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The "One Health" approach is a comprehensive, integrated scientific framework that redefines health as a unified system grounded in the structural interconnections among human, animal, plant, and environmental health. It aims to achieve a sustainable balance and comprehensive improvements in health and environmental well-being, starting from the recognition that these components are not independent domains but rather interwoven systems that structurally depend on one another. This concept is grounded in a global institutional vision adopted by the international Quadripartite Partners composed of: (1) the Food and Agriculture Organization of the United Nations (FAO), represented by the International Plant Protection Convention (IPPC), in its role in protecting plant health; (2) the World Organisation for Animal Health (WOAH) in protecting animal health; (3) the World Health Organization (WHO) in protecting human health and preventing transboundary health risks; and (4) the United Nations Environment Programme (UNEP) in protecting ecosystems and ensuring the sustainability of natural resources. These partners work collectively to mainstream the One Health approach as a strategic tool for preventing global health threats, anticipating them, ensuring their early detection, coordinating responses, and promoting sustainable development. In this context, plant health is no longer a narrow technical agricultural field, but has become a structural component of the architecture of global health, as it represents a point of convergence between food and the environment. This article addresses a set of aspects that embody this structural interconnection and cannot be understood or managed except within a single, integrated perspective that makes plant health an active component of the global prevention system, rather than merely a productive sector within the agricultural economy.

Pesticide residues constitute one of the most important pathways for health risks arising from unregulated agricultural practices, not because of the presence of pesticides themselves, but because of their improper use. The source of risk is basically embodied in two specific technical factors: first, failure to comply with the scientifically recommended doses recorded on pesticide labels, whether through deliberate increase or through the uncalculated accumulation of treatments; and second, failure to respect the safety period separating the last pesticide treatment from the harvest date, which is the period necessary for the active substance to degrade to biologically safe levels. These two factors directly lead to exceeding the Maximum Residue Limit permitted in plant food products, a limit set based on studies assessing health risks to consumers. This exceedance results in the transfer of risk from the agricultural domain to the health domain, where contaminated plant products become a source of exposure for humans and animals to toxic compounds with cumulative effects, including disorders of the liver and nervous system, hormonal disruptions, reproductive effects, and increased susceptibility to chronic diseases. This pathway is not merely a technical defect in agricultural practice; it is a mechanism that generates health risks within the food chain and makes the control of pesticide use a public health issue in the full sense of the term, not simply a matter of agricultural regulation.

Mycotoxins (fungal toxins) are extremely dangerous sources of food contamination and are complex biological compounds, as they are secondary metabolic products produced by phytopathogenic fungi during crop infection or during the storage and transport of plant products. The fungi producing these toxins mainly belong to genera widely distributed in agricultural and food systems, such as Aspergillus species producing aflatoxins and ochratoxins; Fusarium species producing fumonisins, zearalenone, and trichothecenes; Penicillium species producing patulin and citrinin; and *Alternaria* species producing alternariol and altertoxins. These fungi are directly associated with plant diseases affecting cereals, fruits, legumes, and other crops, and simultaneously contaminate human and animal food with chemically stable toxins, many of which are not affected by heat or industrial processing. The danger of mycotoxins is determined by their high capacity for bioaccumulation and their chronic, multi-organ toxic effects, including hepatotoxicity, immunosuppression, hormonal disorders, embryonic malformations, and carcinogenicity, making them a health risk in food chains. The production of these fungal toxins is influenced by specific environmental and agricultural factors, including fungal species, humidity, temperature, and plant stress, as well as improper storage conditions such as high moisture, poor ventilation, and long storage periods, which turn food preservation systems into active environments for toxin production. The risk is not limited to the health of the final consumer, but also extends to wide agricultural and economic losses due to crop damage and quality deterioration. Reducing this risk cannot be achieved through partial technical solutions, but rather requires an integrated preventive approach that begins in the field and extends to storage and distribution, through the application of good agricultural practices, including the reduction of plant stress, integrated fungal disease management, genetic selection of resistant varieties, harvesting at the appropriate time, rapid drying, and storage under controlled conditions of humidity, temperature, and ventilation, in addition to systems of monitoring and periodic analysis of mycotoxins in food products. Thus, mycotoxins represent a precise model of the interconnection between plant health and animal and human health, in which plant disease is transformed into a health risk through a continuous environmental-food pathway that can only be interrupted by integrated management of the agri-food system.

