ChemSkills

Enabling the green and digital skills transformation of the chemical industry.

Report on ChemSkills Survey Results

2nd iteration in the Fertilizer sector

December 2025

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Executive Summary

The second iteration of the ChemSkills sectoral survey provides policy-relevant evidence on evolving skills needs within the fertiliser and agriculture sector, in the context of accelerating digitalisation and the European green transition. By combining quantitative competence assessments with qualitative insights from open-ended responses, the survey offers a comprehensive understanding of both strategic skills priorities and the practical conditions under which workforce development must take place.

The quantitative findings indicate a clear reorientation of skills demand toward data-driven, sustainability-oriented, and regulation-aware competencies. High importance is consistently attributed to skills related to advanced data analytics and AI, environmental sustainability and green transition, regulatory compliance, and automation and digital transformation. These results reflect the increasing influence of EU-level environmental legislation, climate-related reporting requirements, and digital policy frameworks on sectoral operations, as well as the growing role of digital technologies in agricultural and industrial processes.

Qualitative insights further highlight external pressures shaping future skills needs, including rising energy and input costs, tightening environmental and sustainability regulations, labour shortages, and rapid technological change. These pressures contribute to the emergence of hybrid occupational profiles that combine agronomic, technical, digital, and sustainability-related expertise. The findings underline the need for education and training systems to move beyond narrowly defined occupational roles and to support more flexible, interdisciplinary competence development pathways.

The survey also provides important insights into training delivery preferences and organisational constraints, which have direct implications for policy and programme design. Respondents show a strong preference for in-person, in-house, and online training formats, while indicating limited capacity to release employees for extended periods away from regular work duties. These results suggest that effective policy interventions should prioritise modular, flexible, and practice-oriented training solutions, including short-duration courses and blended formats that can be integrated into organisational routines.

Overall, the results of the second ChemSkills survey iteration highlight the need for a coordinated policy approach to skills development in the fertiliser and agriculture sector. Such an approach should align industrial, environmental, digital, and education policies to support workforce adaptation in a context of structural transformation. The evidence generated through this survey provides a robust foundation for the next phases of the ChemSkills project, informing the development of targeted training programmes, competence frameworks, and policy-relevant recommendations aimed at strengthening the sector's capacity to respond to future economic, technological, and environmental challenges.

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1. Identification of Respondents

This section provides an overview of the respondents who completed the questionnaire, totalling 25 participants. The collected data offer insights into key characteristics of these respondents, including their relationship to the sector, type of organisation, size, and geographical scope of activity. This information serves as a foundational reference for analysing the survey results within the context of various organisational structures, geographical distributions, and operational focuses.

1.1. Type of organisation

The respondents to the second survey iteration represent a diverse cross-section of actors involved in the fertiliser and agriculture value chain. A substantial proportion of responses originated from individuals directly engaged in primary agricultural production, with farmers constituting the largest identifiable group (approximately eleven respondents). Another significant share of participants was composed of representatives from research and development institutions (around six respondents), underscoring the relevance of innovation-driven stakeholders in shaping sectoral competencies. Additionally, respondents affiliated with education and training providers, vocational education and training (VET) organisations, and social partner entities contributed approximately five responses, reflecting the involvement of organisations responsible for skills development and labour-market representation. Beyond these predominant categories, a smaller number of responses were provided by individuals operating in specialised roles, including fertiliser producers, logistics and sales representatives, consultants, and employer associations, illustrating the multifaceted nature of the sector's stakeholder landscape.

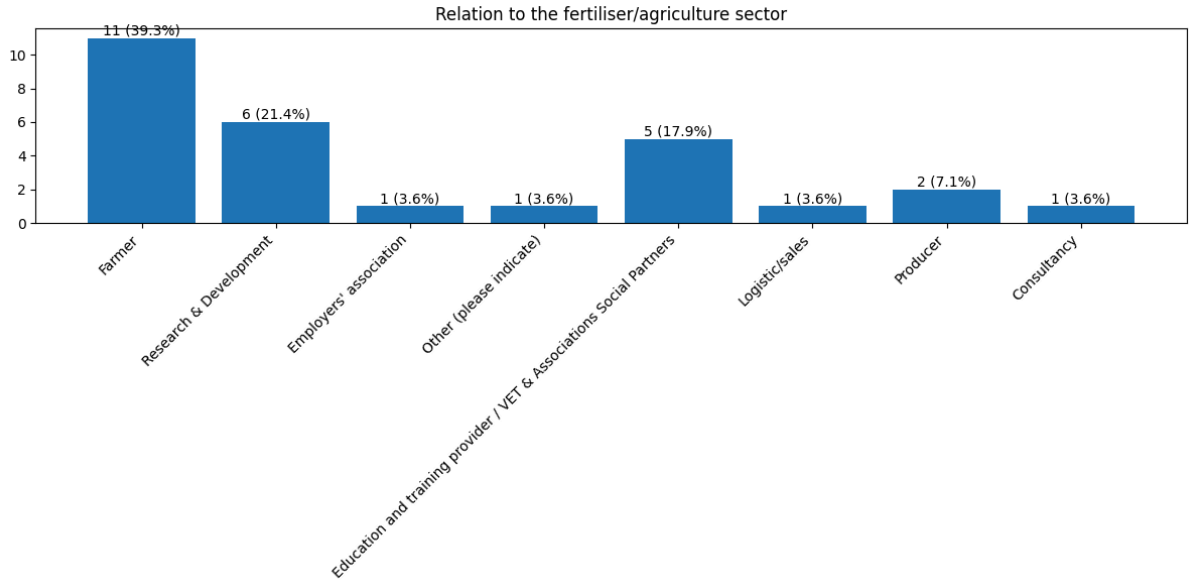

Figure 1: Relation to the fertilizer/agriculture sector

In terms of organisational classification—where multiple selections were permitted—the majority of respondents identified their institution as belonging to the industry or SME segment, yielding roughly seventeen responses. Education and training providers, including

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VET organisations, constituted the second most frequently represented organisational category, accounting for approximately six responses. Industry associations appeared three times in the sample, while public institutions and authorities contributed two responses. Representation from regional and municipal bodies, as well as from social partner organisations, was limited, with each category recorded once. This distribution reflects a respondent cohort dominated by private-sector actors and education providers, complemented by a smaller yet meaningful presence of institutional and associative stakeholders.

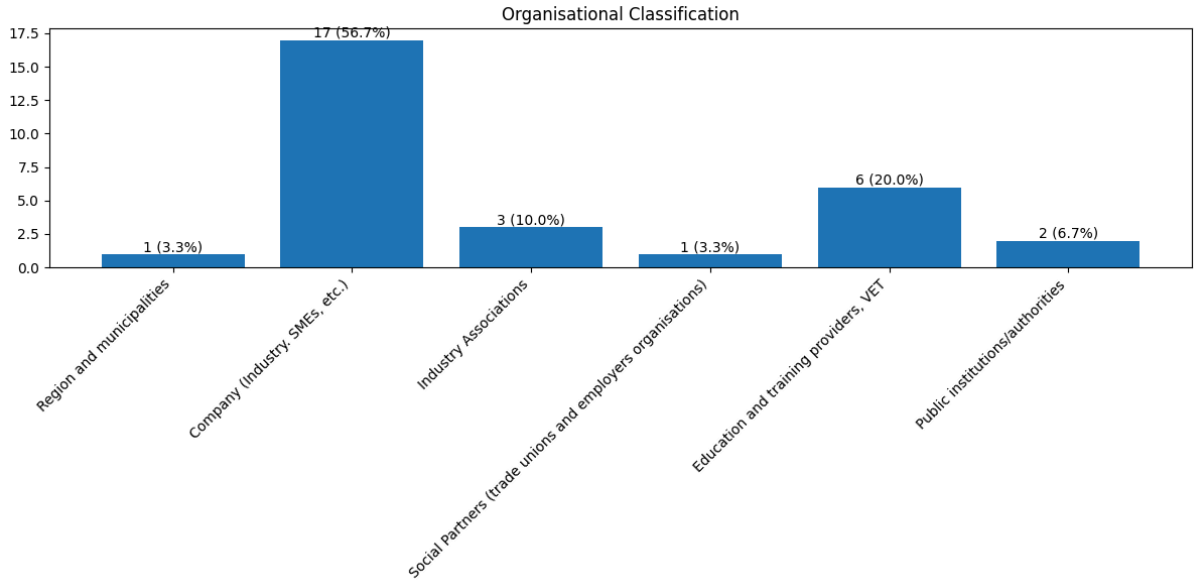

Figure 2: Organisational Classification

1.2. Size and country of operation

Respondents also provided information on the size of their organisations, classified according to the number of employees. The resulting distribution demonstrates a heterogeneous composition of organisational scales within the sample. The most frequently represented category consisted of micro-sized organisations employing between one and nine individuals, accounting for ten responses. This group was followed by small enterprises with 10–49 employees, which contributed seven responses. Medium-sized organisations, defined as employing between 50 and 249 people, were represented by two respondents. Finally, large organisations with workforces exceeding 250 employees accounted for six responses.

