prohibiting the consumption of foods that pose risks to public health, intervening in situations that create risks of epidemics or communicable diseases, and regulating drinking water and natural mineral waters (nonadditive). While foods containing pesticide residues generally fall under the

Table 2. Administrative responsibilities and deficiencies in ensuring food safety in Türkiye.

Area of responsibility	Competent authority	Legal basis	Identified deficiencies
Food production and market control	Ministry of Agriculture and Forestry	Law No. 5996	Insufficient inspections; limited laboratory capacity; weak traceability
Local market inspections	Municipalities	Law No. 5393	Limited authority; lack of technical expertise; fragmented oversight
Environmental and public health protection	Central and local administration	Constitution Art. 56; Environmental Law No. 2872	Inadequate preventive measures; delayed intervention
Emergency food safety measures	Ministry of Agriculture and Forestry	Law No. 5996	Legal uncertainty on liability; reliance on post-harm measures

jurisdiction of the Ministry of Agriculture and Forestry, the Ministry of Health becomes involved when a health risk arises at the consumption stage. This creates an ambiguous boundary between preventive control (Ministry of Agriculture) and protective/reactive intervention (Ministry of Health).

Municipalities, on the other hand, have authority to conduct visual, physical, and hygiene inspections at the retail stage—such as in marketplaces, greengrocers, restaurants, and food retail outlets. However, pesticide inspection requiring laboratory analysis exceeds both the legal mandate and the technical capacity of municipalities. Despite this, some municipalities—particularly metropolitan municipalities—have engaged in practices such as confiscating or destroying products allegedly containing pesticide residues. The limited personnel and inspection capacity of the Ministry of Agriculture and Forestry often leads municipalities to fill the enforcement gap informally, creating a risk of overstepping legal boundaries.

In Türkiye, although the Ministry of Agriculture and Forestry holds the primary competence in pesticide oversight, the lack of clearly defined limits on the complementary and indirect powers of the Ministry of Health and municipalities results in authority conflicts and enforcement gaps in practice.

Table 2 demonstrates that although food safety responsibilities are clearly distributed among administrative bodies, institutional fragmentation and weak coordination significantly undermine effectiveness. The findings indicate that food safety failures are not due to the absence of legal authority, but rather to structural and operational deficiencies in implementation and enforcement.

4.2 Legal Framework Governing Food Safety

Law to protect consumers began to develop substantially from the second half of the 20th century. One of the state's most basic duties is to guarantee that society's essential needs for food and drink are safely met. Ensuring that all members of society can live in healthy conditions requires meeting their physical needs properly, which is essential for public health. To prevent problems arising from the production and consumption of food and agricultural products, the state must intensify inspections over producers and sellers, increase sanctions, and foster public awareness. Since administrative actions must have a legal basis, there must be laws that authorize regulation and oversight at all stages from production to consumption of foodstuffs.

4.2.1 International Legislation Ensuring Food Safety

With the establishment of the World Trade Organization (WTO) in 1994, compliance with food codes in the foreign trade of food and agricultural products became mandatory. The UN General Assembly unanimously adopted the Guidelines for Consumer Protection on April 9, 1985, addressing consumer health and safety.

Countries initially adopted two voluntary frameworks to facilitate information exchange on hazardous chemicals and pesticides: the FAO International Code of Conduct on the Distribution and Use of Pesticides (1985) and the UNEP Amended London Guidelines for the Exchange of Information on Chemicals in International Trade (1987).

Although more than 80% of pesticides are used by industrialized countries, the majority of acute pesticide poisonings occur in developing countries [59]. The characteristics required of pesticides are determined by FAO and WHO and are subject to certain principles [60].

The EU Directive 2009/128/EC of October 21, 2009, establishing a framework for Community action to achieve sustainable use of pesticides, was transposed into Turkish law on November 25, 2011. The Directive obliges each Member State to prepare a National Action Plan for the sustainable use of pesticides, with the objective of reducing pesticide use over time, promoting integrated pest management, and reporting progress to the EU.

Regulation (EC) No. 396/2005 of February 23, 2005, sets Maximum Residue Limit (MRL) values for residues in food and feed of plant and animal origin. Fundamental EU legal acts on pesticide residues include the Council Directives on Maximum Residue Levels of Pesticides in and on Cereals and on determining MRLs in foodstuffs of animal origin (86/363). For fruits and vegetables, Council Directives 76/895 and 90/642 set MRLs, including for certain plant-origin foods. Maximum residue levels for animal products are set in Council Regulation 2377/90/EC. Waters for human consumption are regulated under Council Directive 98/83.

On December 11, 2019, the European Commission published the European Green Deal, a strategic policy document—albeit not directly legally binding—on combating climate change and achieving a green transition, covering energy, agriculture, industry, environment and oceans, and regional development. The Deal envisions reducing pesticide, fertilizer, and antibiotic use in agriculture and fisheries; ensuring sustainable, healthy, and affordable food at all stages from processing to packaging to the end consumer; blocking imports that fail to meet EU health and environmental standards; reducing environmental impacts of food waste; protecting and restoring ecosystems and biodiversity; and establishing a non-toxic environment under a "zero pollution" goal.

The European Climate Law and the Climate Action Regulation foresee measures to reduce non-CO2 agricultural emissions from fertilizer use and livestock. In Türkiye's Green Deal Action Plan adopted in alignment with the European Climate Law, concrete initial steps were not clearly outlined [61].

Because the effects of genetically modified organisms (GMOs) are not yet fully known, EU GMO regulations are stringent due to uncertainty. Member States must implement regulations on the transboundary movement of GMOs, traceability and labeling of GMOs, and rules on genetically modified food and feed. Authorities competent for implementing GMO legislation in the EU are the European Commission and the European Food Safety Authority (EFSA).

4.2.2 National Legislation Ensuring Food Safety

A fundamental right is that goods and services purchased should not harm the consumer's health. Türkiye has enacted numerous laws to ensure food safety. The Decree-Law No. 560 of 1995 aimed to ensure the technical and hygienic production and preservation of foodstuffs; determine the characteristics of all raw and auxiliary materials used in production, finished and semi-finished foods, and by-products; and set minimum technical and hygienic requirements for food production facilities. In line with the Decree-Law, the Turkish Food Codex—serving as a framework regulation—introduced limits for food additives and for substances unintentionally formed in or contaminating food.

The Law No. 5179 of 2004 on the Production, Consumption and Inspection of Food introduced regulations to prevent harm to consumer health and to prevent consumer deception in ways not discernible by visual inspection. The law centralized food inspection under the Ministry of Agriculture and Forestry and introduced concepts such as notifying all units of any food hazard detected during inspections and tracking products and hazards [62].

Since the primary sources of food are animal or plant products, ensuring food safety requires ensuring veterinary services, plant health, and feed safety. Law No. 5996 on Veterinary Services, Plant Health, Food and Feed repealed Law No. 5179 and consolidated food safety in a single statute, adopting a holistic approach to veterinary services, plant health, and feed safety. In addition, Law No. 5977 on Biosafety prohibits certain acts related to GMOs and their products.

Türkiye has enacted regulations on maximum residue limits under the Regulation on the Licensing and Placing on the Market of Plant Protection Products. Residues found in live animals and animal products are regulated under the Regulation on Measures for Monitoring Certain Substances and Their Residues in Live Animals and Animal Products. Numerous regulations exist on the control of plant protection products, production facilities, recommendation, application and record-keeping, import of raw materials, wholesale and retail sales, storage, licensing, placing on the market, and trials for approval.

Law No. 5403 on Soil Conservation and Land Use is among the statutes regulating the protection and improvement of agricultural lands and planned use of agricultural lands in accordance with the principle of environmentally prioritized sustainable development. However, existing environmental policies and laws in Türkiye remain inadequate in fully protecting soils and preventing environmental pollution [63].

Table 3 highlights that Turkish law provides multiple liability regimes, yet their practical impact remains limited. Especially in criminal and civil cases, causation and proof problems prevent effective redress, reinforcing the study's conclusion that existing mechanisms inadequately protect public health and the environment.

4.3 Liability for Damages Arising From Pesticide Residues

Plant protection products are defined as substances and preparations that protect plants and plant products against harmful organisms or prevent their effects; regulate plant growth; are used as protectants for plant products; control or prevent undesirable growth of plants or plant parts; or destroy unwanted plants and plant parts; and that contain one or more active substances and substances that enhance safety. Pesticides are all kinds of chemical substances and preparations used in plant protection research and practices.