Fungi shared between plants, animals, and humans embody dangerous forms of biological overlap between health systems, as they represent a trans-species pathogenic pattern capable of exploiting agricultural and environmental domains. These fungi do not belong to a single disease system, but move within a connected ecological network that includes soil, water, air, and living organisms, benefiting from environmental stress, microbial imbalances, and weakened plant, animal, or human immunity. The genus *Paecilomyces* represents a structural model of this intertwined pathogenic pattern, particularly the species *Paecilomyces formosus*, which is characterized by its wide environmental distribution in soil, plants, insects, and nematodes, and by its ability to cause multi-system diseases across different hosts. At the plant level, this fungus is associated with tree and crop decline diseases, in which it invades roots and vascular tissues, disrupting the absorption of water and mineral elements and causing wilting, structural deterioration, and the gradual death of the plant. At the animal level, it causes multiple systemic and localized infections, including those of the respiratory system, skin, eyes, and nervous system. At the human level, this fungus is capable of causing a wide spectrum of diseases ranging from superficial and corneal infections to deep systemic infections, especially in immunocompromised individuals, and its treatment may require surgical intervention combined with antifungal drug therapy. Its danger lies not only in its pathogenic capacity, but in the fact that it is part of a single ecological system in which plants, animals, and humans share the same microbial space, making its transmission between hosts a natural outcome of ecosystem overlap rather than an accidental event. This dynamic also applies to other shared fungi such as *Fusarium solani*, *Rhizopus arrhizus*, and *Curvularia lunata*. Reducing this type of risk requires the adoption of an integrated preventive approach based on managing plant health as a component of comprehensive health prevention, through improving soil health, reducing plant stress, applying integrated fungal disease management, strengthening environmental epidemiological surveillance, integrating early warning systems, and coordinating between agricultural, veterinary, and human health sectors, in a way that limits the formation of pathogenic environmental reservoirs before their transfer to the animal and human domains. In this sense, plant health becomes a proactive preventive element within the One Health approach, rather than merely a productive field within the agricultural system.

Shared resistance to fungicides is one of the most dangerous structural problems at the intersection of plant, animal, and human health. It arises not from the identity of the chemical substances used, but from the identity of their molecular modes of action, despite differences in their chemical compositions. Agricultural fungicides and antifungal drugs used in human and veterinary medicine are, in most cases, chemically different compounds; however, many of them share the same molecular mode of action, as they target the same biological pathways inside the fungal cell. This leads to the emergence of a unified selective pressure on fungi in agricultural and environmental domains. The similarity in the mechanism of action constitutes the scientific basis of the phenomenon of cross-resistance, which is defined as the ability of a pathogen to exhibit resistance to a compound to which it has not been directly exposed, solely because it shares the same mode of action as another compound to which it was previously exposed. This is clearly exemplified by pesticides and drugs belonging to the family of Azoles, which are widely used as agricultural fungicides to protect crops and, at the same time, as medical antifungals for the treatment of humans and animals. Despite differences among the agricultural and medical molecules in this group, they all target the same key enzyme in the biosynthetic pathway of ergosterol, the main structural component of the fungal cell membrane. With the intensive and repeated use of Azoles in agriculture, environmental fungi are subjected to continuous selective pressure, leading to the emergence of genetic mutations and regulatory modifications in their metabolic pathways, enabling them to resist this type of enzymatic inhibition. When these resistant strains enter the human or animal health domain, medical treatments targeting the same mechanism of action become ineffective, even if the fungus has not previously been exposed to the drug itself. Thus, agricultural fields are transformed into evolutionary spaces for the production of drug resistance, and the agricultural system becomes an indirect part of the equation of medical treatment failure. This dynamic reveals that fungal resistance is not merely a therapeutic issue, but a multi-sectoral environmental and evolutionary phenomenon that requires integrated management, including the regulation of agricultural fungicide use, rotation of modes of action, reduction of selective pressure, and coordination of agricultural, veterinary, and human health policies within the One Health framework, as the only framework capable of addressing this phenomenon in an integrated manner rather than as an isolated sectoral problem.

