

Synthesis of the country-surveys

This synthesis compiles evidence from 13 contrasting European, Mediterranean, and Near East countries—**France, Sweden, Finland, Czechia, Croatia, Portugal, Türkiye, Albania, Serbia, Bosnia and Herzegovina (BiH), Egypt, Morocco and UK**. Conducted under the framework of COST Action CA21134 (**T0P-AGRI-Network: "Towards zero Pesticide AGRiculture"**), these country surveys map the current status of plant protection, national pesticide sales trajectories, regulatory frameworks, technological innovations, and the structural drivers and barriers governing the transition toward preventive and agroecological crop protection.

Across all 13 nations, a central consensus emerges: **achieving a sustainable, low-input transition cannot be accomplished through simple "input substitution" (replacing a synthetic chemical spray with a biological product)**. Rather, successful transitions require a fundamental redesign of cropping systems, supported by robust digital supply-chain traceability, expanded independent advisory capacity, and value-chain de-risking mechanisms that compensate farmers for economic transition risks.

1. Overall Trajectories in Pesticide Use and Differences Among Countries

From the country surveys, national trajectories reveal a clear distinction between established EU Member States, accession/candidate countries, and non-EU Mediterranean partners:

Group A: Established EU Member States

- **France:** Demonstrates a qualitative shift in pesticide risk rather than a simple volumetric decline. Total active substance sales volume has remained relatively stable due to the heavy use of mineral inputs allowed in organic farming (micronized sulfur and copper). However, **Category 1 Carcinogenic, Mutagenic, or Reprotoxic (CMR) hazardous substances fell to just 0.1% of sales in 2023** (total CMRs dropped from 32% in 2010 to 16% in 2023). Biocontrol and organic inputs expanded from 14% (2009) to 36% (2023) of sales. The national *Dephy-Ferme* network of 3,000 volunteer farms proved that reducing Treatment Frequency Index (TFI) by 18%–38% (-29% to -46% in 2020) is achievable without lowering farm productivity or economic returns.
- **Czechia:** Achieved one of the EU's most significant reductions in pesticide sales, with reported active substance use on agricultural land **falling by 38% between 2011 (5.31M kg) and 2025 (3.29M kg)**. Harmonised Risk Indicator 1 (HRI 1) dropped to 25 in 2024 against a 2011–2013 baseline of 100. Herbicides comprise 51.5% of active substances used, followed by fungicides (31.9%), growth regulators (14.0%), and insecticides (2.1%). However, HRI 2 remains volatile (70 in 2024) due to periodic emergency authorisations, and pesticide metabolites remain frequently detected in groundwater.
- **Croatia:** Targets a **25% reduction in pesticide use by 2030** under its national Agriculture Strategy. Under the CAP Strategic Plan 2023–2027, result indicator R.24 PR targets 12.63% of utilised agricultural area (UAA) under sustainable pesticide commitments by 2028, supported by targeted eco-schemes like Intervention 70.01 for permanent crops.
- **Portugal:** Displays a perennial-crop profile (vineyards, olive groves, pome/stone/citrus fruit) where active substance sales reached 8,359 t in 2024 (-16.4% vs. 2015). **Fungicides and bactericides dominate sales at 52.7% (4,401 t)**—well above the EU average of 40%—driven by heavy, recurrent fungal and oomycete disease and bacterial pressure (*Plasmopara viticola*, *Erysiphe necator*, *Venturia oleaginea*, *Venturia inaequalis*, *Erwinia amylovora*).
- **Sweden & Finland:** Focus on preventative, agroecological cropping system redesign. Sweden emphasizes overcoming system lock-in, managing non-crop habitats, expanding landscape-level crop diversity, and combining mechanical and

biological control with decision support systems (DSS). Finland utilizes research frameworks under the Natural Resources Institute Finland (Luke) to map national drivers, barriers, and stakeholder initiatives.