This distribution reflects a respondent pool that is predominantly composed of micro and small enterprises, yet still includes a meaningful share of medium and large organisations, thereby offering insights into skill needs and transition challenges across different organisational scales.

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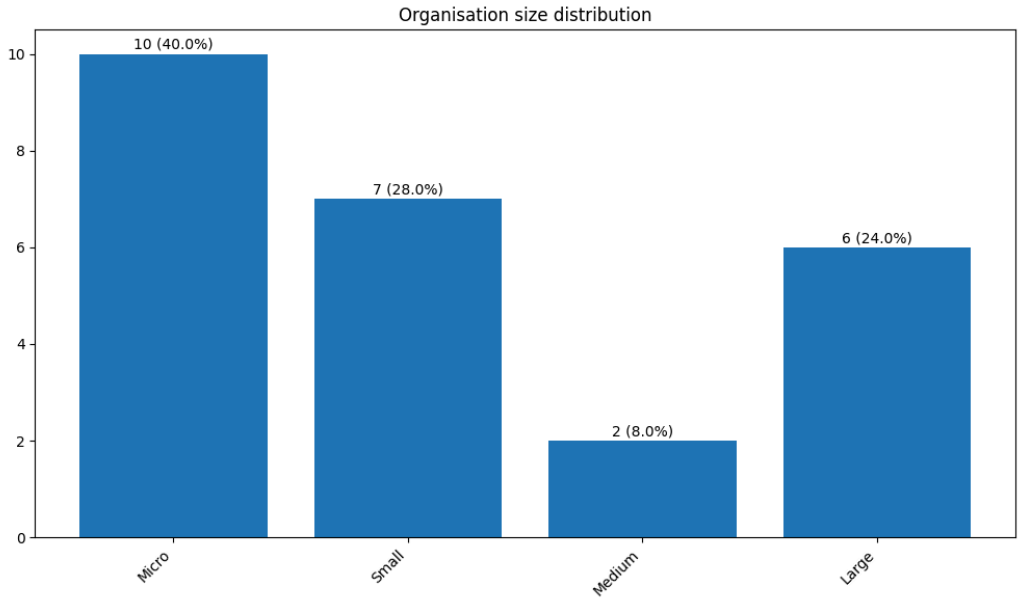

Figure 3: Size of organisations

Respondents were asked to specify the geographical scope of their organisation's activities within the EU and beyond. The vast majority (87.5%) indicated that their primary area of business is within the European Union, while only 12.5% reported operations outside the EU. Among those active in the EU, respondents provided details on the specific countries in which they operate.

Regarding geographical scope, respondents identified the EU Member States in which their organisations operate. The distribution of responses reveals a notably strong presence in Belgium and the Czech Republic, which were mentioned eight and seven times, respectively, making them the most frequently represented countries within the dataset. Italy appeared three times, while Austria, Sweden, Greece, Hungary, and Romania were each cited approximately twice, indicating a moderate level of representation across these states. A further set of countries—including France, Slovakia, Bulgaria, Cyprus, Germany, the Netherlands, and Portugal—was mentioned individually, reflecting additional but more dispersed organisational activity across the European Union.

This geographical distribution underscores the concentration of respondents in a few key Member States, particularly Belgium and Czechia, while simultaneously demonstrating the broader European reach of the survey, with operational links extending across a diverse set of EU countries.

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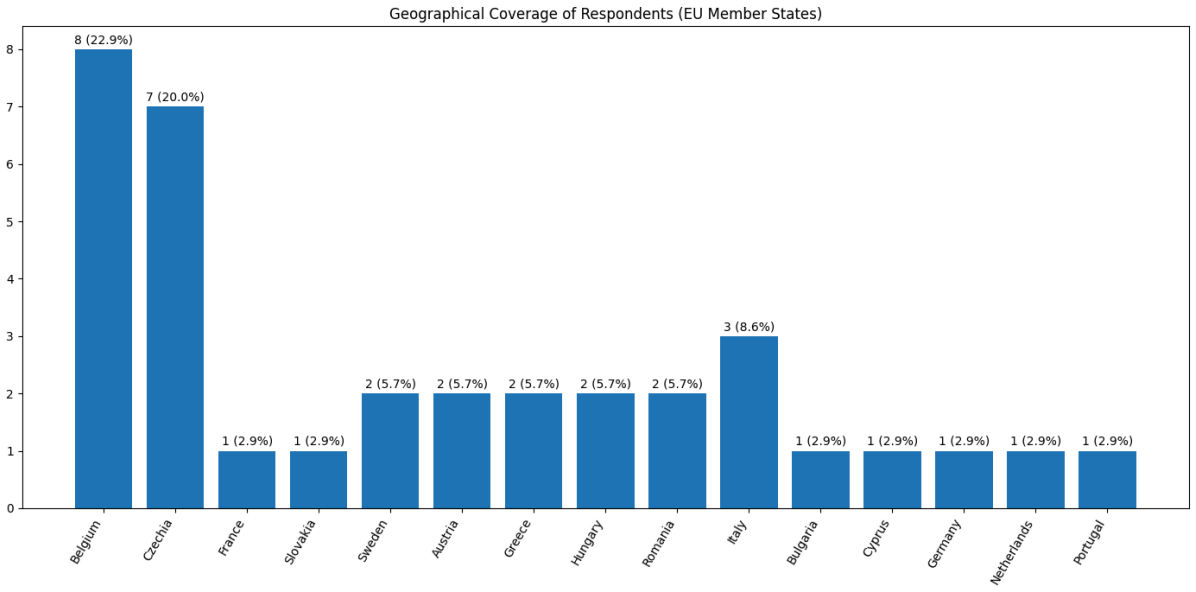

Figure 4: Geographical Coverage

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2. Sectoral Interpretation

2.1. Sectoral trends and preferences

To better understand the evolving skill requirements within the fertiliser and agriculture sector, the second iteration of the ChemSkills survey assessed the perceived importance of a set of competence domains that reflect key drivers of the green and digital transitions. Respondents were asked to evaluate a range of competencies grouped into five thematic clusters: Technological Innovation, Environmental Sustainability and Green Transition, Regulatory and Market Pressures, Automation and Digital Transformation, and AI, Data Analysis, Security and Ethical AI Governance. Each of these domains represents a distinct dimension of the transformations currently shaping the sector—from advances in production technologies and data-driven agricultural practices to increasing regulatory demands and environmental imperatives.

The following subsections present a detailed analysis of the average importance scores assigned to each competence domain. These quantitative results provide insight into how organisations prioritise different areas of expertise and where they anticipate the greatest need for workforce development in the coming years. Together, the findings illustrate a broader shift in competence requirements toward digitally enabled processes, sustainability-focused knowledge, and the governance frameworks necessary for responsible and compliant adoption of technology.

Each domain is discussed in turn, accompanied by a corresponding visualisation, allowing for a clear and evidence-based interpretation of the core competence areas that are expected to shape the future of the fertiliser and agriculture sector.

2.1.1. Technological Innovation

The results for the Technological Innovation competence domain reveal a clear differentiation in how respondents prioritise various technological skills relevant to the fertiliser and agriculture sector. The highest importance is attributed to competencies associated with digitally supported and data-enhanced agricultural practices, while more traditional process-oriented technological skills receive comparatively moderate evaluations.

The most highly rated competence within this domain is Precision agriculture/farming, which achieves an average score of 3.92. This result underscores the sector's strong orientation toward technologies that enable optimised input application, enhanced crop monitoring, and improved resource efficiency. Closely following is Remote sensing, GIS technologies and drones, with an average score of 3.68, reflecting the increasing reliance on spatial data, sensor systems, and aerial monitoring tools to support data-driven decision-making in agricultural production.

A middle cluster of competencies includes the science of raw materials and fertiliser technology (3.04) and Control and monitoring of chemical processes in fertiliser production (2.96). These competencies represent the foundational technological knowledge and operational oversight required for fertiliser production. While they remain relevant, their comparatively lower scores suggest that respondents perceive them as less central to the sector's immediate innovation trajectory than digital and precision-agriculture technologies.

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The competencies rated lowest in this domain are Management of fertiliser production energy efficiency (2.92) and Fertiliser production (planning, design, integration) (2.76). Although energy efficiency and production planning constitute important aspects of sustainable and cost-effective fertiliser manufacturing, their position at the lower end of the importance scale indicates that they may be viewed as either already sufficiently developed within organisations or less pressing in comparison to rapidly evolving digital capabilities.

