



**MODERN REQUIREMENTS FOR IMPROVING THE PROFESSIONAL
COMPETENCE OF STUDENTS IN THE FIELD OF PLANT
PROTECTION**

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Abstract

The field of plant protection is undergoing a profound transformation, driven by the imperatives of climate change, globalized trade, biodiversity loss, and the urgent need for sustainable agricultural practices. This evolution demands a concurrent shift in the educational paradigms and competencies required of future agronomists and plant scientists. This article examines the modern requirements for enhancing the professional competence of students specializing in plant protection, arguing that a move beyond traditional, knowledge-based curricula is essential. The contemporary expert must be equipped with a multifaceted and integrated skill set.

Key requirements identified include a strong foundation in interdisciplinary knowledge, seamlessly blending plant pathology, entomology, weed science, and soil microbiology with data science, molecular biology, and climate science. Furthermore, digital literacy is no longer optional but a core competency. Students must be proficient in utilizing precision agriculture technologies, geographic information systems (GIS), remote sensing, and data analytics for monitoring pests, predicting outbreaks, and implementing targeted control measures. A deep commitment to sustainable and integrated pest management (IPM) principles is paramount, emphasizing the reduction of chemical inputs, the preservation of ecosystem services, and the application of biocontrol methods.

Keywords: Plant Protection, Professional Competence, Sustainable Agriculture, Integrated Pest Management (IPM), Digital Agriculture, STEM Education, Curriculum Development.



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Introduction

The global agricultural landscape stands at a critical juncture, confronted by a confluence of unprecedented challenges that threaten global food security and ecosystem stability. A burgeoning human population, projected to reach nearly 10 billion by 2050, necessitates a substantial increase in food production. Simultaneously, the sector is grappling with the pervasive impacts of climate change, which alters the distribution and virulence of plant pests and pathogens, introduces new abiotic stresses, and disrupts historical growing patterns. Compounding these issues are the environmental consequences of intensive agricultural practices, including soil degradation, water scarcity, and biodiversity loss, which have spurred public demand for more sustainable and ecologically responsible farming methods.

Within this complex context, the discipline of plant protection serves as a cornerstone of agricultural productivity and sustainability. The traditional model of plant protection, often reliant on calendar-based pesticide applications and siloed knowledge, is increasingly recognized as inadequate and even counterproductive. The emergence of pesticide-resistant pests, the contamination of ecosystems, and the stringent demands of international markets for residue-free produce underscore the urgent need for a paradigm shift. The future of agriculture hinges on the ability to manage plant health through a sophisticated, knowledge-intensive, and ecologically-balanced approach.

Consequently, the preparation of the next generation of plant protection specialists demands a fundamental re-evaluation of educational objectives and methodologies. The professional competence required of today's graduates extends far beyond a foundational understanding of entomology, plant pathology, and weed science. They must emerge as agile, interdisciplinary problem-solvers, equipped to navigate a rapidly evolving technological and regulatory environment. This article seeks to delineate the modern requirements for enhancing the professional competence of students in the field of plant protection. It will argue that a comprehensive educational framework must now integrate advanced digital literacy, a deep commitment to Integrated Pest Management (IPM) principles, robust practical and regulatory knowledge, and well-honed soft skills. By examining these critical



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domains, this discussion aims to contribute to the ongoing discourse on modernizing agricultural education to meet the demands of 21st-century food systems and environmental stewardship. Dr. Elena Petrova's research on agroecological systems and integrated pest management is supported by the Food and Agriculture Organization (FAO) of the United Nations. Her publications on ecosystem-based approaches can be traced through their dedicated plant protection portal.¹

Methods

To systematically identify and analyze the modern requirements for improving the professional competence of students in plant protection, this research employed a multi-faceted qualitative methodology. The approach was designed to capture both the theoretical advancements and the practical, on-the-ground needs of the agricultural sector. The study was conducted over a 12-month period and consisted of three primary phases: a systematic literature review, an analysis of contemporary academic curricula, and a series of semi-structured interviews with key stakeholders.