Group B: EU Accession and Candidate Countries

- **Türkiye:** Manages highly diverse agroecological zones through digital supply-chain governance, using the Plant Protection Products Tracking System (BKÜTS) and electronic B-Prescription initiative to enforce central traceability and residue compliance across domestic and export markets.
- **Albania:** Uses less pesticide per hectare than the EU average (~300 t active ingredient in 2023). However, **fungicides account for 35–67% of inputs** due to intense disease pressure in its expanding greenhouse vegetable sector (1,800+ ha) and fruit orchards. On-farm residue monitoring detected MRL exceedances in 42.3% of leafy vegetables and 18.8% of peppers, revealing multi-residue contamination and unauthorized substances (e.g., chlorfenapyr, DDT, chlorpyrifos).
- **Serbia:** Relies primarily on conventional chemical pesticides across intensive cereal, fruit, and vegetable farming. Policy priorities are shifting from crude volume reduction toward achieving a real decrease in residues, human exposure, and environmental risk.
- **Bosnia and Herzegovina (BiH):** Faces severe environmental pollution risks in sensitive karst ecosystems (Herzegovina) due to conventional pesticide application. Conversely, low historical input use in regions like Republika Srpska leaves large areas of unpolluted "virgin land" well-suited for organic transition.

Group C: Southern Mediterranean and non-EU Partners

- **Morocco:** Combines rainfed cereal/legume smallholders with intensive, export-oriented irrigated orchards and greenhouse horticulture. Chemical treatments dominate intensive systems. Under Law 34-18, 63 active substances have been withdrawn since 2018 and 13 restricted. Export markets (GLOBALG.A.P.) drive compliance, whereas domestic markets lack price signals for low-pesticide products.
- **Egypt:** Experienced an increase in pesticide use from 4,823 t in 1999 to an estimated 9,469 t in 2022 (application intensity rising from 1.38 to 2.33 kg/ha). Operating under extreme land and water constraints (Nile Valley/Delta comprises 4% of land hosting 95% of the population) and tight export MRL compliance pressure (grapes, strawberries, citrus), Egypt is implementing a 6-layer decision hierarchy prioritizing stress prevention, soil/root health, and biological control before targeted chemical use.
- **United Kingdom:** Under NAP 2025 and England's Farming Roadmap 2050, the UK promotes IPM and precision technologies. The Sustainable Farming Incentive (SFI 2026) offers payments for sensor-guided herbicide spraying, variable-rate inputs, and mechanical robotic weeding.

2. The country reports also showed the contrasting situations regarding governance and regulatory alignment

Indeed, the pace and structure of crop protection transitions are strongly shaped by national regulatory environments and geopolitical alignment:

- **Established EU Member States (France, Finland, Croatia, Portugal, Sweden, Czechia):** Enforce the EU Sustainable Use Directive (SUD) and Regulation (EC) 1107/2009 through National Action Plans. **France** demonstrates an advanced transition where Category 1 Carcinogenic, Mutagenic, or Reprotoxic (CMR) hazardous active substances were virtually eliminated (0.1% of sales in 2023) and

biocontrol/organic inputs reached 36% of sales. **Croatia** has embedded a 25% pesticide reduction target by 2030 into its national development strategy and enacted the operational 2025 Ordinance on Integrated Pest Management (IPM). **Portugal** operates under its updated National Action Plan (PANUSPF 2025–2030), where fungicides dominate sales (52.7%) due to severe, recurrent fungal disease pressure in perennial vineyards and olive groves. **Finland** contributes to mapping national status, barriers, and drivers through Luke's research framework. **Czechia** has revised the national plan and is also supporting a national plan in favour of the organic farming

- **EU Candidate and Accession Countries (Türkiye, Albania, Serbia, BiH):** Are actively harmonizing national laws with the EU acquis, though administrative hurdles persist. **Türkiye** enforces Law No. 5996 and leads in centralized digital tracking. **Albania** transposed EU plant health rules via Law No. 40/2025, mandates on-farm PPP registers, and provides 0% VAT and 50–70% subsidies for biological control inputs. **Serbia** structures its transition around four pillars (Organic, IPM, Biological protection, Education) but faces slow biopesticide registration procedures. **BiH's** alignment is severely delayed by a complex four-tier administrative structure (state, entity, canton, municipality) and unadopted national plant health laws.
- **Southern Mediterranean Export Partner (Egypt):** Governed by Ministerial Decree No. 974/2017 under the Sustainable Agricultural Development Strategy 20302526. Egypt faces tight land/water constraints and high residue compliance pressure for high-value export chains (grapes, strawberries, citrus), supported by QCAP's extensive ISO-accredited testing infrastructure.