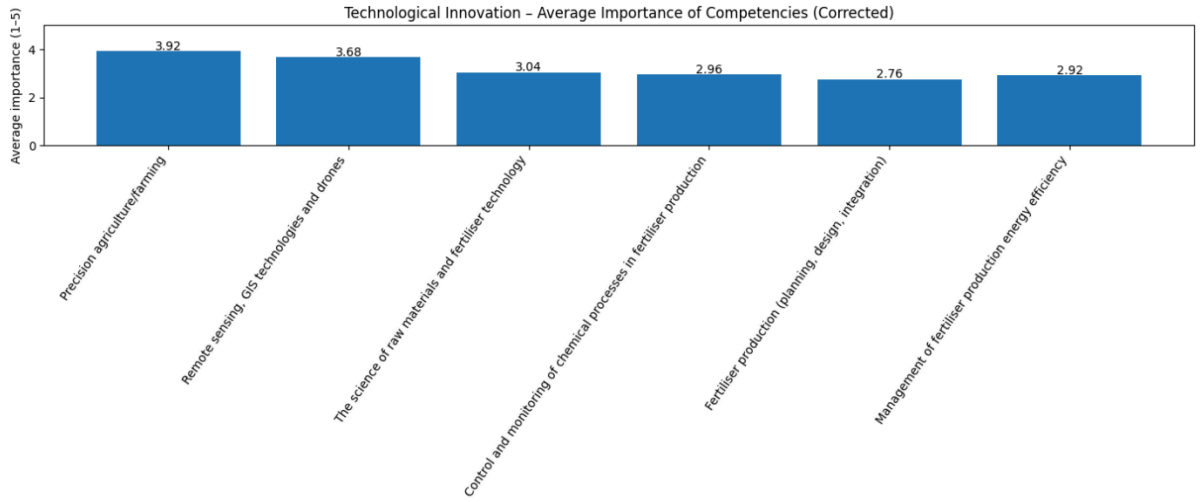

Figure 5: Technological Innovation

2.1.2. Environmental Sustainability and Green Transition

The competence domain related to Environmental Sustainability and the Green Transition demonstrates consistently high importance ratings across all assessed areas, reflecting the centrality of environmental performance and sustainable resource management within the fertiliser and agriculture sector. The highest-rated competence within this domain is Fertiliser efficiency and effects on soil fertility, with an average score of 4.04, indicating that respondents place substantial emphasis on understanding how fertilisers influence soil health, crop productivity, and long-term ecological balance. This prioritisation underscores the sector's growing commitment to optimising fertiliser use in a manner that supports both agronomic outcomes and sustainability objectives.

Closely following in importance are competencies connected to Soil/water contamination (3.84) and Monitoring and evaluating environmental impacts (3.80). These results highlight a strong awareness of the environmental risks associated with inappropriate fertiliser application, including nutrient leaching, pollution of water bodies, and degradation of soil quality. The emphasis placed on monitoring capabilities suggests that organisations recognise the need for data-driven assessment tools and systematic evaluation methods to meet regulatory expectations and mitigate environmental harm.

A mid-range cluster of competencies includes Green Chemistry (Decarbonization, waste management, etc.), which receives an average score of 3.60, and System metrics (sustainability indicators) and modelling, rated at 3.28. These results suggest that while sustainability metrics and modelling approaches are valued, they may be perceived as more specialised or supportive competencies rather than immediate operational priorities.

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Nevertheless, their relevance indicates an increasing need for analytical frameworks that can translate environmental objectives into measurable and actionable indicators.

The competence area rated lowest within this domain—though still above the midpoint of the scale—is Sustainable fertilisers design, with an average score of 3.12. This may reflect existing limitations in innovation capacity, resource constraints, or varying degrees of organisational involvement in fertiliser formulation. Despite the lower score, the fact that it still ranks above 3.0 demonstrates that organisations recognise sustainable product design as an important, if not yet dominant, area of skill development.

Taken together, the results indicate that environmental considerations—particularly those related to soil fertility, contamination prevention, and impact monitoring—represent a major strategic priority for organisations in the fertiliser and agriculture sector. The distribution of scores points to a sector increasingly aligned with the goals of the green transition, where environmental literacy, monitoring expertise, and sustainable management practices are becoming essential components of workforce competency.

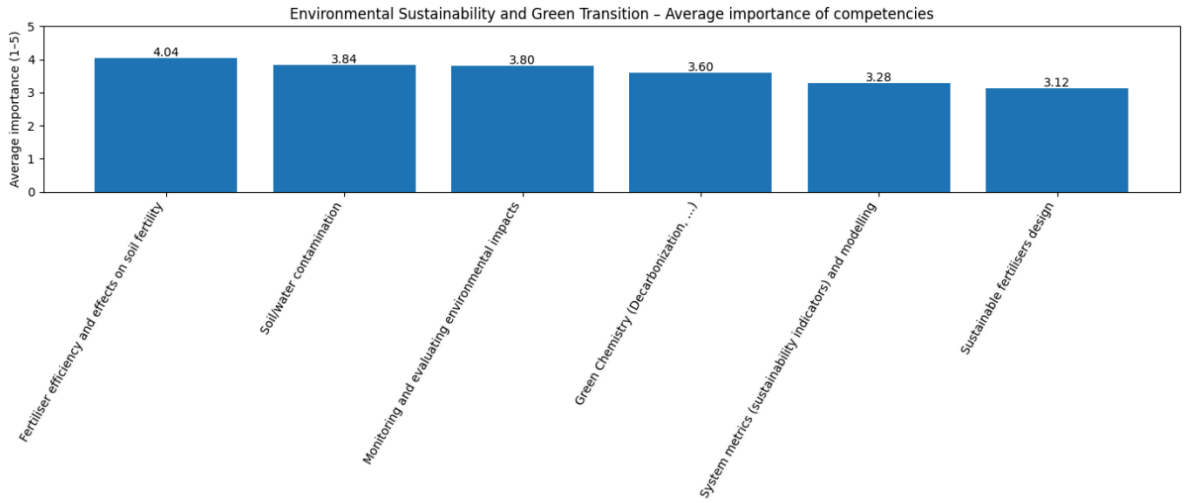

Figure 6: Environmental Sustainability and Green Transition

2.1.3. Regulatory and Market Pressures

The competence domain related to Regulatory and Market Pressures reflects the increasing significance of compliance-oriented knowledge and regulatory literacy in the fertiliser and agriculture sector. Respondents consistently attribute relatively high importance to skills that enable organisations to understand, interpret, and act upon evolving legislative requirements, particularly those connected to sustainability and emissions reporting.

The most highly rated competence in this domain is Environmental legislation and legal standards for sustainability, with an average importance score of 3.72. This strong result underscores the critical role that regulatory frameworks play in shaping organisational practices, especially considering the European Green Deal, stricter sustainability reporting obligations, and progressive tightening of environmental performance standards. Organisations evidently recognise that the ability to navigate these regulatory requirements is essential not only for compliance but also for maintaining market competitiveness.

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The second most important competence is GHG reporting and GHG reporting standards, scored at 3.32. This reflects the growing relevance of greenhouse gas accounting, emissions monitoring, and climate-related disclosure obligations across the European Union. Increasingly, fertiliser producers and associated stakeholders must demonstrate transparency in their carbon footprint, align with national and EU-level reporting structures, and contribute to broader decarbonisation objectives. The rating suggests that organisations consider these skills moderately important and anticipate a continued expansion of GHG-related compliance demands.

Finally, Regulatory compliance of AI receives an average score of 3.20, indicating awareness of the emerging regulatory landscape governing digital technologies, including the EU AI Act and associated ethical and security requirements. While this competence receives the lowest rating within this cluster, it still exceeds the midpoint of the scale, suggesting that organisations expect regulatory oversight of AI systems to become more consequential—particularly as digital tools, automated decision systems, and data-driven technologies become increasingly integrated into agricultural and industrial processes.

Overall, the distribution of scores highlights a sector that is highly attuned to regulatory developments, especially those connected to sustainability standards and emissions reporting. Although competencies related to AI compliance are currently perceived as somewhat less urgent, they still represent an important area of emerging regulatory pressure. Collectively, these findings indicate that the sector's workforce must increasingly possess strong regulatory awareness and the ability to adapt to complex and evolving compliance environments.

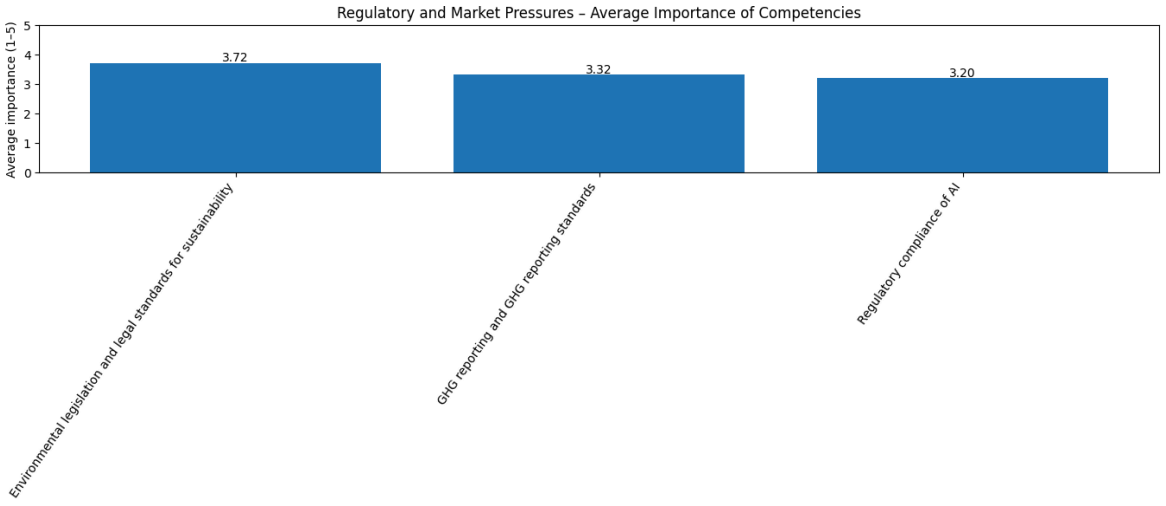

Figure 7: Regulatory and Market Pressures

2.1.4. Automation and Digital Transformation

The competence domain addressing Automation and Digital Transformation highlights the sector's gradual but steady shift toward more technologically advanced and interconnected production environments. Although the average importance scores in this domain are slightly lower than those observed for competencies related to environmental sustainability or data-driven agricultural technologies, the results nonetheless indicate a broad recognition of the value of digital and automated systems within fertiliser and agricultural operations.