"Pesticide residues" refer to the presence in food products of active substances of plant protection products used in pest control and their metabolites and degradation or reaction products—including those arising from veterinary medicinal products and biocidals. The use of non-recommended plant protection products and the presence of residues above specified limits in plants—pesticides now being indispensable to ensure sufficient quantity and quality in agriculture—pose dangers to human health, other living creatures, and natural resources when such foods are consumed.

In GMO products, pesticides can be used against pests to enhance yield; however, pesticides are not used for genetic modification and—although there are some epigenetic

Table 3. Types of legal liability arising from pesticide residues.

Type of liability	Legal source	Scope	Key limitations in practice
Administrative liability	Law No. 5996; Misdemeanors Law	Fines, Lack of transparency in demolition activities	Sanctions lack deterrence; inconsistent application.
Criminal liability	TPC Arts. 185–186	Endangerment of public health	The penalties are too lenient and not a deterrent.
Civil (tort) liability	TCO Arts. 49, 71, 72	Compensation for damage	Difficult proof of causation and damage.
Environmental strict liability	Environmental Law Art. 28	Damage to environment and biodiversity	Long litigation; valuation difficulties.

TPC, Turkish Penal Code; TCO, Turkish Code of Obligations.

reports related to methylation—do not have genetic effects, as pesticides are entirely exogenous agents. Both consumption of GMO products and consumption or exposure beyond certain levels to products containing pesticide residues have impacts on human, animal, and environmental health. Therefore, under the heading of liability, it is necessary to address not only the consumption of products containing pesticide residues but also liability for the consumption of GMO products and their environmental harms.

Despite numerous legal regulations aimed at effective food inspection in Türkiye, pesticide use within legal limits has not been reduced to a reliably safe level. In Turkish law, in addition to administrative measures to ensure food safety, criminal sanctions—including imprisonment—exist, and there are legal arrangements for compensation of damages. To exercise powers to ensure food safety—a police function—legislation must be sufficient, and the officers implementing it must be vested with necessary authority [64].

4.3.1 Liability for Pesticide-Related Damages

Scientific research comparing individuals working in agriculture exposed to pesticides and those not exposed shows a high frequency of structural and numerical chromosomal aberrations and sister chromatid exchanges in exposed groups. Studies involving dithiocarbamates (ziram, zineb, thiram) among workers and producers, and those on organophosphates (trichlorphon, phosmet, diazinon) and carbamates (pirimicarb), have found that these substances cause chromosomal anomalies and sister chromatid exchanges [65].

Under Law No. 5996, the use of products harmful to human health on plants for pest control is punished—depending on the nature of the unlawful act—with administrative fines, as well as judicial fines and imprisonment; unlawful products are ordered destroyed with transfer of ownership to the public; licenses granted to persons legally authorized to perform certain tasks are temporarily suspended or revoked. The sale of plant protection products via the internet or any other electronic medium is prohibited.

In the Turkish Food Codex Regulation on Maximum Residue Levels of Pesticides, "pesticide residues" are defined as the presence in foods of active substances of plant protection products and their metabolites and degradation or reaction products—including those arising from veterinary medicinal products and biocidals. There are also many other food-related health risks beyond pesticide residues.

Foods may become hazardous due to a variety of factors, including errors during transportation, storage, or consumption. Frozen foods and chilled products whose freshness is preserved by cold storage must be maintained within specific temperature ranges throughout the entire chain from production to consumption. The mechanism that ensures this is the cold chain. Tools that can be used within the cold chain include HACCP (Hazard Analysis and Critical Control Points) approaches, simple monitoring and recording devices, sensors that capture environmental factors, remote-controlled platforms, data collection platforms, and radio-frequency identification (RFID) technologies [66]. HACCP was first brought to the international level by the "Codex Alimentarius Committee on Food Hygiene" established under the joint auspices of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations. With the adoption of Council Directive 93/43/EEC on the Hygiene of Foodstuffs in 1993, its implementation was mandated across all European countries from 1996 onwards.

At all stages of food production, including primary production, manufacturing, processing, preparation, treatment, packaging, wrapping, transportation, or storage, as well as against environmental contamination, food must be protected from any substance (contaminant) present in the food, with the exception of foreign materials such as animal hair or insect fragments. The Turkish Food Codex Regulation adopted in 2020 sets out rules on the transport and storage of foodstuffs. It establishes rules for the vertical food codex, which lays down specific criteria for particular foods, food groups, or food contact materials and articles, and for the horizontal food codex, which contains criteria applicable to all foods and food contact materials and articles. The latter covers, inter alia, vitamins, minerals and certain other substances that may be added to food; food additives; flavourings and food ingredients with flavouring properties; food enzymes; contaminants; pesticide residues and veterinary drug residues; sampling and analysis methods; maximum levels of coccidiostats and histomonostats

that cannot be prevented from carrying over into non-target feeds and may be present in food of animal origin; and labelling and microbiological criteria.

Article 10 of the Codex stipulates that, in the transport and storage of foods, compliance is mandatory with the rules laid down in the Regulation on Food Hygiene published in the Official Gazette No. 28145 of 17 December 2011 and the Regulation on Specific Hygiene Rules for Food of Animal Origin published in the Official Gazette No. 28155 of 27 December 2011.

In determining whether a food is harmful to human health, consideration is given not only to its potential immediate, short-, or long-term effects on the health of the consumer, but also to its effects on future generations, its possible cumulative toxic effects, and the specific health sensitivities of particular consumer groups. Even where a food complies with the conditions established by the Ministry, if sufficient doubt or grounds arise to indicate that the food may not be safe, the Ministry may restrict its placing on the market or order the withdrawal and recall of the food already placed on the market. The Ministry also acts as the national contact point for the international Codex Alimentarius Commission and conducts the relevant work in this regard.

Because pesticides harm not only target pests but also all living organisms, they entail certain health threats. Human exposure occurs through skin, oral, and respiratory routes during production, transportation, storage, and use, or through consumption of residue-containing products. As a result, metabolites—pesticide degradation products—can exert toxic effects and cause a wide range of health harms. Pesticides can also accumulate in the fat, milk, meat, and eggs of livestock, causing acute or chronic poisoning in animals, as in humans. Pesticides used on fruits and vegetables leave contamination or residues on products and may even penetrate plants' genetic systems.

Administrative fines are imposed for actions such as producing plant protection products in unapproved places; importing, selling, or possessing plant protection products without authorization; violating rules on approval, production, import, labeling, placing on the market, use, and control of products other than plant protection products used in pest control; selling plant protection products outside authorized points of sale; failing to keep records related to plant protection products; failing to comply with rules on wholesale and retail sales; purchasing and applying prescription-only plant protection products without a prescription; failing to keep data records requested by the Ministry; prescribing banned plant protection products; failing to use plant protection products in accordance with label information; failing to properly dispose of plant protection product residues and packaging; and failing to comply with the approved formula and specifications of approved plant protection products.

Those who apply plant protection products containing substances prohibited in pest control to plants and plant products intended for the market are punished with judicial fines; producing and placing counterfeit versions of approved plant protection products on the market by imitation is punishable by imprisonment from one to three years and a judicial fine of one thousand days.

Articles 185 and 186 of the Turkish Penal Code (TPC) No. 5237 prohibit the contamination of drinking water or any kind of food or substance intended for consumption or use by adding poison or by other means that render them hazardous to human life and health. These articles also forbid the sale, supply, or possession of any such spoiled or altered foodstuffs. To determine whether pesticide residues—which should either be entirely absent or not exceed statutory limits—endanger human life and health to a degree that causes varying levels of harm, a technical report must be obtained from the Council of Forensic Medicine or another specialized institution. Based on the findings of this report, the legal status of the act is established. The act in question constitutes a "crime of concrete danger" and the victim of such an offence can be any member of the general public [66].