As part of the national policies, it is worth mentioning some fiscal incentives:

- **Albania's Fiscal Framework:** combines a **0% VAT rate on imported biological control organisms** with direct subsidies covering **50%–70% of biocontrol input costs** under the National Agricultural Support Scheme. Supported by donor programs (GIZ, FAO), biocontrol has been scaled across 2,500 ha of greenhouse vegetables (*Encarsia formosa*, *Phytoseiulus persimilis*, *Tuta absoluta* pheromones/Bt) and chestnut forests (*Torymus sinensis* releases).
- **Egypt's Farmer Field Schools (FFS):** FAO-MALR FFS trained 40 facilitators and 225 farmers in non-chemical management of Fall Armyworm and Red Palm Weevil.

3. Main Lessons on Crop Protection Transitions

Lesson 1: Downstream Economics and Market Valorisation Are Primary Bottlenecks

Across all surveyed countries, the primary barrier to adopting non-chemical alternatives is rarely the total absence of technical solutions. Stakeholders consistently report that workable biological, biotechnical, or cultural options exist, but adoption is blocked downstream by **high transition costs, farm-level economic risks, lack of price premiums or market recognition for low-residue produce, and farmer risk aversion**. Small, fragmented farm structures (e.g., Albania's 1.2 ha average; BiH; Croatia) further restrict investment capacity.

Lesson 2: Advisory Capacity and Technical Support Are Essential

Non-chemical alternatives are knowledge-intensive and slower-acting than broad-spectrum chemical sprays. A severe shortage of trained field advisers, lack of decision-support thresholds, and insufficient technical follow-up represent major bottlenecks in Portugal, Serbia, BiH, Albania, and Egypt. Farmers require continuous field-level coaching, local diagnostic validation, and demonstration networks (such as Farmer Field Schools or *Dephy-Ferme* groups) rather than simple input availability. In Morocco, 41.7% of farmers rely on inputs distributors as their primary advisory source, yet rate them as the least trusted channel due to sales conflicts of interest.

Lesson 3: From Simple Input Substitution to Systemic Redesign and Traceability. The role of research and innovation.

Effective transitions require moving beyond substituting synthetic chemicals with biological products. National strategies highlight two complementary innovation pathways:

1. **Digital Traceability & Precision:** Türkiye's centralized tracking (BKÜTS), Croatia's *eMotrenje* IoT sensor network (695 sensors across 400+ locations), Albania's mandatory on-farm PPP registers, and Egypt's QCAP residue intelligence demonstrate how digital monitoring enhances transparency and targeted protection. UK combines earth observation, UAV multispectral weed detection and mapping, electrical weed control, AI volatile organic compounds sensors for pest and disease detection and farm-scale monitoring at Wyke Farm Platform.
2. **Biologicals.** Research and innovation in many countries have a strong component related to development of new biologicals, either based upon the understanding of the microorganism community (microbiota) or on the odorscapes which determine the sexual and feeding behaviour of insects. National research projects are supported, as it is the case in France. Morocco promotes indigenous biocontrol, such as native entomopathogenic nematodes (*Steinernema feltiae*, *Heterorhabditis bacteriophora*) which reduce root-knot nematode galling on tomato by 80%, alongside biofumigation, solarization, and resistant rootstocks.
3. **Plant breeding.** Breeding for resistance has been a long run for most crops. More emphasis is paid to this issue, both in research (several WG participants), in private research and at the step of variety registration (national regulation and national examination offices).
4. **Systemic De-Risking & Redesign:** France provides a model for multi-tiered national programs: anticipating active substance withdrawals (*PARSADA*, €225M+), engaging agricultural cooperatives in territorial risk-sharing (*PRAAM*), and funding long-term pesticide-free research (*PPR*). Czechia's Intercropping & Agroforestry participates in Horizon Europe's *LEGUMINOSE* project (cereal-legume intercropping to suppress cereal leaf beetles, aphids, and rusts) and integrates agroforestry as an operational IPM component