Soil, organic and mineral fertilizers, and the microbial systems associated with them constitute the most important pathways for the transmission of health risks within the agri-food system, where soil is simultaneously transformed from a productive medium into a dynamic environmental reservoir for pathogenic organisms and biological and chemical contaminants. Agricultural soil is not merely a physical medium for plant growth but a complex ecosystem containing microbial communities, chemical residues, and toxic mineral elements that can bioaccumulate and be transferred through food chains. This risk increases with the unregulated use of organic fertilizers, especially untreated animal manure, which may carry human and animal pathogens such as *Escherichia coli*, *Salmonella*, *Listeria monocytogenes*, and *Clostridium* spp., as well as parasites such as *Toxoplasma gondii* and *Cryptosporidium*. Excessive use of chemical fertilizers, such as nitrogenous and phosphate fertilizers, also contributes to ecological imbalance, as it can lead to groundwater contamination with nitrates, which are considered carcinogenic to humans. In addition, heavy metals such as lead, cadmium, mercury, and arsenic represent silent contaminants that accumulate in soil as a result of irrigation with water polluted by industrial waste, and are transferred to plants and then to humans and animals through the food chain, causing neurotoxic, renal, and hepatic effects, hormonal disorders, and long-term carcinogenicity. When these biological and chemical elements are introduced directly into the soil without rigorous scientific methods, agricultural fields become open epidemiological and toxicological reservoirs, from which risks are transferred to plants through roots and leaf surfaces, and then to humans and animals through food and water. Reducing these risks requires the adoption of a comprehensive preventive approach based on the sanitary management of soil as both an epidemiological and toxic element, through regulating the use of organic and mineral fertilizers, enforcing mandatory biological treatment of organic fertilizers, rationalizing chemical fertilization, monitoring the accumulation of heavy metals, and periodically analyzing soil quality and irrigation water. In this sense, soil is transformed from a neutral element in the agricultural system into a strategic axis for comprehensive health prevention, where controlling its microbial and chemical systems becomes a fundamental part of health, food, and environmental security.

It is particularly striking that approximately 15% of the world's countries permit the use of antibiotics in the agricultural sector (for example, for the control of fire blight in pome fruits), despite the absence of any rational basis to justify treating these compounds as legitimate tools in plant health management. Antibiotics are not plant protection products, nor do they fall within the logic of agricultural protection; rather, they are therapeutic medical compounds designed to combat bacterial infections in humans and animals. Their use in agricultural fields not only represents a deviation from rational logic but also transforms agricultural ecosystems into spaces where therapeutic compounds are applied outside their natural functional context. Even more problematic is the resort by some countries to the use of antibiotics to control certain fungal plant diseases (such as mildew, Fusarium wilt, Rhizoctonia rot) instead of specialized fungicides, a practice that lacks any logical basis, since antibiotics target bacteria, whereas fungi possess fundamentally different cellular structures and metabolic pathways, making such intervention unjustified. Permitting the use of antibiotics in agriculture does not constitute a mere technical choice, but rather a structural flaw in the logic governing the relationship between plant health and animal and human health, which necessitates a strict re-framing of the role of drugs in the agricultural system, within the One Health vision, where a functional separation is supposed to exist between tools of plant protection and tools of medical therapy, in order to protect ecosystems and preserve medicines from functional deviation.

Antimicrobial resistance (AMR) represents one of the most dangerous structural threats to global health in the twenty-first century, not merely as a medical phenomenon but as a comprehensive ecological system that reshapes the relationships among humans, microbes, and the environment. Antimicrobial resistance is not simply therapeutic failure, but a direct result of long-term selective pressure exerted by human activities on microbial systems through medicine, agriculture, animal husbandry, food industry, and water and environmental management. Bacterial resistance arises mainly through two integrated principal biological pathways. The first consists of intrinsic genetic mutations arising from replication errors during bacterial replication, leading to the emergence of resistant strains; over time, resistant strains persist while sensitive strains gradually disappear, in a process that leads to the fixation of resistance within bacterial populations. The second pathway is horizontal gene transfer, which is more dangerous and more rapid at spreading resistance, whereby ready-made resistance genes are transferred between bacteria via mobile genetic elements, including plasmids and bacteriophages (viruses that infect bacteria). These mechanisms allow the transfer of resistance not only within a single bacterial species but also between different bacterial species and even genera. This enables the movement of resistance among different bacterial types within soil, water, plants, and the bodies of animals and humans. Agricultural and food ecosystems play a central role in this dynamic, as soil, irrigation water, fertilizers, animal waste, and wastewater are transformed into environmental reservoirs of resistance genes, from which they are transmitted into food chains and to human and animals. This phenomenon is embodied in clear examples such as multidrug-resistant bacteria in fresh foods, antibiotic-resistant strains in aquatic environments, and the transfer of resistance genes from non-pathogenic environmental bacteria to pathogenic bacteria through mechanisms of horizontal gene transfer. Thus, antimicrobial resistance constitutes a health crisis that transcends sectoral boundaries and cannot be addressed through isolated medical interventions, but rather requires a comprehensive approach that reorganizes the relationship between human, microbes, and the environment through rationalizing antimicrobial use in all sectors, regulating agricultural and food activities, protecting ecosystems, monitoring environmental reservoirs of resistance, and unifying health, agricultural, and environmental policies within the One Health framework, as the framework capable of dismantling the complex structure of this phenomenon and dealing with it as a globally interconnected system rather than as a separate sectoral problem.