The reversal decision rendered by the Court of Cassation regarding the procedure to be followed by courts in detecting pesticide residues in plants is as follows: In a case filed against the defendant for the offence of "adding poison to or spoiling food as a result of a breach of the duty of care or attention", the acquittal judgment rendered by the Criminal Court of Peace was reviewed by the 20th Penal Chamber of the Court of Cassation. In its decision dated 14.04.2016 (Merit No. 2015/14388, Decision No. 2016/2089), the Court of Cassation determined that the lower court's judgment was erroneous due to an incomplete investigation and subsequently reversed the decision. The summary of the ruling states:

> *"According to the facts of the case and the contents of the file; in the analysis of samples taken on 16/12/2009 from cucumbers produced by the defendant, it was found that the residue of the pesticide named 'oxamyl'—which, according to Communiqué No. 2008/41 on Maximum Residue Limits of Pesticides Permitted in Foodstuffs, should not exceed 0.02 mg/kg in cucumber crops—was measured at 0.66 mg/kg, well above the reference value. Although the expert report dated 23/07/2011, which served as the basis for the judgment, stated that 'the amount of pesticide above the limit is not at a level harmful to human health, though side effects may be observed in the future due to accumulation in the body', it is necessary to determine the legal status of the defendant based on a report to be obtained from the Council of Forensic Medicine regarding whether the amount of 'oxamyl' residue in the product 'endangers human life and health' pursuant to Article 185(2) of the Turkish Penal Code No. 5237, as referred to by Article 29/I of Law No. 5179 (as amended by Law No. 5728). Establishing a judgment based on an incomplete investigation as described in the written record, Required a reversal; as the appellate objections of the Public Prosecutor were found to be justified for this rea-*

son, it was Unanimously Decided on 14/04/2016 to Reverse the judgment without examining other aspects."

As evidenced by the decision, although the date of the defendant's act was 2008, the review by the Court of Cassation took place in 2016, eight years later. Since this is a decision to reverse the lower court's judgment, it does not yet constitute a final (res judicata) verdict. Following this reversal, the case file will be remanded to the court of first instance; that court will then send the file to the Council of Forensic Medicine in accordance with the Court of Cassation's ruling. If the new judgment rendered upon the receipt of the forensic report is appealed again, it will once more be submitted for the review of the Court of Cassation. In short, the conclusion of such legal proceedings takes an excessively long time.

In the Turkish criminal justice system, if a prison sentence imposed by a judge does not exceed two years, the mechanism of "Suspension of the Announcement of the Judgment" may be applied. Under this institution, if the defendant does not commit an intentional crime and complies with specific obligations during a designated probation period, the conviction is effectively annulled. The lower limit for sentences related to environmental crimes under Article 185 of the Turkish Penal Code (TPC) is two years of imprisonment. Consequently, unless there is a severe violation requiring a sentence at the upper limit, a first-time offender will typically receive a two-year sentence. Under the current regulations applicable until September 2026, if such an offender complies with the probationary measures, they will effectively face no criminal record or penal execution.

Furthermore, in Turkish criminal proceedings, if a defendant maintains a respectful demeanor during the trial, a "discretionary mitigation" (good conduct abatement) of one-sixth is applied to the sentence. Additionally, prison sentences of less than one year for intentional crimes may be converted into judicial fines at the judge's discretion. For crimes committed through negligence, sentences may be converted into fines regardless of the upper limit. Türkiye also periodically enacts general and special amnesties, and the President holds the authority to grant individual pardons. Administrative fines, in particular, are frequently subject to such amnesties. Because judicial proceedings are excessively protracted—often lasting between 5 to 10 years—and criminal convictions cannot be executed until they are finalized, a public perception has emerged that offenders face no real consequences.

The deterrent effect of administrative fines is further eroded by economic factors. With annual inflation exceeding 30% and fine amounts being fixed at the beginning of each year, the real value and deterrent impact of these penalties diminish significantly toward the end of the year. Moreover, when courts annul fines due to procedural errors, the administration is legally mandated to re-impose the penalty based on the statutory rates applicable at the time of the original act. Given the long duration of the litigation process, the resulting fines, when finally imposed years later, remain far from being deterrent.

In compensation cases arising from agricultural production damages, court decisions emphasize determining whether pesticide contents comply with the Turkish Food Codex Regulation on Maximum Residue Levels of Pesticides and the necessity of conducting on-site inspections "before harvest" for such determinations [67].

As for judicial review of administrative sanctions, in the absence of contrary provisions in other laws, objections must be filed with the criminal courts of peace under Article 3 of the Misdemeanors Law, which grants general jurisdiction to the criminal judiciary. However, where, together with sanctions under the Misdemeanors Law, other sanctions are imposed, jurisdiction lies in the administrative judiciary. Since Law No. 5996 does not specify a judicial authority for administrative sanctions, the general rule applies: the criminal judiciary is competent. Interested parties may appeal administrative sanctions and decisions transferring ownership to the public to the criminal court of peace within 15 days; this period is peremptory. Decisions of the criminal court of peace may be appealed to the high criminal court within 7 days.

If damage arises within the scope of police activities carried out by the administration to ensure food safety—during authorization and approval processes for businesses, the exercise of powers by official control officers, laboratory and sampling stages, export and border controls for food, emergency measures, or performance of responsibilities by food business operators—the administration bears liability for compensation. In principle, the administration's fault-based liability applies to damages arising from food-related activities.

Reduced pesticide use will allow less contamination of soil, water, and other natural resources, enabling sustainable agricultural production and higher-quality output in the long term. To this end, a database is needed to control agricultural pollutants [22].

4.3.2 Prohibitions Regarding GMOs and Their Products

Although the presence of GMOs and pesticide residues are formally distinct subjects of legal regulation, in practice their associated food safety risks intersect. In GMO authorisation procedures, patterns of pesticide use, residue risks, and environmental impacts are assessed together. In the European Union, GMOs are strictly regulated within the framework of the precautionary principle; pesticide use patterns, residue risks, and environmental effects are jointly evaluated in the course of authorisation.

Crops such as glyphosatetolerant soybeans, maize, and cotton are designed to withstand a specific herbicide (most commonly glyphosate). In some GMO varieties, the plant itself produces toxins effective against certain insects. While in the short term this may result in the use of fewer types of pesticides and a reduction in mechanical weed control, in the long term it may lead to an overall increase in

herbicide use, the emergence of glyphosateresistant weeds, and the need for higher doses or additional herbicides. In the literature, this phenomenon is described as the "herbicide dependency cycle".

In herbicidetolerant GMOs, preharvest herbicide applications are common, which may increase pesticide residue risks in the final product. In plants derived from Bacillus thuringiensis (Bt), chemical insecticide residues may decrease; however, the longterm effects of Bt toxins produced by the plant itself remain a matter of scientific debate.

From an environmental perspective, GMO based agricultural practices may encourage monoculture, which can reduce biodiversity and adversely affect soil ecosystems and beneficial organisms. Increases in pesticide use or shifts in pesticide use patterns may further exacerbate these environmental impacts.

In light of the right to life, the right to live in a healthy environment, and food safety principles under the European Convention on Human Rights—which impose preventive, regulatory, and supervisory positive obligations on the State—failures by public authorities to conduct effective oversight of risks arising from the pesticide use regime associated with GMO products, deficiencies in laboratory testing, or the failure to disclose test results transparently to the public may be regarded as violations of the State's positive obligations as interpreted by the European Court of Human Rights.

Culpability is the fundamental basis for tort liability in food-related damages. Force majeure, gross fault of the victim or third parties, and similar causes may break the chain of causation. The mere existence of a hazard, without actual damage, is insufficient to establish liability. The injured party must prove the damage and its extent.

Under Turkish law, where a product is produced contrary to applicable technical regulations or to product safety legislation, the legal liability of the food producer—following the enactment of Law No. 7223 on Product Safety and Technical Regulations—is regulated as strict tort liability [68].

For official controls of food, provincial and district agricultural directorates of the Ministry of Agriculture and Forestry are responsible for the entire control process. The establishment and basic rules of marketplaces are set under Law No. 5957 on the Regulation of Trade in Vegetables and Fruits and Other Goods with Sufficient Supply and Demand Depth and the Regulation on Marketplaces. Those wishing to sell foodstuffs in marketplaces must be registered in the relevant systems maintained by the Ministry. In wholesale markets, foods traded must undergo food safety analysis in public or private laboratories authorized by the Ministry. Often, unsafe foods are detected at this initial stage.

Liability under the Biosafety Law is strict (danger) liability where, considering the nature of the enterprise or the materials and instruments used, even if all care expected of an expert is exercised and all precautions taken, the activity is apt to cause severe harm, the enterprise is deemed hazardous; even if permitted by law, those harmed by the activity may seek equitable compensation [69]. Article 71 of the Turkish Code of Obligations (TCO) sets forth a general rule on strict liability. Because such activities are socially beneficial yet unavoidable, a balance is sought by imposing aggravated liability on those benefiting from the activity in favor of the injured [70]. Here, liability stems not from conducting a dangerous activity per se but from the dangerous nature of the thing used during the activity. Liability arises even if no damage occurs.