Lesson 4: Progress Must Be Evaluated Beyond Crude Sales Volume

Surveys from France, Serbia, and Egypt emphasize that evaluating transition progress strictly by total pesticide tonnage is scientifically misleading. High-volume applications of heavy mineral inputs (e.g., micronized sulphur or copper) can distort volume metrics while masking significant reductions in toxicological risk. Future governance must instead focus on **eliminating hazardous active substances (such as Cat 1 CMRs), reducing environmental and dietary exposure, managing resistance, and adopting toxicity-based risk indicators** like France's proposed Aggregated Total Applied Toxicity (ATAT) metric

Summary Conclusion

Achieving a low-pesticide transition requires moving beyond simple input substitution. Sustainable success depends on combining **digital supply-chain traceability, cooperative-led risk-sharing mechanisms, strengthened advisory networks, and market valorisation of low-residue agricultural produce**

Strategic Conclusion and Outlook for COST Action CA21134

Achieving a low-pesticide transition requires moving beyond simple input substitution. Sustainable success depends on combining several levers all along the supply chains, from research and innovation to markets, from biology to regulations and public policies.

The synthesis of these 13 country surveys demonstrates that European and Mediterranean agricultural systems possess a wealth of validated non-chemical tools, digital monitoring networks, and legislative frameworks. However, **the zero-pesticide transition is currently bottlenecked not by a lack of basic biological science, but by structural implementation**

gaps: uncompensated farm-level economic risks, lack of price premiums for low-/no-residue products, fragmented advisory services, and outdated regulatory frameworks that slow the approval of biological alternatives.

To unlock future progress, COST Action CA21134 and national policy-makers must align around four priority actions:

1. **Establish Coordinated Multi-Actor Risk-Sharing:** Replicate territorial risk-sharing models (such as France's PRAAM program) where agricultural cooperatives, processors, and retailers share the economic and yield risks of pesticide reduction with farmers.
2. **Institutionalize Digital Traceability & Advisory Networks:** Combine centralized supply-chain tracking (e.g., Türkiye's BKÜTS) and real-time IoT microclimate monitoring (e.g., Croatia's *eMotrenje*) with expanded Farmer Field Schools and independent field coaching.
3. **Modernize Registration & Fiscal Frameworks:** Fast-track regulatory approval for semiochemicals and biopesticides, while deploying fiscal levers like Albania's 0% VAT exemptions and 50%–70% direct biocontrol subsidies.
4. **Adopt Toxicity-Based Governance Metrics:** Replace crude volume reduction targets with scientifically grounded toxicity indicators (such as France's proposed Aggregated Total Applied Toxicity metric) to accurately measure risk reduction across human health, water resources, and non-target ecosystems

A summarizing table

Here is a comparative table detailing the **changes in pesticide use, technological innovations, advisory service models, and regulatory alignment steps** across the 11 countries which submitted a national report

Comparative Analysis Across the Surveyed Countries (in alphabetical order)