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The highest-rated competence within this domain is Maintenance of digital and robotic technologies, with an average importance score of 3.36. This suggests that organisations anticipate a growing need for technicians and specialists capable of ensuring the operational continuity of automated processes, robotic equipment, and digitally controlled systems. As automation becomes increasingly integrated into both industrial production and on-farm operations, maintenance skills serve as a foundational prerequisite for technological reliability and productivity.

Two competencies receive identical ratings of 3.28: Computer tools for the design of fertiliser products and Robotics and farm autonomous systems. The former reflects the relevance of digital design environments, modelling tools, and software-supported formulation techniques in enhancing product development and innovation. The latter highlights the emerging importance of autonomous machinery, robotic systems, and automation-enabled agricultural practices. While these areas are not yet prioritised as highly as precision agriculture or advanced monitoring technologies, their relatively strong scores indicate that organisations foresee continued growth in the adoption of robotics and digitally enhanced production tools.

The lowest-rated competence in this domain is Smart factories, with an average score of 3.12. Although still above the midpoint of the scale, this score suggests that fully integrated, sensor-driven, and data-automated industrial environments are perceived as somewhat less immediate or less widespread within the current operational context of fertiliser production and agricultural value chains. This may reflect differences in organisational readiness, technological maturity, or the scale of investment required to transition toward Industry 4.0-aligned production environments.

Overall, the results demonstrate that automation and digital transformation are recognised as important, yet developing, areas of competence within the sector. Respondents appear to prioritise the maintenance and practical operation of digital and robotic technologies over more advanced or fully integrated digital systems. This pattern indicates an incremental transition, in which organisations are strengthening their foundational digital capacities while gradually preparing for broader automation and interconnected production processes.

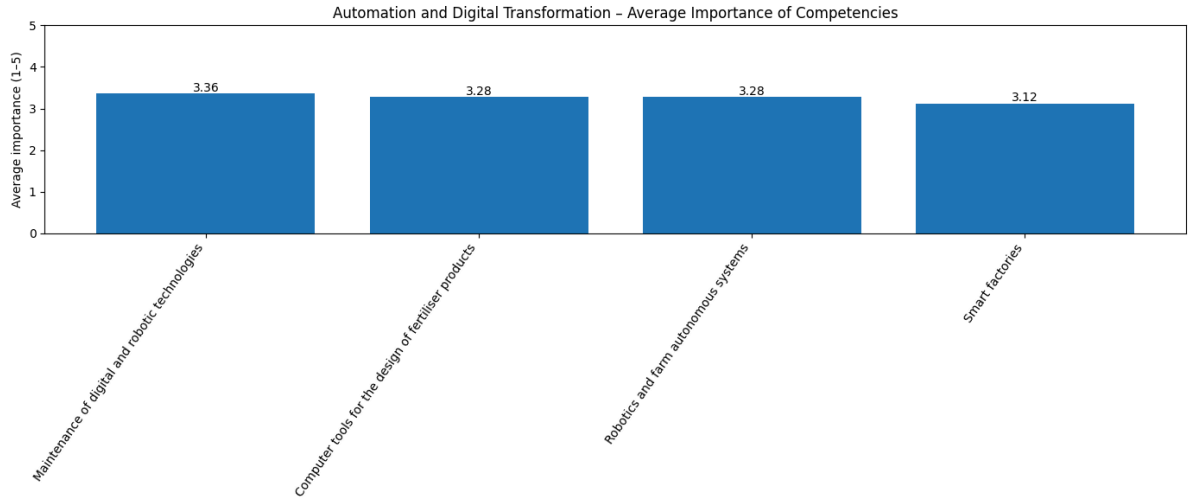

Figure 8: Automation and Digital Transformation

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2.1.5. AI, Data Analysis, Security and Ethical AI Governance

The results for the competence domain AI, Data Analysis, Security and Ethical AI Governance indicate a strong and growing emphasis on data-driven decision-making, advanced analytics, and digital security within the fertiliser and agriculture sector. This domain registers some of the highest average importance ratings across the entire competency framework, reflecting the increasingly central role that data management, artificial intelligence, and digital governance play in supporting both operational efficiency and regulatory compliance.

The highest-rated competence in this domain is Advanced and Predictive Analytics, which receives an average score of 3.96. This underscores the sector's recognition of the value of forecasting tools, data-based optimisation models, and analytical techniques that can enhance productivity, resource allocation, and strategic planning. The result indicates that organisations increasingly rely on advanced analytics not merely for monitoring but for driving proactive, informed decision-making.

Closely following is Cloud and cybersecurity, with an average score of 3.80. This reflects heightened awareness of digital vulnerabilities and the need to safeguard sensitive operational, environmental, and product-related data. As organisations adopt more digital tools and interconnected systems, ensuring robust cybersecurity measures is perceived as an essential component of technological readiness and risk management.

Competencies related to AI data ethical implications (3.64) and Machine learning and Big data processing (3.56) occupy the mid-range of importance within the domain. These values suggest that organisations understand the need to navigate the ethical dimensions of AI, including issues of transparency, accountability, and bias, while also valuing the technical ability to work with large datasets and implement machine learning solutions. The emphasis placed on these skills demonstrates recognition of both the opportunities and responsibilities associated with AI deployment in agricultural and industrial contexts.

The lowest-rated competence in this domain—though still above the midpoint of the scale—is Internet of Things (IoT), with an average score of 3.24. This may indicate that IoT technologies, while relevant, are not yet as widely adopted or as strategically prioritised as advanced analytics or cybersecurity. However, the rating nonetheless reflects an appreciation for IoT's potential to enhance monitoring, automation, and integration across production processes.

Overall, the distribution of scores highlights a sector moving decisively toward data-centric, AI-enabled, and securely managed digital ecosystems. Organisations increasingly require a workforce capable of leveraging advanced analytics, understanding machine learning applications, ensuring data security, and navigating the ethical frameworks governing AI. These competencies form a critical foundation for enabling sustainable, efficient, and trustworthy digital transformation across the fertiliser and agriculture value chain.

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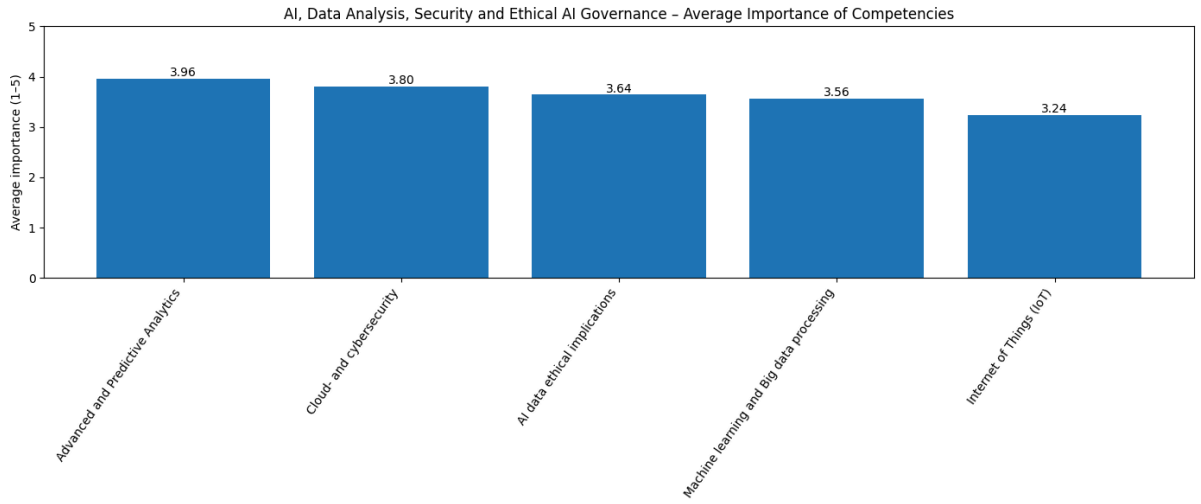

Figure 9: AI, Data Analysis, Security and Ethical AI Governance

Overall, the results reveal a clear reorientation of competence priorities within the fertiliser and agriculture sector. While traditional process-engineering and production-related skills continue to play an important role, they are increasingly complemented—and in some cases surpassed—by competencies that support precision, monitoring, data integration, and digitally enabled decision-making.