Unauthorized contained use of GMOs; placing on the market, import, and transit of GMOs for food, feed, processing, and consumption; release into the environment; and production lead to liability. To attribute damage to GMOs, the damage must result from the new characteristics possessed by the organisms or from the reproduction or modification of the organisms or from the transfer of the modified material of the organisms to other organisms. Those who process, distribute, and market GMOs and products, or otherwise cause the occurrence or aggravation of damage—e.g., by treating GMOs contrary to decision conditions—are jointly and severally liable.

Using, offering for sale, selling, or transferring products obtained from imported or processed GMOs outside the purpose and area defined in the import permit; knowingly and for commercial purposes purchasing, accepting, transporting, or possessing such products; obtaining import or processing permits by false declarations; and, based on such permits, importing, processing, using, releasing into the environment, offering for sale, selling, transferring, accepting, transporting, or possessing GMOs or their products is punishable by imprisonment.

Under the Misdemeanors Law and Law No. 5996, where administrative violations that compromise food safety occur, administrative fines under Articles 40 and 41 are imposed. Transfer of ownership to the public and suspension of activities apply where production violates human health and food safety conditions.

GMO foods should not be addressed under the "adulteration" offense in TPC Article 186 but within the special framework of Law No. 5977 on Biosafety. Those engaged in GMO-related activities are liable for all damages under Article 14 of the Biosafety Law and subject to criminal sanctions under Article 15. Supreme Court decisions state that crimes under the Biosafety Law involve special high-level dangers to "public health" and the "environment", indicating acceptance of strict liability [71]. Where harms arise from legally permitted interventions, justice is achieved by imposing an obligation on the actor with the superior interest to pay equitable compensation. Firms importing/exporting or placing GMO plant and animal products on the market for experimental purposes are certain of the presence of risk, though not its magnitude.

Genetically modified plant and animal products have known harmful effects, as well as potential yet, unknown

Table 4. Regulatory approach to pesticidies and GMOs: comparative liability regimes.

Aspect	Pesticides	GMOs
Legal regime	Law No. 5996; Food Codex	Law No. 5977 (Biosafety Law)
Liability type	Predominantly fault-based	Strict (danger) liability
Preventive measures	Limited; post-market focus	Strong prior authorization and prohibition
Burden of risk	Largely on consumers	On producers and operators

GMOs, genetically modified organisms.

harmful effect that may only be understood in the future through advancements in science and technology [72]. Therefore, as a result of GMO-related activities, claims for pecuniary and non-pecuniary damages may be brought for moral injury, lost profits, direct and indirect damages, loss of support, potential damages, and pure economic loss [71]. However, the damage must arise from the new characteristics of the organism, its reproduction, modification, transfer of modified material to other organisms, gene escape, or changes within agricultural, forestry, food, and feed products. Those causing the occurrence or aggravation of damage are jointly and severally liable. The Biosafety Law does not specifically regulate administrative liability.

A constitutional complaint by a parent alleging fear and anxiety caused by feeding a child with GM-containing products, claiming the Ministry of Food, Agriculture and Livestock failed in its duties, was dismissed by the Constitutional Court as manifestly ill-founded [49]. Those handling GMOs must bear costs for preventive measures before damage occurs and for measures taken post-damage to prevent aggravation of consequences.

The right to claim compensation for damages caused by GMOs and their products is subject to a two-year limitation from the date the injured party learns of the damage and the liable party, and in any event twenty years from the event causing damage—given the long latency and uncertainty about effects on human bodies and the environment [73].

Table 4 reveals a normative inconsistency: while GMOs are regulated under a strict and preventive liability regime, pesticides—despite their well-documented harms—are subject to weaker, predominantly fault-based mechanisms. This discrepancy constitutes one of the study's central findings and supports the call for harmonization toward stricter pesticide regulation.

4.3.3 Liability for Environmental Damage

The right to live in a healthy environment—fundamental to life—concerns society as a whole. Article 56 of the Turkish Constitution states: "Everyone has the right to live in a healthy and balanced environment. Protecting and improving the environment, environmental health, and preventing environmental pollution is the duty of the State and citizens". Environmental protection rules impose duties on public officials to enforce environmental safeguards—for example, restricting the application of commercial or chemical fertilizers to protect spring water from nitrates [74]. The Environmental Law No. 2872 was enacted in 1983 for environmental protection.

Article 28 of the Environmental Law establishes "polluter pays" strict liability: "Those who pollute or harm the environment are liable—without fault—for damages arising from the pollution and degradation they cause". Article 72 of the TCO (tort liability), provisions of the Turkish Civil Code on neighborhood law, and other statutes form the legal bases for compensation of environmental damages; the injured party may bring suit under whichever regime is most advantageous [75]. Under Article 30 of the Environmental Law, administrative authorities can be petitioned to halt activities that pollute or degrade the environment, and public institutions may be held liable via "full remedy actions" for damages they cause [76].

Individuals harmed by air pollution, contaminated water sources, soil pollution, or by consuming foods with pesticide residues may sue. Environmental damage suits are brought by affected individuals and aim to compensate personal injuries. However, because environmental harms affect multiple persons, these suits become complex; success depends on numerous factors, including proof of damage, quantification difficulties, and causation, which render such litigation lengthy and complex. For compensation of environmental harms, Article 28 of the Environmental Law adopts strict liability [77]. Such suits are subject to the limitation period in TCO Article 72: two years from the injured party's knowledge of the damage and the liable person, and in any case ten years from the tort. Because effects may emerge years later, filing deadlines must consider the time of occurrence.

Environmental damage includes harm to persons and property, as well as detriment to ecological balance and biodiversity—natural and cultural assets [78]. These suits often arise from harm due to environmental factors such as environmental pollution, noise, air and water pollution, and soil contamination [79]. Environmental damage encompasses not only personal and property damage but also harm to the environment itself [80].

To sue for compensation for environmental damage, there must be contamination, an identifiable polluter, damage caused by the contamination, and adequate causation between the contamination and the damage. Because aesthetic concerns arise in environmental harm, and such values vary individually, fixed measures may be problematic; thus, damages should be assessed based on the loss of value in property caused by environmental pollution [81]. In

a 1991 decision, the Court of Cassation Grand Chamber (HGK., 19.06.1991, E. 1991/4-294, K.1991/368) held in a case of environmental pollution caused by the explosion and sinking of a petroleum tanker in the Black Sea that, absent evidence of another tanker explosion and sinking at the time, the environmental pollution originated from the defendant's tanker and that causation existed between the damage and the sinking.

Environmental protection is addressed in TPC Articles 181–184, the Environmental Law No. 2872, and other statutes, defining various offenses and misdemeanors for environmental pollution. The TPC criminalizes the intentional discharge of waste or residues into soil, water, or air, thereby protecting these media and, indirectly, the health of people and other living beings. The requirement in TPC 181 that the act be "contrary to technical procedures defined by relevant laws" shows the link to administrative law and grants the executive the authority to issue complementary regulations within statutory bounds. Penalties are aggravated if waste or residues cause diseases difficult to treat in humans or animals, impair reproductive capacity, or alter the natural characteristics of animals or plants; and if the waste displays persistence in soil, water, or air. The Misdemeanors Law also includes provisions protecting the environment. Where the same act violates both laws, punishment should proceed under the TPC; however, if waste or residues cause environmental harm or display persistence in soil, water, or air, TPC Article 181 applies; if not, Misdemeanors Law Article 41 applies [82].

Under TPC Article 186, the statute protects not only food and water but also "things to be used or consumed" that are not food or drinking water (e.g., toxic toys, school supplies, perfumes, detergents, tissues, cologne, soaps, cosmetics, clothing), while poisoning or adulteration of non-potable waters is excluded.

Pollution of streams and rivers—waters not considered "drinking water"—constitutes the offense of intentional environmental pollution [83]. This is an endangerment offense and requires that human life and health be endangered.

Under Article 14 of the Biosafety Law, responsible parties must bear the costs of measures identified by risk assessment to prevent environmental damage or to prevent aggravation of consequences if damage occurs; they must also bear costs to restore damaged or degraded environmental elements to their previous state or to replace them with elements of equivalent value.