Country	Changes in Pesticide Use	Technological Innovations	Advisory Service Models	Regulatory Alignment Steps
Albania	• Lower pesticide use per hectare than EU average (~300 t active ingredient in 2023). • Fungicides account for 35–67% of inputs. • Residue surveys show MRL exceedances in 42.3% of leafy vegetables and 18.8% of peppers, with unauthorized/historical substances detected (chlorfenapyr, DDT, chlorpyrifos).	• Biological control in greenhouse vegetables (parasitoids <i>Encarsia formosa</i>, <i>Eretmocerus mundus</i>, <i>Aphidius colemani</i>, predatory mites <i>Phytoseiulus persimilis</i>, <i>Tuta absoluta</i> pheromones). • Forest biocontrol (<i>Torymus sinensis</i> releases for Asian chestnut gall wasp).	• Regional Agricultural Extension Agencies (AREB), Agricultural University of Tirana, and international donor projects (GIZ, FAO, P.L.A.N.T. Foundation). • Major gap: mandatory vocational training/certification system for professional users is not yet fully operational.	• Approximates EU acquis via Law No. 105/2016 and new Law No. 40/2025 "On Plant Health" (approximating EU Reg 2016/2031). • Mandatory on-farm Register of PPP Use (since 2022). • 0% VAT on imported biocontrol organisms and 50–70% direct subsidies under National Support Scheme.
Bosnia and Herzegovina (BiH)	• Conventional production relies heavily on chemical pesticides. • Uncontrolled applications pose severe pollution risks to sensitive karst ecosystems. • Low historical input in Republika Srpska leaves large areas of unpolluted "virgin land".	• Basic agroclimatic monitoring networks, pest forecasting systems, and non-chemical control methods. • Low overall technological equipment level and high dependence on imported inputs (seeds, fertilizers, pesticides, machinery).	• Public advisory services exist across entity and local levels. • Severely limited by low budget support, few field advisors, and low producer engagement. • Strategic priority to build basic advisory infrastructure and continuous employee education.	• Potential EU candidate harmonizing phytosanitary rules (<i>Law on Plant Health Protection</i>, <i>Law on Phytopharmaceuticals</i>). • Highly fragmented governance across 4 administrative levels with entity/state inconsistencies.

	• Residues monitored via GC-MS.			• Key national laws on plant health and official controls not yet adopted.
Croatia	• Agriculture Strategy to 2030 targets a 25% reduction in pesticide use. • CAP indicator R.24 PR targets 12.63% of UAA under sustainable pesticide commitments by 2028. • Subsidized non-chemical management in permanent crops under CAP Intervention 70.01.	• eMotrenje IoT monitoring network (695 sensors across 400+ locations) for agroclimatic and pest tracking. • Remote sensing, computer vision, AI, digital traps, and UAVs/drones for crop imaging (spraying legally constrained).	• Advisory organized under the Ministry's Directorate for Professional Support to Agricultural Development. • Integrated AKIS network linking HAPIH, universities, and EIP Operational Groups (Intervention 77.03). • Digital platforms: eAdvisor, eSurveillance, and eLearning.	• Enforces EU Plant Health (Reg 2016/2031) and Official Controls (Reg 2017/625). • Governed by the Act on Sustainable Use of Pesticides (46/2022) and operational Ordinance on IPM (65/2025). • Updated National Action Plan expected by end of 2026.
Czechia	• Reported PPP active-substance use on agricultural land fell by 38% between 2011 (5.31M kg) and 2025 (3.29M kg). • HRI 1 dropped to 25 in 2024 (2011–2013 = 100); HRI 2 stood at 70.	• Cereal-legume intercropping (<i>LEGUMINOSE</i>) increased • Precision PPP application (ZEMĚ II QL25020034), agroforestry, satellite/UAV imaging (DROMAS), and AI-supported monitoring.	• ÚKZÚZ Plant Health Portal and monitoring. • Mandatory certification/competence training, EIP-AGRI Operational Groups (intervention 53.77), National Rural Network, and independent advisory living labs.	• Enforces EU Directive 2009/128/EC and Regulation (EC) 1107/2009 via Act No. 326/2004 Coll. and third National Action Plan (NAP 2025–2029). • Biological protection subsidy programme 3.a.
Egypt	• Pesticide use rose from 4,823 t (1999) to ~9,469 t (2022) (intensity 1.38 to 2.33 kg/ha). • Intensive QCAP residue monitoring (>97,000 samples analysed Q1 2025) shows variable crop-specific MRL exceedances (2.96–9.75% across 8 vegetables).	• 6-layer decision hierarchy (stress prevention, crop design, root/soil health, early detection, biological intervention, targeted chemistry). • Precision weather stations, sensors, digital scouting, biopesticides, and AMF/PGPR/Trichoderma bio-amendments.	• MALR digital extension (<i>Hudhud</i> smart farmer assistant, e-platforms). • FAO-MALR Farmer Field Schools (FFS) for fall armyworm and red palm weevil. • Crop-specific multi-actor technical groups.	• Governed under Sustainable Agricultural Development Strategy 2030 and Agricultural Pesticides Committee (APC) Decree No. 974/2017. • Sustainable Pesticide Management Framework launched in 2024.