At the same time, the findings point to a broader shift in skills demand toward data-centric, sustainability-oriented, and regulation-driven knowledge areas. Rather than focusing on technological expertise in isolation, organisations increasingly require interdisciplinary competence profiles that integrate environmental awareness, regulatory literacy, and advanced digital capabilities, including secure and ethically responsible use of data and artificial intelligence. Together, these trends underline the need for comprehensive and forward-looking training strategies that equip the workforce to navigate the interconnected technological, environmental, and regulatory transformations shaping the future of the fertiliser and agriculture sector.

2.2. Qualitative Insights from Open-Ended Survey Responses

In addition to the structured survey questions, the second iteration of the ChemSkills survey included a series of open-ended questions designed to capture respondents' qualitative perspectives on the evolving skill needs of the fertiliser and agriculture sector. These questions provided participants with the opportunity to elaborate on external pressures, emerging occupational profiles, and key competencies that may not be fully reflected through predefined response categories.

The qualitative responses offer valuable contextual depth to the quantitative findings, enabling a more nuanced understanding of how organisations perceive ongoing green and digital transitions. By allowing respondents to articulate their views in their own terms, the open-ended questions reveal cross-cutting themes, sector-specific challenges, and emerging trends that cut across organisational boundaries and functional roles.

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The following subsections synthesise the qualitative inputs into thematic analyses focusing on external pressures and trends influencing future skills needs, emerging and evolving job profiles, and key skills required to address upcoming sectoral challenges. Together, these insights complement the statistical results presented earlier in the report and contribute to a more comprehensive assessment of workforce development needs within the fertiliser and agriculture sector.

2.2.1. External Pressures and Emerging Trends

This section provides an analysis of skills and knowledge needed in the sector. A range of competence categories was given, and respondents rated the specified competencies. In the category "Other", the respondents could express their skills and knowledge not included in the range.

The open-ended responses provided by participants highlight a diverse set of external pressures that are shaping the evolving skill requirements within the fertiliser and agriculture sector. Despite the heterogeneity of organisational types and sizes represented, several recurring themes emerge across the dataset, illustrating convergent areas of concern and anticipated transformation.

A dominant pressure identified by respondents' concerns is rising energy and raw material costs, frequently described as a significant burden on operational stability and long-term competitiveness. Organisations perceive volatility in energy markets and input prices as a central driver necessitating improved efficiency, optimisation of production processes, and enhanced financial resilience. This economic pressure intersects with the need for workforce competencies in energy management, sustainable resource use, and technological innovation aimed at reducing dependency on fluctuating global supply chains.

Closely related are references to tightening EU sustainability regulations and environmental compliance requirements. Respondents underscore increasing expectations associated with emissions monitoring, sustainable fertiliser use, reduction of environmental impacts, and alignment with EU regulatory frameworks. These trends reveal the growing importance of regulatory literacy and the need for organisations to develop internal capacity to interpret and implement complex environmental legislation. Some respondents also emphasise pressure from GHG reporting obligations, reflecting the regulatory shift toward transparent climate accountability.

A third salient theme relates to digitalisation, automation, and smart technologies. Multiple respondents highlight the accelerating role of precision agriculture, IoT, AI, remote sensing (DPZ), robotics, and automated monitoring systems. These technologies are perceived both as external pressure—due to the sector's need to keep pace with innovation—and as an opportunity, enabling more efficient production, enhanced decision-making, and improved environmental performance. Respondents specifically mention that digital innovations are reshaping skills expectations toward data literacy, digital tool proficiency, and the ability to operate and maintain advanced technological systems.

Additionally, respondents mention labour shortages, particularly in skilled technical roles, which intensify the need for training and upskilling. The scarcity of qualified personnel is perceived as both a current operational challenge and a long-term structural issue exacerbated by demographic trends and the evolving skill profile required in modern agriculture and fertiliser production.

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Some responses further point to market pressures, including shifts in agricultural practices such as reduced fertiliser use, changing customer expectations, and the need to strengthen research collaboration and knowledge dissemination. These pressures indicate a broader transformation of industry norms, where innovation capacity, stakeholder engagement, and adaptability become critical competencies for organisations navigating a rapidly changing environment.

Overall, the open-ended responses paint a coherent picture of a sector confronted by economic volatility, regulatory escalation, technological acceleration, and workforce constraints. These pressures collectively necessitate a strategic emphasis on developing skills in sustainability management, digital and data-driven technologies, compliance, and operational innovation. The findings suggest that future workforce development must be multidimensional, integrating technical, regulatory, and digital competences to enable organisations to respond effectively to the complex and interconnected challenges ahead.

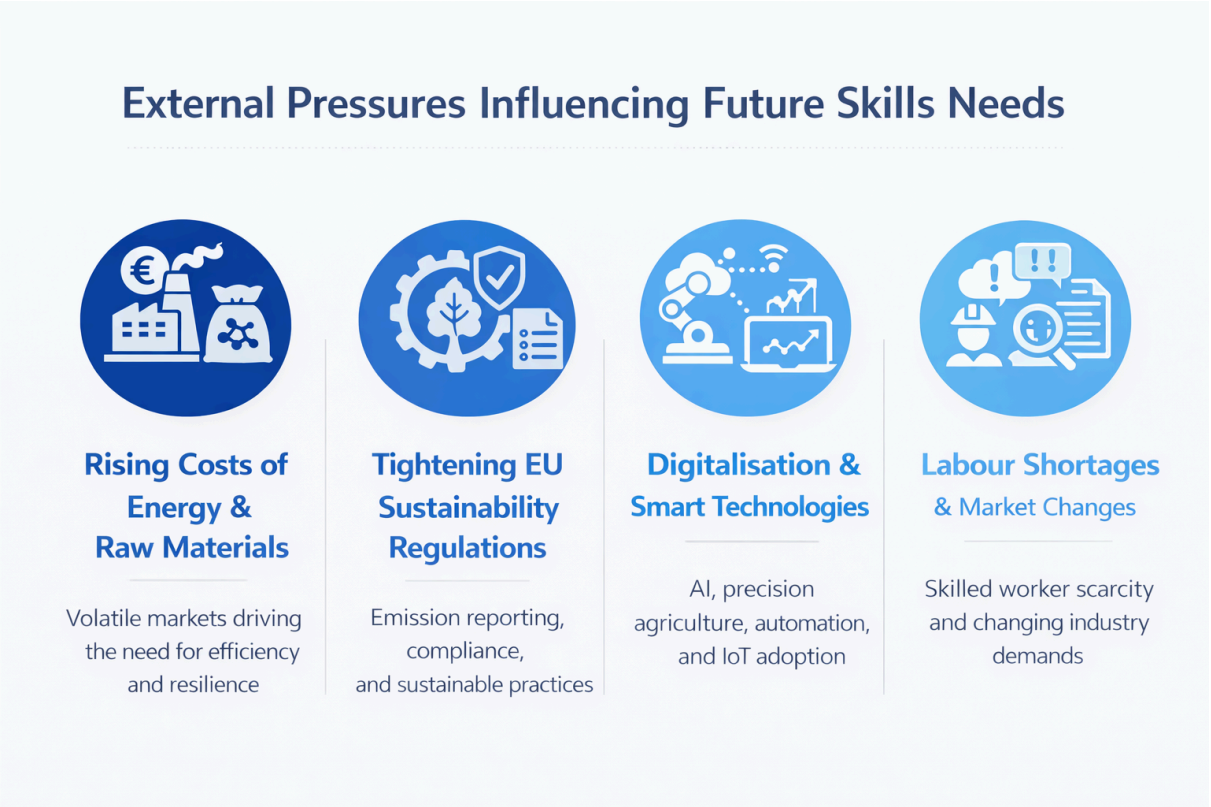

Figure 10: Overview of external pressures and trends influencing future skills needs in the fertiliser and agriculture sector Source: Qualitative analysis of open-ended survey responses. Note: The infographic presents a schematic synthesis of recurring themes and does not reflect quantitative frequencies.

2.2.2. Emerging Job Profiles and Occupational Trends

Responses to the open-ended question concerning future job roles and occupations reveal a clear transformation of the fertiliser and agriculture sector toward more data-driven, digitally enabled, and sustainability-oriented professional profiles. Across organisations of varying sizes and types, respondents consistently highlight the emergence of new hybrid roles that combine technical expertise, digital competencies, and domain-specific agricultural knowledge.

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A prominent trend identified in the responses is the growing demand for data- and analytics-focused roles. Job profiles such as *Agronomic Data Analyst*, *data specialist*, and *experts in monitoring and optimisation* are frequently mentioned. These positions are expected to support decision-making processes related to fertiliser application, soil and crop monitoring, and production efficiency. The emphasis on data-driven roles reflects the increasing availability of digital tools, sensors, and monitoring systems, as well as the need to translate complex datasets into actionable insights.

Closely linked to this development is the anticipated rise of AI- and digital-technology-related occupations, including *AI developers for smart agriculture*, *digital technology specialists*, and *IT professionals*. Respondents indicate that such roles will be critical for the development, implementation, and maintenance of advanced digital solutions, including precision agriculture systems, automation technologies, and intelligent monitoring platforms. Several responses underline the importance of professionals capable of integrating digital technologies into existing production and agricultural practices, particularly within small and medium-sized enterprises.