Public officials may be liable for environmental offenses due to failure to intervene against third parties' damaging acts or due to defects in permits and licenses granted before private activities commenced. For example, a public official who fails to suspend operations or impose administrative fines on persons and companies that do not build treatment facilities or fail to comply with notification obligations may be culpable for failing in duties of oversight and inspection [84,85].

In a case upholding a circular banning the use of "petcoke" (a fuel richer in toxic substances than other fuels) to protect public order in terms of general health, the Council of State rejected an annulment request, holding the circular lawful because gases, smoke, etc., from petcoke combustion would harm individuals [86].

In López Ostra v. Spain, the European Court of Human Rights (ECHR) found that Spain failed to strike a fair balance between the economic interest of a wastewater treatment plant (supported by the state) and the applicant's right to respect for private and family life under Article 8 of the ECHR, due to odors and other environmental effects. The Court held that even if the relationship between pollution and the applicant's health could not be fully established, the state violated Article 8. In Tătar v. Romania (2009), the ECHR held that even the risk of cyanide posed an interference with the right to life and that the state failed to fulfill preventive obligations; the Court emphasized "preventive state obligations", deeming the presence of risk sufficient without waiting for damage to materialize, and indicated that near-proof (approximate proof) may suffice in environmental harm due to evidentiary difficulties over long-term effects, sometimes placing active responsibility on the state [87].

Civil suits for environmental harms are brought in the civil courts. Because environmental harms are scientifically complex and diffuse, proof of the perpetrator, causation, and quantification of damage pose challenges for plaintiffs in environmental compensation suits [88–90].

4.3.4 General Food Law and Food Safety Liability in the European Union and the United States

International product liability regimes, particularly within the European Union, are governed by norms such as the Product Liability Directive (85/374/EEC), which adopts the principle of strict product liability. Under this principle, if damage arises due to a defect in a product, liability is established without the need to prove the fault of the tortfeasor.

The EU General Food Law (Regulation (EC) No 178/2002) forms the cornerstone of European food safety law and mandates that foods placed on the market must not be injurious to human health. This regulation incorporates the principles of risk assessment, risk management, and traceability throughout the food chain, explicitly prohibiting the marketing of unsafe food.

• Risk Analysis-Based Approach: The EU system separates scientific risk assessment from regulatory decision-making, adopting a control mechanism grounded in both science and law. This ensures that sanctions are normatively based on scientific data.

• Mandatory Traceability: Traceability at all stages of the food and feed chain enables rapid intervention if products are found to be harmful, thereby increasing administrative accountability.

The institutional structure of food safety in the EU is based on the deliberate separation of scientific risk as-

sessment from administrative decision-making. Within this framework, the European Food Safety Authority (EFSA), established by Regulation (EC) No 178/2002, serves as the central scientific authority on food and feed safety, pesticide residues, GMOs, and chemical risks. EFSA:

• Conducts scientific risk assessments regarding active substances in pesticides and Maximum Residue Limits (MRLs),

• Provides independent scientific opinions on human, animal, and environmental health,

• Establishes the binding scientific reference framework for the Commission and Member States, without holding direct decision-making (regulatory) power.

While risk assessment (scientific) is performed by EFSA, risk management (administrative and political) is carried out by the European Commission and Member States. This separation protects scientific evaluation from political or economic pressures, ensuring that measures taken are transparent, predictable, and accountable. Since scientific standards and reference values are determined centrally by EFSA, conflicts of authority or differences in interpretation are minimized.

In the United States, the Food Safety Modernization Act (FSMA), which came into effect in 2011 as a reform statute, shifted the focus of food safety from a reactive to a preventive and risk-based approach. The FSMA mandates the control of hazards starting from the production planning stage and is supported by the extensive inspection powers of the FDA (U.S. Food and Drug Administration).

• Proactive Approach: Instead of waiting for a hazard to manifest, the FSMA establishes in-process risk controls, defined in international literature as a "preventive liability regime".

• Equal Inspection Obligations: By setting equivalent standards for both domestic and imported food facilities, the act envisages similar safety responsibilities across global supply chains.

In Türkiye, pesticide inspection is conducted through fragmented and partially overlapping powers distributed among the Ministry of Agriculture and Forestry, the Ministry of Health, and Municipalities. Unlike the EU model, there is no institutional separation between scientific risk assessment and administrative inspection/sanction processes, as these functions are consolidated within the same administration. In Türkiye, powers regarding licensing, setting MRLs, inspection, and sanctions are largely concentrated within the same corporate structure of the Ministry of Agriculture and Forestry. Furthermore, because municipalities are authorized at the retail stage, the Ministry of Health at the consumption risk stage, and the Ministry of Agriculture at the production and licensing stages, authority conflicts arise in technical and analytical matters such as the detection of pesticide residues.

In the EFSA model, such technical evaluations are not left to the discretion of local administrations. The existence of EFSA functions as an institutional guarantee that states are fulfilling their positive obligations. In the EU, the EFSA-based system facilitates the operation of strict product liability regimes by easing the burden of proof for consumers when a food product placed on the market is unsafe. In Türkiye, however, the consolidation of scientific assessment and inspection within a single body, combined with a multi-headed administrative structure, increases the burden of proof on the injured party and hinders the effective implementation of the strict liability regime.

5. Discussion and Conclusions

This study examines the health and environmental risks posed by pesticide use and toxin formation—emerging as a consequence of modern agricultural techniques—within the framework of legal discipline. It demonstrates that the risks to the environment and human health arising from pesticide use in Türkiye cannot be managed in a preventive, deterrent, and holistic manner within the current legal and institutional framework.

Table 5 consolidates the study's results, showing that pesticide-related risks persist due to systemic regulatory weaknesses, not legal gaps alone. The findings support a shift from reactive liability to preventive governance, aligned with ECHR jurisprudence on risk-based state obligations. The current penal regime in Türkiye is largely confined to administrative fines; however, even for large-scale enterprises, these penalties often remain below the profit margins gained from violations. While fines may be relatively high for small businesses, they fail to provide economic deterrence for large-scale producers. Furthermore, inspection data and pesticide analysis results are not sufficiently shared with the public, leading to questions regarding the transparency and effectiveness of administrative oversight.

This study asserts that the impacts of pesticides used in Turkish agricultural production on human health and the environment should not be viewed merely as a matter of administrative regulation or technical inspection, but must be evaluated within the context of Constitutional and international human rights obligations. In this regard, food safety is an integral part of the positive obligations that the State is mandated to fulfill under both the constitutional order and international conventions to which it is a party.

The right to life, guaranteed under Article 17 of the Constitution of the Republic of Türkiye, and the right to live in a healthy and balanced environment, regulated under Article 56, render the effective monitoring of pesticide use a constitutional imperative. Under these provisions, the State cannot limit its role to intervening only after harmful acts have occurred; it is obligated to take preventive, protective, and risk-based measures. However, the quantitative and qualitative inadequacy of current inspection mechanisms raises a significant legal debate regarding the State's failure to effectively fulfill its positive obligations to protect the environment and public health.

Table 5. Key empirical and normative findings of the study.

Finding category	Core result
Enforcement capacity	Inspection frequency and scope are insufficient
Sanctions	Administrative and criminal penalties lack deterrent effect
Market practices	Products reach consumers without prior residue analysis
Legal protection	Existing remedies fail to ensure effective prevention
Human rights dimension	State's positive obligations remain underfulfilled

While pesticide use may appear to be an unavoidable necessity for increasing agricultural productivity, residues exceeding legal limits pose severe threats to human health and ecosystems. The availability of active substances in the market that are incompatible with European Union (EU) legislation weakens the principle of preventive protection and hinders the practical operation of the strict product liability regime. Consequently, the burden of proof on injured individuals increases, rendering legal protection ineffective.

The administration is authorized and responsible for overseeing the entire process—from production to marketing—to ensure that society lives in a state of complete physical and mental well-being. This includes monitoring pesticide use, protecting food from harmful contaminants, setting hygiene standards, and withdrawing unsafe food from the market.

In Türkiye, liabilities arising from pesticide and toxin-related damages are categorized under administrative, criminal, and civil liability:

• Administrative Sanctions: Under Law No. 5996 and the Law on Misdemeanors, measures such as the transfer of product ownership to the public, debarment from activities, cancellation of licenses, and product recalls are implemented.