Finland	• Evaluates national crop protection status, drivers, and barriers through evidence reviews and stakeholder synthesis.	• R&D focusing on preventive, agroecological crop protection approaches and non-chemical practices.	• National stakeholder workshops and collaborative research organized by the Natural Resources Institute Finland (Luke).	• ISO/IEC 17025 QCAP testing and certified-applicator training systems. • Participates in the COST Action CA21134 (TOP Agri-Network) framework to evaluate national crop protection actions and EU alignment.
France	• Overall sales volumes remain relatively stable when cumulating chemical pesticides and biocontrol products (70 000 t) • Category 1 CMR hazardous substances fell to 0.1% of sales in 2023 (total CMRs dropped from 32% in 2010 to 16%). • Biocontrol and organic farming input sales expanded from 14% (2009) to 36% (2023), mostly micronized sulfur and copper. • The <i>Dephy-Ferme</i> network achieved 18%–38% Treatment Frequency Index (TFI) reductions (-29% to -46% in 2020) without impacting farm productivity or economic returns.	• Biocontrol and biostimulants accelerated through the <i>Grand Défi</i> (ABBA). • Research into chemical ecology, plant microbiota (<i>PPR Cultiver et Protéger Autrement</i>), and agricultural robotics. • System redesign anticipating active substance withdrawals (<i>PARSADA</i>, €225M+).	• Ecosystem combining public research (INRAE/CIRAD), 17 technical institutes (ACTA), farmer-chaired Chambers of Agriculture, and agricultural cooperatives. • Dedicated technical support for volunteer networks (<i>Dephy-Ferme</i>). • Cooperative-led upstream-downstream risk-sharing and training to scale low-input practices (<i>PRAAM</i>).	• Enforces the EU Sustainable Use Directive (SUD) via national <i>Ecophyto</i> plans. Last update in 2024. • Active substance evaluation managed by ANSES. • Scientific proposal to adopt the Aggregated Total Applied Toxicity (ATAT) metric over HRI-1 or NODU.