Another recurring theme concerns agri-tech and interdisciplinary management roles, such as *Agri-Tech managers* or positions combining technological, agronomic, and organisational responsibilities. These roles are described as bridging traditional agricultural expertise with emerging technological capabilities, enabling coordination between production, data management, sustainability objectives, and innovation processes. This trend suggests an increasing need for professionals with hybrid skill sets that span technical knowledge, systems thinking, and strategic oversight.

In addition to industry-focused roles, respondents from education, research, and public institutions highlight the continued importance of researchers, educators, and training professionals. These occupations are viewed as essential for supporting knowledge transfer, workforce upskilling, and the development of new competencies aligned with digital and green transitions. The inclusion of these profiles reflects recognition of the role played by education and research in sustaining long-term sectoral innovation.

Overall, the responses indicate that future employment in the fertiliser and agriculture sector will increasingly favour multidisciplinary roles that integrate agronomic expertise, digital literacy, data analytics, and sustainability awareness. Traditional job profiles are expected to evolve rather than disappear, with many positions incorporating new technological and analytical dimensions. These findings underscore the need for adaptable training pathways and continuous professional development to equip the workforce for emerging occupational demands driven by technological advancement and environmental transformation.

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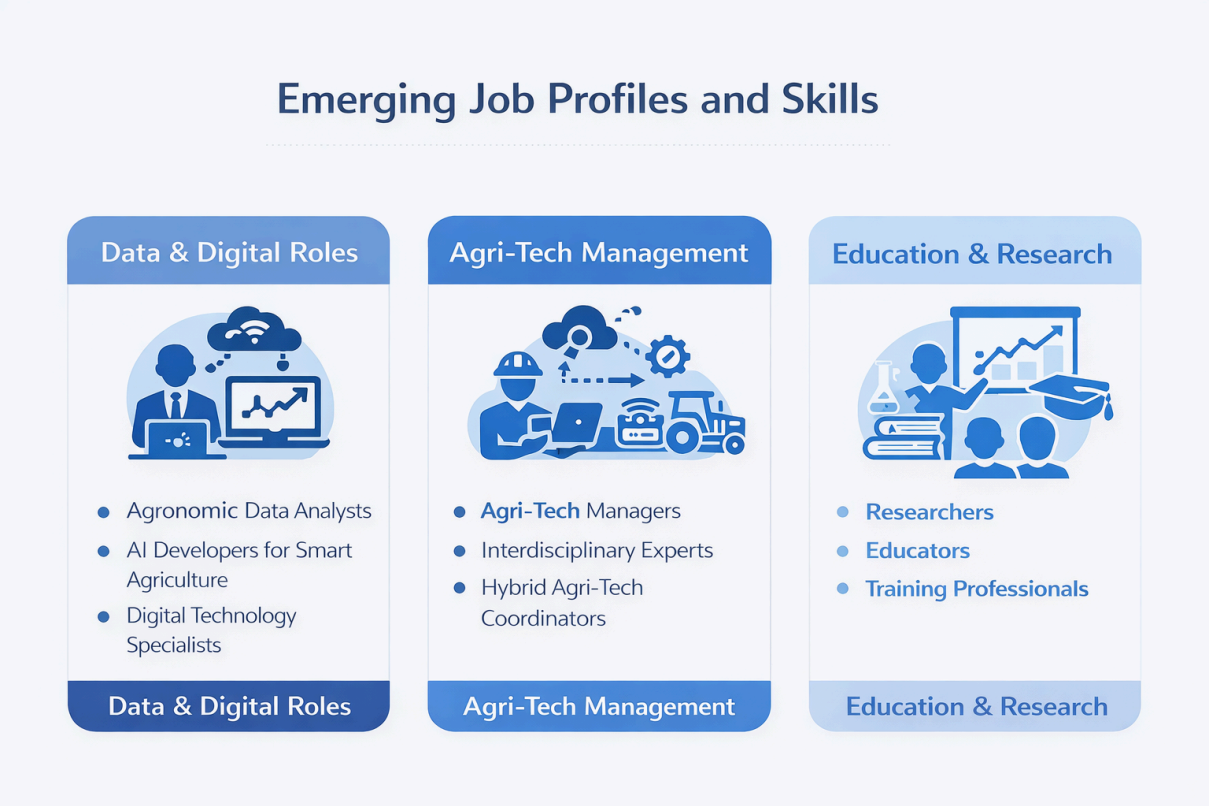

Figure 11: Emerging and evolving job profiles identified by respondents
Source: Qualitative analysis of open-ended survey responses. Note: The infographic presents a schematic synthesis of recurring themes and does not reflect quantitative frequencies.

2.2.3. Key Skills Required to Address Future Sectoral Challenges

Responses to the open-ended question focusing on key skills required to meet future challenges highlight a clear shift toward a combination of digital, analytical, sustainability-oriented, and transversal competencies. Rather than emphasising narrowly defined technical skills alone, respondents consistently point to the growing importance of integrated skill sets that enable adaptation to technological change, regulatory complexity, and evolving market expectations.

A prominent theme emerging from the responses is the increasing demand for digital and data-related skills. Respondents frequently mention competencies linked to data analysis, digital tools, artificial intelligence, and information technologies. Skills such as working with digital platforms, interpreting data outputs, and leveraging analytical tools for decision-making are perceived as essential across multiple occupational profiles. This reflects the broader digitalisation of the fertiliser and agriculture sector, where data-driven approaches underpin production optimisation, environmental monitoring, and strategic planning.

Closely related is the emphasis on technological and innovation-oriented skills, including the ability to understand and operate advanced technologies such as precision agriculture systems, automation tools, and smart monitoring devices. Respondents highlight the need not only for technical operation but also for problem-solving capabilities and continuous learning, enabling workers to adapt to rapidly evolving technological environments.

Another recurring theme concerns sustainability-related skills, particularly those associated with environmental management, resource efficiency, and compliance with sustainability

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standards. Respondents underline the importance of understanding soil health, fertiliser efficiency, emissions reduction, and environmental impact assessment. These competencies are increasingly viewed as core requirements rather than specialised knowledge, reflecting the central role of sustainability objectives in shaping sectoral practices and regulatory obligations.

In addition to technical and sustainability-oriented skills, respondents place strong emphasis on transversal and soft skills. Competencies such as adaptability, critical thinking, communication, and interdisciplinary collaboration are frequently mentioned as necessary for navigating complex organisational and regulatory contexts. Several responses also highlight the importance of change management and the ability to translate technical knowledge into practical applications across different stakeholder groups.

Finally, a number of respondents stress the growing relevance of training, knowledge transfer, and lifelong learning skills. As technologies and regulatory frameworks continue to evolve, the capacity to continuously update skills—both individually and organisationally—is perceived as a key factor in maintaining competitiveness and resilience. This includes not only participation in training but also the ability to disseminate knowledge within organisations and across value chains.

Overall, the responses suggest that future skill requirements in the fertiliser and agriculture sector will be characterised by hybrid competence profiles, integrating digital literacy, sustainability awareness, technological proficiency, and strong transversal skills. These findings reinforce the need for flexible and modular training approaches that support continuous upskilling and reskilling in response to interconnected green and digital transitions.

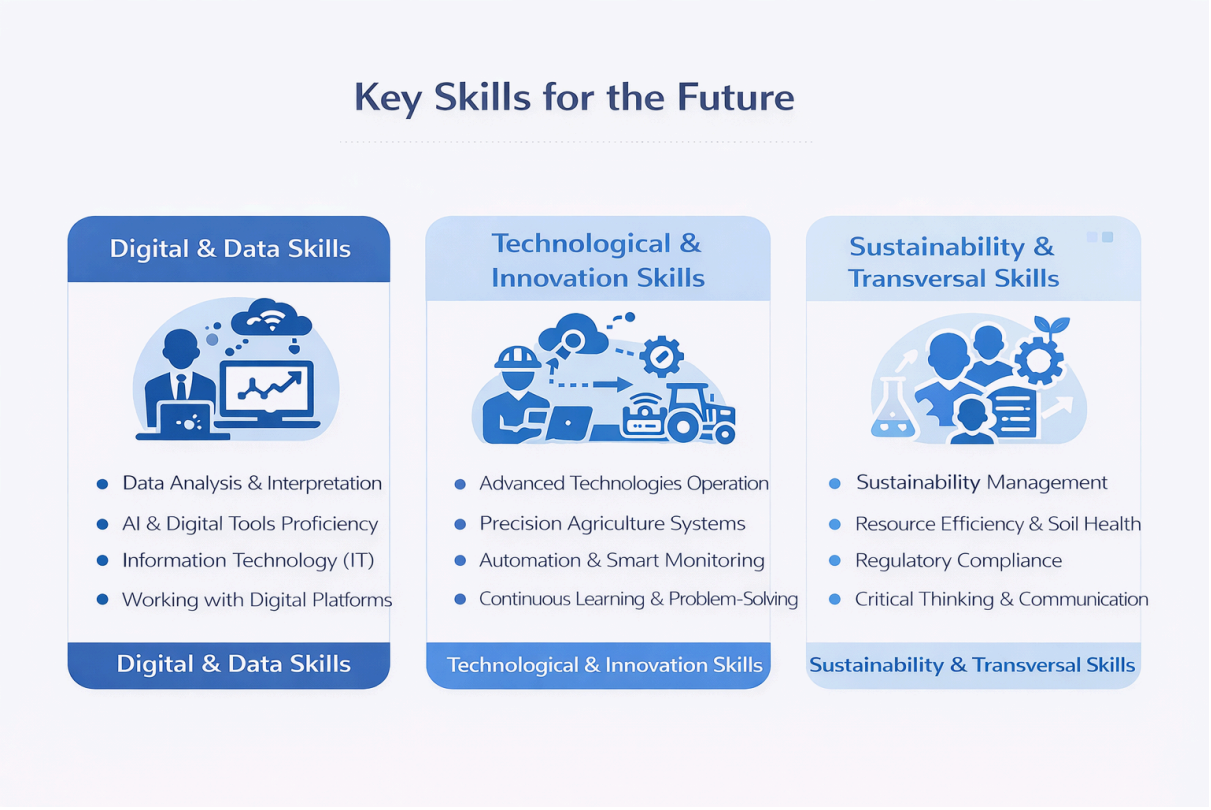

Figure 12: Key skills required to address future sectoral challenges

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Source: Qualitative analysis of open-ended survey responses. Note: The infographic presents a schematic synthesis of recurring themes and does not reflect quantitative frequencies.