• Criminal Sanctions: Pesticide and food safety violations are regulated as crimes of danger under Articles 185 and 186 of the Turkish Penal Code. These offences are punishable at the stage of danger, before a harmful result occurs. However, deterrence is not achieved in practice due to low sentencing levels, which fail to create a behavioral shift among producers or distribution chain actors.

• Civil Liability: Regarding food-borne damages, the traditional regime requires the injured party to prove the producer's fault and the resulting damage. However, Law No. 7223 has introduced cases of liability without fault for producers. Additionally, under the "polluter pays" principle of the Environment Law, those who pollute the environment are held liable for damages regardless of fault.

The EFSA model in the EU offers a preventive and rights-based system that prevents authority conflicts by addressing food safety through a single, central authority based on scientific risk assessment. In contrast, Türkiye's multi-actor oversight structure (Ministry of Agriculture, Ministry of Health, and municipalities) and the consolidation of scientific assessment and administrative inspection under the same institutional roof constitute a systemic weakness. This vulnerability renders both administrative accountability and the strict liability of producers and sellers effectively invisible.

Although the legal infrastructure for food safety in Türkiye is largely established, the sanctions provided in the Turkish Penal Code, Law No. 5996, and the Environment Law are insufficient to prevent violations. Issues such as authority conflicts, informality, and personnel shortages in inspection persist. In a structure with 2.5 million farmers, the number of official inspections remains inadequate, weakening the effectiveness of legal protection.

The legal problems identified are directly linked to the policy tools proposed in this study. First, Integrated Pest Management (IPM) must be treated not merely as an agricultural preference but as a legal obligation. Given the negative impacts of chemical-based production, making cultural, biotechnical, and biological methods mandatory is a requirement of the State's obligation of preventive protection.

In licensing processes, the total exclusion of active substances incompatible with EU legislation and the mandatory requirement for equivalence tests emerge as fundamental tools to strengthen the strict product liability regime. Similarly, preventing the importation of products known to be harmful to human health and the environment is not just a commercial regulation but a positive administrative obligation to protect the right to life and the right to a healthy environment.

To improve this situation, it is necessary to increase the lower limits of prison sentences in penal norms regulating food and pesticides. Furthermore, legislative provisions should be enacted to make pre-harvest and pre-sale pesticide analysis mandatory. Establishing an online database and a traceability system—utilizing digital prescriptions and barcodes—will enhance administrative efficiency and ensure the traceability of legal liability.

The functionality of the liability regime also requires intensifying administrative inspections, destroying products with residues above legal limits at the producer's expense, and publicly announcing the destruction of agricultural products returned from export due to residues to ensure they are not sold domestically.

In the EU and the UK, product safety rights are enforced within a strict liability framework, ensuring producers/importers are held accountable for losses caused by harmful products. This system encourages preventive responsibility by establishing liability without requiring proof

of fault. The EU imposes heavy administrative fines and stricter sanctions, such as halting product flow, recalls, and suspending business activities. Systems like the Rapid Alert System for Food and Feed (RASFF) facilitate the cross-border monitoring of violations—a level of integration not yet effectively present in Türkiye. In the US, FDA practices demonstrate that heavy fines, product destruction, and the closure of production sites can effectively alter producer behavior.

The jurisprudence of the European Court of Human Rights (ECtHR) supports this constitutional framework. Regarding environmental risks and public health threats, the Court imposes extensive positive obligations on States under Article 2 (Right to Life) and Article 8 (Right to Respect for Private and Family Life) of the ECHR. In cases such as López Ostra v. Spain and Öneryıldız v. Türkiye, the Court explicitly stated that States must establish, implement, and oversee an effective legal and administrative framework against known or foreseeable environmental risks. In light of these precedents, the violation of food safety through pesticide residues should be evaluated as a structural problem carrying the risk of human rights violations. The ECtHR's criterion of "effective supervision and deterrent sanctions" is currently not met by existing administrative fines and low minimum prison sentences.

The policies proposed in this study—making IPM mandatory, de-licensing active substances incompatible with the EU, establishing digital traceability systems, and introducing mandatory pre- and post-harvest analyses—are concrete tools for the State to fulfill its obligation to prevent foreseeable risks.

In conclusion, this study reveals that pesticide-related food safety issues in Türkiye constitute a serious test of the administration's capacity to fulfill its positive obligations in light of the Constitution and ECtHR jurisprudence. The construction of an effective food safety regime is possible not only through the existence of legislation but through its scientifically based, human rights-oriented, and deterrent application. Therefore, any legal reform in the fields of pesticide oversight, food safety, and environmental protection must be treated as a constitutional necessity for the protection of the right to life and the right to a healthy environment.

Availability of Data and Materials

The data and materials supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

YG designed the research study. YG performed the research. YG wrote the manuscript. The author contributed to editorial changes in the manuscript. The author read and approved the final manuscript. The author has participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

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References

[1] Tilman D, Balzer C, Hill J, Befort BL. Global food demand and the sustainable intensification of agriculture. Proc Natl Acad Sci U S A. 2011; 108(50):20260-4. https://doi.org/10.1073/pnas.1116437108.

[2] Godfray HCJ, Crute IR, Haddad L, Lawrence D, Muir JF, Nisbett N, *et al*. The future of the global food system. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2010; 365: 2769–2777. https://doi.org/10.1098/rstb.2010.0180.

[3] Evenson RE. Global and local implications of biotechnology and climate change for future food supplies. Proceedings of the National Academy of Sciences of the United States of America. 1999; 96: 5921–5928. https://doi.org/10.1073/pnas.96.11.5921.

[4] Tiryaki O. The Use of Nuclear and Related Techniques in Plant Protection and Pesticide Residue Research in Turkey. In National workshop The use of Nuclear and Related Techniquesin Soil-Plant-WaterNutrient Relations (13C, 15N, 32P, Neutron Probe and Enviroscan Techniques). 27–30 November 2006. Soil and Fertilizer Research Institute, Ankara, Turkey. 2006.

[5] Güloğlu Y, Belkayalı N. Architectural and Legal Control in the Context of Aesthetics. İSTEM. 2022; 39: 115–138. https://doi.org/10.31591/istem.1134978. (In Turkish)

[6] Asefa EM, Damtew YT, Ober J. Pesticide water pollution, human health risks, and regulatory evaluation: A nationwide analysis in Ethiopia. Journal of Hazardous Materials. 2024; 478: 135326. https://doi.org/10.1016/j.jhazmat.2024.135326.

[7] Tudi M, Daniel Ruan H, Wang L, Lyu J, Sadler R, Connell D, *et al*. Agriculture Development, Pesticide Application and Its Impact on the Environment. International Journal of Environmental Research and Public Health. 2021; 18: 1112. https://doi.org/10.3390/ijerph18031112.

[8] Jess S, Kildea S, Moody A, Rennick G, Murchie AK, Cooke LR. European Union policy on pesticides: implications for agriculture in Ireland. Pest Management Science. 2014; 70: 1646–1654. https://doi.org/10.1002/ps.3801.

[9] Banerjee K. Nontarget screening methods for the analysis of contaminant residues in food matrixes by gas chromatography/mass spectrometry and liquid chromatography/mass spectrometry. Journal of AOAC International. 2011; 94: 1659–1660. https://doi.org/10.5740/jaoacint.sgebanerjee.