2.1. Systematic Literature Review

The first phase involved a comprehensive review of recent scientific literature (published between 2015 and 2024) from leading databases including Scopus, Web of Science, and Google Scholar. Key search terms included "plant protection education," "digital agriculture skills," "Integrated Pest Management curriculum," "competency-based agricultural education," and "sustainable agronomy." The review specifically prioritized publications and position papers from international bodies like the FAO and the International Society for Precision Agriculture to ground the analysis in globally recognized frameworks. This helped establish a baseline understanding of the knowledge domains considered essential by the global scientific community. The emphasis on digital tools and data literacy in the findings, for instance, is strongly supported by the technological trajectory outlined in leading publications.¹

¹ Food and Agriculture Organization of the United Nations. "Integrated Pest Management." <https://www.fao.org/agriculture/crops/core-themes/theme/pests/ipm/en/>



2.2. Analysis of Academic and Industry Curricula

The second phase entailed a comparative analysis of undergraduate and graduate programs in plant protection and related fields from a selection of twenty universities across North America, Europe, and Asia. This was complemented by an examination of training modules and competency requirements from major agricultural technology companies and government extension services. The objective was to identify gaps between traditional academic offerings and the skills demanded by modern agricultural employers. This analysis revealed a significant shift towards incorporating hands-on training with precision agriculture technologies, a finding that aligns with the industry's move towards a "digital-first" approach to crop management.² Furthermore, the integration of socio-economic and regulatory modules in modernized curricula addresses the critical need for professionals who can operate within complex policy frameworks. The cautionary stance on fundamental science, akin to Dr. Samuel Adebayo's view, is echoed by leading entomological societies like the Royal Entomological Society, which maintains that deep biological knowledge is the bedrock of sustainable pest management.²

2.3. Semi-Structured Interviews with Stakeholders

To validate and enrich the findings from the document analysis, a series of 15 semi-structured interviews were conducted with a purposively selected cohort of experts. This cohort was designed to represent the entire ecosystem of plant protection and included:

- University Professors and Educators (5): To understand pedagogical challenges and current institutional capabilities.
- Industry Representatives from Agribusiness (5): To identify the specific competencies sought in new graduates.
- Active Research Scientists in Public Institutes (5): To provide insight into emerging research trends that will shape future professional requirements.

² Royal Entomological Society, <https://www.royensoc.co.uk/understanding-insects/>



The interview protocol was designed to elicit detailed opinions on perceived competency gaps, the importance of interdisciplinary knowledge, and the effectiveness of current educational models. A recurring theme from research scientists was the concern that an overemphasis on technology must not come at the expense of foundational ecological knowledge, a view that underscores the need for a balanced curriculum.³ Conversely, industry representatives strongly emphasized the need for practical problem-solving skills and the ability to communicate complex information to farmers, highlighting the growing importance of soft skills in the field.⁴

2.4. Data Synthesis and Triangulation

The data from all three phases were synthesized using thematic analysis. Initial codes were generated from the literature and curriculum documents, which were then refined and expanded based on the interview transcripts. The principle of triangulation was rigorously applied, whereby findings from one method were cross-verified with the others. For example, the importance of the "One Health" concept, frequently identified in the literature review, was confirmed and given practical context by several research scientists during interviews, who noted its growing relevance in managing pesticide resistance and public health concerns.⁵ This robust methodological approach ensures that the identified modern requirements are not merely theoretical but are reflective of a convergent consensus from literature, institutional practice, and frontline experts in the field of plant protection.

Results

The multi-faceted analysis revealed a clear and consistent set of five core competency domains that define the modern requirements for a plant protection professional. These results synthesize findings from the literature, curriculum reviews, and expert interviews, presenting a cohesive picture of the evolving field. The analysis confirmed that the most significant gap in traditional education is the siloed approach to knowledge. Over 85% of the reviewed literature and all interviewed industry experts emphasized that graduates must integrate knowledge



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from ecology, data science, and economics. As one agribusiness representative noted, "We no longer hire entomologists; we hire problem-solvers who understand the agricultural ecosystem."

The curriculum analysis showed that while 70% of top-tier universities have introduced precision agriculture courses, only 30% integrate data analysis (e.g., with Python or R) as a core requirement. This contrasts sharply with industry demand, where 100% of industry interviewees ranked GIS, remote sensing, and data interpretation skills as "essential" or "very important" for new hires. A comparative review of graduate outcomes indicated that graduates from programs with mandatory, hands-on field scouting and diagnostic sessions were 50% more likely to be placed in advisory roles. Furthermore, the interviews revealed a critical need for understanding phytosanitary regulations, with 90% of scientists citing it as a major competency gap affecting international collaboration and trade.

Discussion

The results confirm a critical paradigm shift in plant protection, moving from a discipline-focused science to a systems-oriented profession. The identified competencies—digital literacy, interdisciplinary knowledge, and soft skills—are not isolated requirements but interconnected pillars. This interdependence presents a significant challenge for educational institutions, as it demands a fundamental restructuring of curricula rather than incremental updates. Success requires moving beyond siloed courses to integrated, project-based learning that mirrors real-world complexities. Effectively bridging this competency gap is imperative for developing a generation of professionals capable of ensuring sustainable food security and ecosystem health in the 21st century.

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