2.2.4. Additional Emerging Job Profiles

Responses to the final open-ended question, in which participants were invited to identify up to three additional job profiles relevant for the future of the fertiliser and agriculture sector, further reinforce the sector's ongoing transformation toward sustainability-oriented, technology-enabled, and interdisciplinary roles. The diversity of responses reflects variations in organisational size and type; however, several common patterns emerge across the dataset.

A significant share of respondents highlights technically specialised roles linked to sustainable production and resource efficiency. Profiles such as *chemical engineers focused on resource-efficient technologies*, *agricultural engineers*, and *operational managers* are frequently mentioned. These roles emphasise the optimisation of production processes, the responsible use of inputs, and the integration of environmental considerations into core operational functions. Their prominence suggests that traditional engineering and operational roles are not diminishing but rather evolving to incorporate sustainability and efficiency objectives.

Another prominent category includes agri-tech and digital-oriented job profiles, such as *Agri-Tech Manager*, *Smart Farming Technician*, *data specialist*, and *future farmer*. These roles combine agricultural knowledge with digital competencies, reflecting the increasing integration of data analytics, precision farming technologies, and automated systems into everyday agricultural practice. Respondents' references to such profiles underscore the growing need for professionals capable of bridging the gap between advanced technologies and practical on-farm or industrial applications.

Several responses also point to the emergence of advisory, research, and development-oriented roles, including *research developers* and *Sustainable Farm Management Advisors*. These profiles are oriented toward supporting innovation, providing expertise on sustainable practices, and facilitating knowledge transfer across the sector. The inclusion of such roles highlights the importance of research capacity and advisory services in enabling organisations—particularly smaller enterprises and farms—to adapt to regulatory, technological, and environmental change.

In addition, some respondents explicitly note that certain job profiles are context-dependent or not universally applicable, indicating that the relevance of specific roles may vary according to organisational size, maturity, and strategic focus. This observation reinforces the notion that future workforce needs in the fertiliser and agriculture sector will be highly heterogeneous, requiring flexible and adaptable training pathways rather than one-size-fits-all solutions.

Overall, the responses to this question illustrate that future employment in the sector will increasingly revolve around hybrid job profiles combining technical expertise, digital skills, sustainability awareness, and managerial or advisory capabilities. These findings further confirm the importance of interdisciplinary education and continuous upskilling in preparing the workforce to meet the complex demands of the sector's green and digital transitions.

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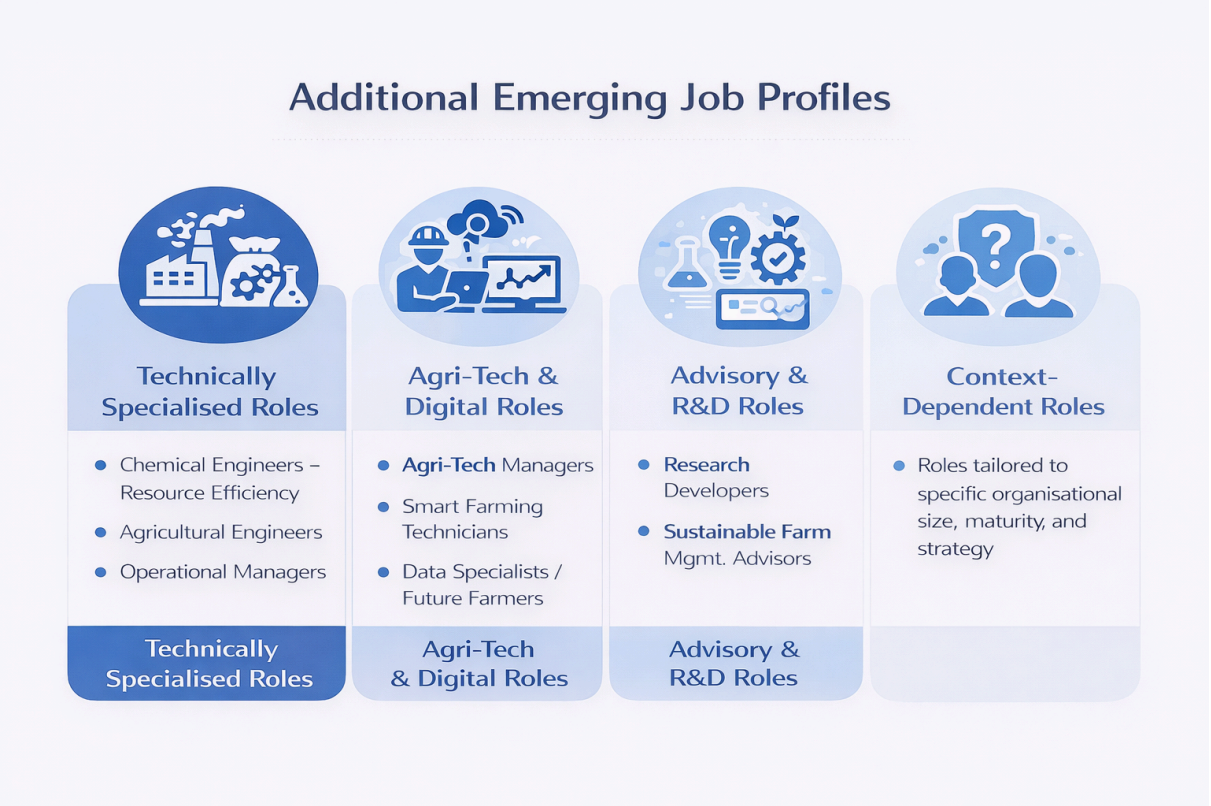

Figure 13: Additional job profiles proposed by respondents across the fertiliser and agriculture value chain Source: Qualitative analysis of open-ended survey responses. Note: The infographic presents a schematic synthesis of recurring themes and does not reflect quantitative frequencies.

While the qualitative insights presented in the previous chapter provide an in-depth understanding of external pressures, emerging job profiles, and evolving skill requirements, it is equally important to examine how organisations translate these needs into concrete workforce development practices. In particular, the feasibility and effectiveness of upskilling and reskilling initiatives depend not only on identified competence gaps but also on organisational preferences, constraints, and capacities related to employee training. The following chapter, therefore, shifts the focus from skills demand to training delivery, exploring preferred training formats and time availability for employee participation. This analysis offers a practical perspective on how training programmes can be designed to align with organisational realities in the fertiliser and agriculture sector.

2.3. Training Needs, Formats and Organisational Constraints

Employee training and continuous professional development represent a critical component of workforce adaptation in the context of ongoing digital and green transitions within the fertiliser and agriculture sector. To better understand organisational approaches to training, the second iteration of the ChemSkills survey included a set of questions focusing on preferred training formats, time availability for training participation, and related organisational constraints.

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This section presents an analysis of respondents' preferences regarding different modes of training delivery, as well as the maximum duration for which employees can be released from regular work duties to engage in training activities. Together, these insights provide a structured overview of how organisations balance the need for upskilling and reskilling with operational requirements and time constraints.

The findings contribute to a more comprehensive understanding of training feasibility across diverse organisational contexts and offer important implications for the design of future training programmes. In particular, the results highlight the need for flexible, modular, and context-sensitive training solutions that can accommodate varying preferences, resource capacities, and operational realities within the sector.

2.3.1. Preferences Regarding Training Formats for Employees

The survey results concerning preferred training formats for employees provide important insights into how organisations in the fertiliser and agriculture sector prioritise different modes of learning and professional development. Overall, the findings indicate a clear preference for structured, interactive, and organisation-embedded training formats, while more technologically advanced or less conventional approaches receive comparatively lower importance ratings.

The highest importance is attributed to in-person trainings, such as workshops and seminars, which achieve an average importance score of 4.3. This strong preference highlights the continued value placed on face-to-face learning environments that enable direct interaction, hands-on experience, and immediate knowledge exchange. The relatively low variance associated with this format further suggests a broad consensus among respondents regarding its effectiveness and relevance.