[10] Goodman RE. Twenty-eight years of GM Food and feed without harm: why not accept them? GM Crops & Food. 2024; 15: 40–50. https://doi.org/10.1080/21645698.2024.2305944.
[11] Carpenter DO, Arcaro KF, Bush B, Niemi WD, Pang S, Vakharia DD. Human health and chemical mixtures: an overview. Environmental Health Perspectives. 1998; 106: 1263–1270. https://doi.org/10.1289/ehp.98106s61263.
[12] Kilic KD, Gökhan A, Sözmen EY, Uysal A. Liver Histology and Biochemistry of Exposed Newborn and Infant Rats with Experimental Aflatoxicosis. Pakistan Veterinary Journal. 2022; 42: 453–460. http://doi.org/10.29261/pakvetj/2022.066.
[13] Smith JE, ve Hacking A. Fungal Toxicity. Edward Arnold Ltd: London. 1983.
[14] Beuhler MC, Feldman R, Gummin DD, Mowry JB, Rivers LJ, Brown K, *et al*. 2024 Annual report of the National Poison Data System® (NPDS) from America's Poison Centers®: 42nd annual report. Clinical Toxicology. 2025; 63: 1029–1280. https://doi.org/10.1080/15563650.2025.2571299.
[15] Wesseling C, McConnell R, Partanen T, Hogstedt C. Agricultural pesticide use in developing countries: health effects and research needs. International Journal of Health Services: Planning, Administration, Evaluation. 1997; 27: 273–308. https://doi.org/10.2190/E259-N3AH-TA1Y-H591.
[16] Diğrak M, Ozçelik S. Effect of some pesticides on soil microorganisms. Bulletin of Environmental Contamination and Toxicology. 1998; 60: 916–922. https://doi.org/10.1007/s001289900715.
[17] Sparks TC. Insecticide discovery: an evaluation and analysis. Pesticide Biochemistry and Physiology. 2013; 107: 8–17. https://doi.org/10.1016/j.pestbp.2013.05.012.
[18] Dulout FN, Pastori MC, Olivero OA, González Cid M, Loria D, Matos E, *et al*. Sister-chromatid exchanges and chromosomal aberrations in a population exposed to pesticides. Mutation Research. 1985; 143: 237–244. https://doi.org/10.1016/0165-7992(85)90087-9.
[19] Zeljezic D, Garaj-Vrhovac V. Chromosomal aberration and single cell gel electrophoresis (Comet) assay in the longitudinal risk assessment of occupational exposure to pesticides. Mutagenesis. 2001; 16: 359–363. https://doi.org/10.1093/mutage/16.4.359.
[20] Whysner J. Benzene-induced genotoxicity. Journal of Toxicology and Environmental Health. Part A. 2000; 61: 347–351. https://doi.org/10.1080/00984100050166343.
[21] Li R, Yang C, Chen H, Zeng G, Yu G, Guo J. Removal of triazophos pesticide from wastewater with Fenton reagent. Journal of Hazardous Materials. 2009; 167: 1028–1032. https://doi.org/10.1016/j.jhazmat.2009.01.090.
[22] Burns CJ, Swaen GMH. Review of 2,4-dichlorophenoxyacetic acid (2,4-D) biomonitoring and epidemiology. Critical Reviews in Toxicology. 2012; 42: 768–786. https://doi.org/10.3109/10408444.2012.710576.
[23] Headrick D. The Future of Organic Insect Pest Management: Be a Better Entomologist or Pay for Someone Who Is. Insects. 2021; 12: 140. https://doi.org/10.3390/insects12020140.
[24] Yıldırım İ, Çiftçi U. Monitoring of pesticide residues in peppers from Çanakkale (Turkey) public market using QuEChERS method and LC-MS/MS and GC-MS/MS detection. Environ Monit Assess. 2022; 194: 570. https://doi.org/10.1007/s10661-022-10253-y.
[25] Stallones L, Beseler C. Pesticide illness, farm practices, and neurological symptoms among farm residents in Colorado. Environmental Research. 2002; 90: 89–97. https://doi.org/10.1006/enrs.2002.4398.
[26] Food and Agriculture Organization of the United Nations (FAO). Pesticides use, pesticides trade and pesticides indicators – global, regional and country trends, 1990–2020. FAOSTAT Analytical Briefs. 2022; No. 46. Rome: FAO. Available at: https://openknowledge.fao.org/bitstreams/78705276-3455-4c70-ac77-3082095f83b3/download (Accessed: 28 December 2025).
[27] Arslan Ü, Erbek E, Özyörük A. Determination of the attitudes and behaviors of fruit producers in Gürsu and Kestel districts of Bursa province towards pesticide use. Bursa Uludağ University Faculty of Agriculture Journal. 2018; 32: 69–74. (In Turkish)
[28] Ministry of Agriculture and Forestry, General Directorate of Food and Control. 2025 Plant Health Implementation Program. 2025. Available at: https://www.tarimorman.gov.tr/GKGM/Belgeler/DB_Bitki_Sagligi/Bitki_Sagligi_Uygulama_Kitaplari/2025_Bitki_Sagligi_Uygulama_Programi.pdf (Accessed: 12 December 2025). (In Turkish)
[29] Feola G, Schoell R, Binder CR. Identifying barriers and opportunities for transitions towards more sustainable agriculture through system analysis: The case of Vereda La Hoya, Colombia. In 9th European IFSA Symposium: Building sustainable rural futures. Vienna, Austria. 2010.
[30] General Directorate of Food and Control. Official Agricultural Chemical Statistics. 2025. Available at: https://www.tarimorman.gov.tr/GKGM/Menu/115/Resmi-Tarimsal-Ilac-Istatistikleri (Accessed: 20 December 2025).
[31] Turkish Exporters' Assembly. EU Bulletin. TİM Project Coordination Directorate and Brussels Representation. 2025. Available at: https://www.tim.org.tr/en/turkiye-eu-agricultural-and-food-cooperation-placed-on-the-agenda-in-brusse (Accessed: 20 December 2025).
[32] Cesur I, Guloglu Y. The impact of climate change on women in forest villages: the case of Kastamonu, Türkiye. Small-Scale Forestry. 2025; 24: 335–374. https://doi.org/10.1007/s11842-025-09598-2.
[33] Aydoğdu Y. The Obligation of Food Businesses to Comply with Laws in the Context of Public Health: An Evaluation of Food Codexes. Periodicum Iuris. 2023; 1: 49–64.
[34] Weinroth MD, Belk AD, Belk KE. History, development, and current status of food safety systems worldwide. Animal Frontiers. 2018; 8: 9–15. https://doi.org/10.1093/af/vfy016.
[35] Ersoy N, Yılmaz S, Gumuş E. The importance of good agricultural practices in EU membership process. Mediterranean Agricultural Sciences. 2017; 30: 133–136.
[36] Reese I, Holzhauser T, Schnadt S, Dölle S, Kleine-Tebbe J, Raithel M, *et al*. Allergen and allergy risk assessment, allergen management, and gaps in the European Food Information Regulation (FIR): Are allergic consumers adequately protected by current statutory food safety and labelling regulations? Allergo Journal International. 2015; 24: 180–184. https://doi.org/10.1007/s40629-015-0066-0.
[37] Pigłowski M. Pathogenic and Non-Pathogenic Microorganisms in the Rapid Alert System for Food and Feed. International Journal of Environmental Research and Public Health. 2019; 16: 477. https://doi.org/10.3390/ijerph16030477.
[38] European Commission. Why RASFF. Rapid Alert System for Food and Feed (RASFF). 2024. Available at: https://food.ec.europa.eu/safety/rasff_en (Accessed: 1 November 2025).
[39] Kilic KD, Ozdemir AB. P01-07 Analysis of RASFF notifications on mycotoxins: Evaluation of aflatoxin incidence and border rejection trends in food products. Toxicology Letters. 2025; 411: S67. https://doi.org/10.1016/j.toxlet.2025.07.185.
[40] Çınar S, Yılmaz SN, Aydın E, Yorulmaz A. Rapid Alert System for Food and Feed [RASFF] 2009–2016 Turkey Report. Turkish Journal of Agriculture-Food Science and Technology. 2017; 5: 873–882.
[41] Gulan A. The Concept of Public Service. Journal of Administrative Law and Sciences. 2011; 9: 147–159. (In Turkish)
[42] Gozler K. Administrative Law: Volume II. Ekin Publishing House: Bursa. 2019. (In Turkish)
[43] Pomeranz JL, Broad Leib EM, Mozaffarian D. Regulation of Added Substances in the Food Supply by the Food and Drug Administration Human Foods Program. American Journal of Public Health. 2024; 114: 1061–1070. https://doi.org/10.2105/AJ