Disease vectors are intermediate living organisms that transmit pathogens between hosts, and they are primarily invertebrates, especially insects and arachnids such as mosquitoes, flies, fleas, and ticks, which constitute a structural component of the epidemiological cycle of infectious diseases. These vectors are not independent elements of the plant system; rather, many of them depend biologically on flowering plants as a primary source of sugars through nectar, which is an essential nutritional element in their life cycle, reproduction, and ecological survival. This makes plants an indirect component of vector dynamics and their spread, those plants that are themselves exposed to the use of agricultural pesticides. Within this ecological interconnection, the phenomenon of shared insecticide resistance emerges as one of the most dangerous structural challenges in vector management, resulting from the intensive and repeated use of chemical groups with identical modes of action, such as pyrethroids, organophosphates, carbamates, and neonicotinoids. This continuous selective pressure has led to the development of genetic mutations, enzymatic changes, and detoxification mechanisms within insect bodies, enabling them to neutralize or bypass the effects of these insecticides. In this sense, the dynamics of cross-resistance appear within insecticide groups, whereby insects become resistant to multiple compounds that share the same targeted biochemical pathways, even if their chemical structures differ. The impact of this resistance is not limited to the failure of agricultural pest control, but directly affects the effectiveness of public health programs by weakening vector control and increasing the risk of insect-borne disease transmission. Thus, insecticide resistance is transformed from a technical problem in pest management into a structural issue in health security, where vector control becomes an integrated ecological and biological matter that cannot be separated from plant health, nor from the One Health logic that links ecosystems and public health within a single network of living interactions.

The One Health approach is no longer simply a theoretical framework, but has become an organizational model for rebuilding the concept of health as an integrated living system in which human, animal, plant, and environmental health are intertwined within a single network of biological and ecological interactions. However, the historical trajectory of the application of this concept reveals that human health and animal health have preceded plant health in positioning within this framework, whether at the level of policies, scientific research, international programs, or mechanisms of funding and intervention. This has led to a strong presence of the medical and veterinary sectors in shaping the One Health approach, facing a relatively weaker representation of plant health, despite its structural role in food security, environmental safety, and public health. Nevertheless, this structural imbalance has begun to undergo a gradual transformation, as plant health has started to reposition itself within the global health system as a fundamental preventive pillar rather than merely a productive sector. This transformation is embodied in the special program launched by the International Plant Protection Convention, which aims to strengthen the integration of plant health within the One Health approach through policy development, capacity building, improved inter-sectoral coordination, and the reinforcement of the role of plant protection in safeguarding public health, the environment, and global food security. Through this new trajectory, plant health is no longer a subordinate element in the equation of comprehensive health, but a strategic actor in its preventive construction, where the plant is transformed from a productive organism into a protective element, and from a food resource into a first line of defense within the global health prevention system. The construction of true One Health cannot be completed unless plant health is integrated as a structural component in the architecture of global health, not as a complementary sector, but as one of its fundamental pillars, within a long-term preventive vision that reorganizes the relationship between human, the environment, and living organisms within a new model of sustainable health.

Within the Kingdom of Saudi Arabia, since the establishment of the National Center for the Prevention and Control of Plant Pests and Animal Diseases (Weqaa Center) in 2021, affiliated to the Ministry of Environment, Water and Agriculture, and as the national organization responsible for plant and animal health, Weqaa Center has established a specialized One Health Directorate. This directorate is responsible for studying, documenting, and managing the One Health approach, promoting coordination and integration among sectors concerned with human, animal, plant, and environmental health, supporting information exchange, early warning, and joint response to health risks, in addition to contributing to the development of national policies and programs, capacity building, and cooperation with national and international entities related to the One Health approach.

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