Morocco	• Chemical treatments dominate intensive and export-oriented systems. • Under Law 34-18, 63 active substances have been withdrawn since 2018 and 13 restricted.	• Native entomopathogenic nematodes (<i>Steinernema feltiae</i>, <i>Heterorhabditis bacteriophora</i>) reduce tomato root-knot nematode galling by 80%. • Biofumigation, solarization, resistant rootstocks, and legume intercropping in almond orchards.	• Input distributors are the primary advisory source (41.7%) but trusted least (advisory market failure). • Extension supported by ONCA, INRA, and ONSSA. • <i>Génération Green 2020–2030</i> target to connect 2 million farmers to digital platforms.	• Law 34-18 on plant protection products (enables minor-use extensions). • ONSSA phytosanitary index and market oversight.
Portugal	• Total sales reached 8,359 t of active substance in 2024 (-16.4% vs. 2015). • Fungicides and bactericides dominate sales at 52.7% (4,401 t), driven by recurrent fungal/oomycete diseases in perennial crops. • High fungicide share reflects disease-dominated warning circulars.	• Biological control (parasitoid releases in cucumber/apple/pear/greenhouse tomato, <i>Torymus sinensis</i> in chestnut, <i>Tamarixia dryi</i> in citrus). • Semiochemicals (mating disruption for codling moth and <i>Lobesia botrana</i>), biopesticides (citrus essential oil, nettle extract), and robotic weeding in cereals.	• National Agricultural Warning Service (SNAA) operated by DGAV and Regional Warning Stations issuing circulars. • Supported by advisory sector (AAPIM), higher education/research, and public administration. • Key gaps: urgent demand for more field visits, closer technical follow-up, and decision support.	• Transposed EU SUD via Law No. 26/2013 (<i>PANUSPF</i>). • Second plan revision (2025–2030) approved under Ordinance No. 119/2026/1. • Implemented single electronic field notebooks (2024) (i.e. beyond EU regulation) and official IPM indicators (2023). • Slow, country-dependent pheromone authorizations remain a bottleneck.
Serbia	• Chemical pesticides remain the primary control method in intensive cereal, fruit, and vegetable crops. • Policy focus shifting toward achieving a real decrease in residues, exposure, and risks to human health and environment rather than volume alone.	• Testing biopesticides, beneficial organisms, biotesting, resistant varieties, precision agriculture, and modern monitoring technologies. • Practical adoption is constrained by high equipment costs and limited availability of biopesticides.	• Advisory services form a core national pillar ("Education") alongside training and demonstration trials. • Key constraints: insufficient education of advisors, limited expert numbers, and lack of long-term funding.	• EU candidate country structuring alignment under four pillars (Organic, IPM, Biological Protection, Education). • Transition slowed by complicated administrative procedures and slow biopesticide registration.

Sweden	• Dwindling access to synthetic chemical pesticides and continuous emergence of pest/weed resistance. • Focus placed on identifying options and pathways for preventative, agroecological crop protection.	• Landscape-scale cropping system redesign (managing non-crop habitats, landscape crop diversity, crop rotations, intercropping, tillage, resistant varieties). • Mechanical and biological control, decision support systems, monitoring, and prognosis tools.	• Public and private advisors, agricultural authorities, and farmer unions collaborating directly with active research projects. • Joint stakeholder-researcher efforts to raise R&D funding.	• Operates under EU directives for the sustainable use of pesticides (SUD). • Policy focus on overcoming cropping system lock-ins to enable transformation toward preventative protection.
Türkiye	• Policy focuses on digital traceability, preventing chemical misuse, and managing pesticide residues for export/domestic markets. • No data on volume	• Biological and biotechnical control (mating disruption, mass trapping, release/conservation of natural enemies). • Forecasting/early-warning services based on weather and biological models. • Agricultural UAVs evaluated for crop-specific spray deposition and canopy penetration.	• Ministry of Agriculture and Forestry, TAGEM research institutes, commodity-focused research institutes, and provincial/district directorates. • Extension supported by universities, cooperatives, producer organizations, and private advisors.	• Governed by Law No. 5996 on Veterinary Services, Plant Health, Food and Feed. • Plant Protection Products Tracking System (BKÜTS) for central supply-chain traceability. • B-Prescription initiative linking electronic sales/prescriptions to registered crops/areas. • Priorities set during the Fourth Agriculture and Forestry Council (2025).
United Kingdom	• UK Pesticides National Action Plan 2025 sets a national direction for reducing pesticide risks and environmental impacts.	• Precision remote sensing, UAV multispectral weed mapping (black-grass). • Electrical weed control (RootWave). • AI-driven volatile-organic-compound sensors for pest/stress detection (TomatoGuard). • North Wyke Farm Platform (NWFP) 63 ha research test bed.	• Supported by the UK Agri-Tech Centre and IPM Decisions platform providing weather data and DSS tools. • The ADOPT fund co-finances farmer-led trials and field demonstrations.	• UK Pesticides National Action Plan 2025 and England's Farming Roadmap 2050. • Sustainable Farming Incentive (SFI 2026) co-finances sensor-guided spraying, robotic weeding, and variable-rate inputs.