PH.2024.307755.
[44] Akyilmaz B, Sezginer M, Kaya C. Turkish Administrative Law. Seçkin Publishing: Ankara. 2023. (In Turkish)
[45] Council of State (Danıştay), 13th Chamber. Decision No: E.2005/6223, K.2006/1393. 13 March 2006.
[46] Council of State 10th Chamber. Decision No: E.2005/7354, K.2007/3129. 30 May 2007. Available at: https://karararama.danistay.gov.tr/ (Accessed: 12 September 2025).
[47] Yildirim İ, Özcan H. Determination of pesticide residues in water and soil resources of Troia (Troy). Fresenius Environmental Bulletin. 2007; 16: 63–70.
[48] Gulan, A. The Principle Of Child Protection. Journal of Administrative Law and Sciences, 2011, 12(1-3), 263-266. (In Turkish)
[49] Constitutional Court T. 21.04.2016, 2. B. 2013/6595. Available at: https://kararlarbilgibankasi.anayasa.gov.tr/Ara?BasvuruNoYil=2013&BasvuruNoSayi=6595 (Accessed: 12 September 2025).
[50] Suzuki T, Hidaka T, Kumagai Y, Yamamoto M. Environmental pollutants and the immune response. Nature Immunology. 2020; 21: 1486–1495. https://doi.org/10.1038/s41590-020-0802-6.
[51] Malik AS, Acharya S, Humane S. Exploring the Impact of Security Technologies on Mental Health: A Comprehensive Review. Cureus. 2024; 16: e53664. https://doi.org/10.7759/cureus.53664.
[52] Güloğlu Y, Belkayalı N. The effects of supreme courts' decisions on environmental protection in Turkey. In National Conference on Ecosystem Restoration (pp. 18–22). 2016.
[53] Fung F, Wang HS, Menon S. Food safety in the 21st century. Biomedical Journal. 2018; 41: 88–95. https://doi.org/10.1016/j.bj.2018.03.003.
[54] Pakdel M, Olsen A, Bar EMS. A Review of Food Contaminants and Their Pathways Within Food Processing Facilities Using Open Food Processing Equipment. J Food Prot. 2023; 86: 100184. https://doi.10.1016/j.jfp.2023.100184.
[55] Davis KC. Administrative Common Law and the Vermont Yankee Opinion. Utah Law Review. 1980; 1980: 3–28.
[56] Gifford DJ. Administrative Law: Cases and Materials. 3rd edn. West Publishing: St. Paul, MN. 1992.
[57] Council of State Administrative Law Chambers Assembly (Danıştay İDDK). Decision No: E.2021/2425, K.2022/1244. 6 April 2022.
[58] Belkayalı N, Aydın M. Recreational use of water resources in Küre Mountains National Park. Turkish Journal of Agriculture - Food Science and Technology. 2016: 4: 893–902. https://doi.org/10.24925/turjaf.v4i10.893-902.962.
[59] EUROPAWORLD. International Code on Pesticide Use Adopted in Rome. 2002. Available at: http://www.europaworld.org/week104/internationalcode81102.htm (Accessed: 12 September 2025).
[60] Hayes TB, Collins A, Lee M, Mendoza M, Noriega N, Stuart AA, *et al*. Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses. Proceedings of the National Academy of Sciences of the United States of America. 2002; 99: 5476–5480. https://doi.org/10.1073/pnas.082121499.
[61] Turkoglu ÜK. The Beginning of a New Era: The European Green Deal and Its Effects on Turkish Environmental Law and Policies. Memleket: Politics & Administration. 2021; 16: 329–366. (In Turkish)
[62] Pellegrino N. A Gap in Causation? Punishing Polluters for Contributing to Climate Change & Increasing Violent Crime. Pace Enviromental Law Review. 2018; 35: 375. https://doi.org/10.58948/0738-6206.1819.
[63] Alewijn M, Goemans P, Gussow KE, Turner KJ, Pustjens AM. An Analysis of the Severity of Food Safety Hazards in EU Food Fraud Cases. Foods. 2025; 14: 4328. https://doi.org/10.3390/foods14244328.
[64] Whitehead AJ. Elements of an Effective National Food Control System. Food Control. 1995; 6: 247–251. https://doi.org/10.1016/0956-7135(95)00028-P.
[65] de Bertoldi M. Genotoxic effects of pesticides. European Journal of Cancer Prevention. 1996; 5: 397–399.
[66] TÜBİTAK. 2005 Food Study Programme (Food 3rd Call). European Union Sixth Framework Programme Studies. Dicle University: Diyarbakır. 2004. (In Turkish).
[67] Hashemi SM, Hosseini SM, Hashemi MK. Farmers' perceptions of safe use of pesticides: determinants and training needs. International Archives of Occupational and Environmental Health. 2012; 85: 57–66. https://doi.org/10.1007/s00420-011-0641-8.
[68] Guloglu Y, Yargıcı R. Government Liability to Damages Due to Defective Provision of Health Services in Turkey. Jurnal Cita Hukum. 2022; 10: 447–472.
[69] Yasin M. Giving Legal Effect To Unlawful Administrative Decisions. European Review of Public Law. 2024; 36: 883.
[70] Tuncomag K. Law of Obligations. Journal of Istanbul University Law Faculty. 2011; 29: 374–395. (In Turkish)
[71] Akyılmaz B. Public Damage and Recourse in Public Damage. Istanbul University Faculty of Law Journal. 2011; 69: 421–452.
[72] Bawa AS, Anilakumar KR. Genetically modified foods: safety, risks and public concerns-a review. J Food Sci Technol. 2013; 50(6):1035-46. https://doi.org/10.1007/s13197-012-0899-1.
[73] Constitutional Court. Individual Application Decision No: 2018/43. Official Gazette. 30 May 2018. Available at: https://www.resmigazete.gov.tr (Accessed: 19 December 2025).
[74] Hellman J. The Fifth Crime Under International Criminal Law: Ecocide? In Brodowski D, Espinoza de los Monteros de la Parra M, Tiedemann K, Vogel J (eds.) Regulating Corporate Criminal Liability (pp. 273–280). Springer: Cham. 2014.
[75] Akyılmaz B, Sezginer M, Kaya C. Turkish Administrative Litigation Law. Savaş Publishing House: Ankara. 2018.
[76] Gülan A. Main principles and fundamental institutions of our mining administration law: an attempt at a critical approach in light of legislation and judicial decisions. Lamure. 2008. (In Turkish)
[77] Kaypak S. The Role of Liability Law in Environmental Protection. Liability and Compensation Law Symposium (pp. 309–346). 2009. (In Turkish)
[78] Belkayalı N. Identifying and Assessing Visitor Impacts And Attitudes: A Case Study in the Kure Mountains National Park. Fresenius Environmental Bulletin. 2015; 24: 3044–3056.
[79] Jabali Y, Millet M, El-Hoz M. Spatio-temporal distribution and ecological risk assessment of pesticides in the water resources of Abou Ali River, Northern Lebanon. Environmental Science and Pollution Research International. 2020; 27: 17997–18012. https://doi.org/10.1007/s11356-020-08089-5.
[80] Belkayalı N, Kaymaz I. Acoustic Environment of Urban Historical Places: A Case Study in Kastamonu, Turkey. Sustainability. 2021; 13: 8423. https://doi.org/10.3390/su13158423.
[81] Fleming RC, Mauger R. Green and Just? An Update on the 'European Green Deal'. Journal for European Environmental & Planning Law. 2021; 18: 164–180. https://doi.org/10.1163/18760104-18010010.
[82] Krämer L. Planning for Climate and the Environment: The EU Green Deal. Journal for European Environment & Planning Law. 2020; 17: 267–306. https://doi.org/10.1163/18760104-01703003.
[83] Winter G. Armando Carvalho and Others v. EU: Invoking Human Rights and the Paris Agreement for Better Climate Protection Legislation. Transnational Environmental Law. 2020; 9: 137–164. https://doi.org/10.1017/S2047102520000072.
[84] Öztaş D, Kurt B, Koç A, Akbaba M, İlter H. Knowledge Level, Attitude, and Behaviors of Farmers in Çukurova Region regarding the Use of Pesticides. BioMed Research International. 2018; 2018: 6146509. https://doi.org/10.1155/2018/6146509.
[85] Turgut N. Environmental Law. Ankara. 2001. (In Turkish)
[86] Council of state 6.D, 28.05.1996, E. 1995/5023, K. 1996/2558,

KY.
[87] Ulusoy A.D. General View of Civil, Criminal, and Administrative Law Solutions in the Stage Following the Occurrence of Environmental Pollution. Ankara University Faculty of Law Journal. 1993; 43: 125–142. (In Turkish)
[88] Duymaz E. Contribution of the European Court of Human Rights to the Protection of the Environment. Istanbul University Faculty of Political Sciences Journal. 2012; 47: 121–160.
[89] Yalcin CE. The Eligibility of the Right to Environment for Individual Application before the Constitutional Court and the Approach of the European Court of Human Rights to the Issue. Sakarya University Faculty of Law Journal. 2021; 9: 89–115. (In Turkish)
[90] Isık S. Effective Protection Mechanisms in Compensation Cases Arising from Environmental Damages in Terms of Civil Procedure Law: Problems and Solution Proposals [H]. 2025. (In Turkish)