Similarly, in-house trainings conducted within the organisation receive a high average score of 4.2, reinforcing the importance of training solutions that are tailored to specific organisational contexts, processes, and operational needs. These results indicate that organisations favour learning formats that can be closely aligned with their internal practices and strategic objectives.

Online trainings, including webinars and self-paced online courses, also score highly, with an average importance of 4.1. Despite their digital nature, these formats are clearly perceived as valuable, particularly for their flexibility and accessibility. The relatively low variance associated with online training suggests consistent appreciation across respondents, although they are slightly less prioritised than in-person and in-house formats.

A second tier of preferences includes blended learning formats (online and offline combined), which receive an average score of 3.7, and external training, where employees travel to a training location, with an average score of 3.6. These formats appear to be valued as complementary options, offering a balance between flexibility and structured learning, but they are not perceived as primary training modalities.

Lower average importance scores are observed for synchronised trainings with live interaction (3.3) and non-synchronised, on-demand trainings (3.2). While these formats still exceed the midpoint of the scale, their lower ranking suggests that respondents may perceive them as less effective in fostering engagement or addressing specific skill development needs.

The lowest-rated training format is VR/AR-supported training, with an average importance score of 3.1. This result indicates that immersive technologies, although increasingly

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discussed in the context of innovative training solutions, are not yet widely perceived as essential or readily applicable within current organisational training strategies. Higher variance associated with some of the digitally advanced formats may further reflect differing levels of familiarity, infrastructure readiness, or perceived cost-effectiveness among organisations.

Overall, the distribution of scores suggests that organisations continue to prioritise traditional and blended learning formats that support interaction, contextual relevance, and practical application, while more experimental or technology-intensive training approaches remain supplementary. These findings underline the importance of designing future training programmes that balance digital accessibility with opportunities for direct engagement and organisational specificity.

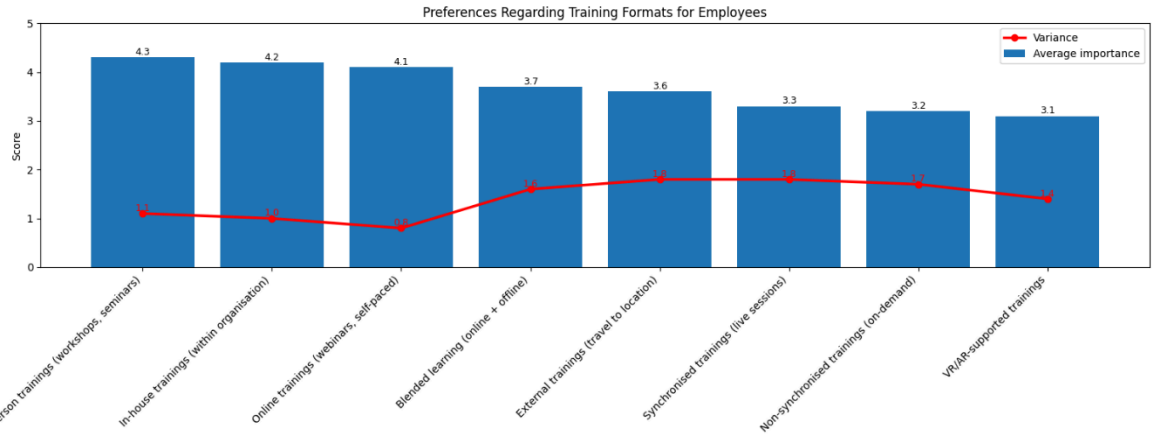

Figure 14: Preferences regarding training formats for employees
Average importance scores and variance of responses for different training formats, based on a five-point Likert scale (1 = not important, 5 = very important). The bar chart represents average importance ratings, while the line illustrates the variance, indicating the degree of consensus among respondents.

2.3.2. Maximum Time Employees Can Be Away from Regular Work Duties for Training

The survey results concerning the maximum time employees can be released from regular work duties for training purposes provide important insights into organisational constraints and flexibility in workforce development planning. The findings indicate that while organisations recognise the importance of training, time availability remains a critical limiting factor influencing the design and delivery of training programmes.

The most frequently indicated option is full-day training, selected by 36% of respondents (9 responses). This result suggests that a significant proportion of organisations are able to accommodate intensive, single-day training formats that allow for focused learning without prolonged disruption to operational activities. Full-day training sessions may therefore represent a pragmatic balance between depth of learning and organisational feasibility.

The second most common response is several days of training, reported by 28% of respondents (7 responses). This indicates that more than a quarter of organisations are willing to release employees for extended training periods, when necessary, particularly for more complex or specialised competencies. Such flexibility may be associated with strategic

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upskilling initiatives, leadership development, or training linked to regulatory compliance and technological transformation.

A further 24% of respondents (6 responses) indicate that employees can be released for half-day training sessions. This preference highlights the continued relevance of shorter, modular training formats that can be more easily integrated into daily work schedules. Half-day sessions may be particularly suitable for targeted skill updates, refresher courses, or introductory training modules.

Finally, 12% of respondents (3 responses) selected other options, suggesting alternative or context-specific arrangements not captured by the predefined categories. These responses may reflect flexible or hybrid approaches, such as staggered training schedules, on-the-job learning, or highly individualised training solutions.

Overall, the distribution of responses demonstrates that organisations in the fertiliser and agriculture sector exhibit moderate to high flexibility regarding employee participation in training, with a clear preference for formats that limit prolonged absence from operational duties. The results underline the importance of designing training programmes that are adaptable in duration, offering both intensive short-term options and modular structures that can accommodate varying organisational constraints. Such flexibility is likely to be critical in ensuring broad participation and effective upskilling across diverse organisational contexts.

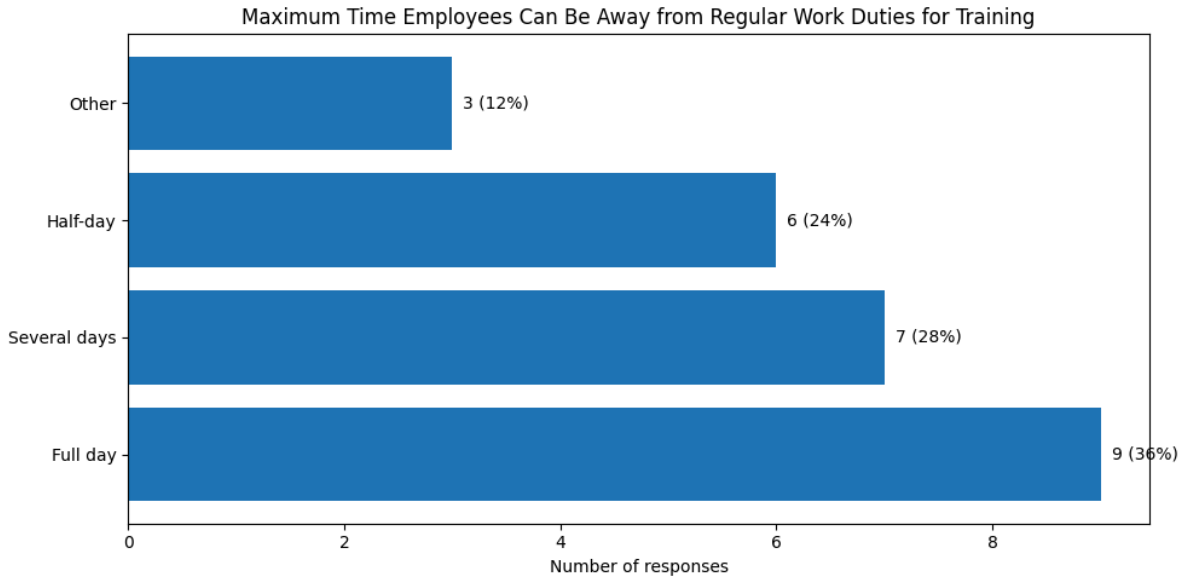

Figure 15: Maximum time employees can be away from regular work duties for training
Distribution of responses indicating the maximum duration for which employees can be released from regular work duties to participate in training activities. Values represent the number of responses and corresponding percentages.

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3. Conclusion

The second iteration of the ChemSkills sectoral survey provides a comprehensive and up-to-date overview of evolving skills needs within the fertiliser and agriculture sector in the context of ongoing digital and green transitions. By combining quantitative assessments of competence domains with qualitative insights derived from open-ended responses, the survey captures both the strategic priorities of organisations and the practical challenges they face in workforce development.

The quantitative results highlight a clear shift in competence requirements toward data-driven, sustainability-oriented, and regulation-aware skill sets. Competencies related to precision agriculture, advanced analytics, environmental sustainability, regulatory compliance, and digital security emerge as particularly important, reflecting the sector's increasing reliance on digital technologies and its growing exposure to environmental and regulatory pressures. At the same time, more traditional technological and process-oriented competencies remain relevant, though they are increasingly complemented by interdisciplinary skills that integrate digital, environmental, and analytical dimensions.

The qualitative findings further enrich this picture by identifying external pressures, such as rising energy and input costs, tightening environmental regulations, accelerating digitalisation, and labour shortages, as key drivers shaping future skills needs. Respondents also emphasise the emergence of hybrid job profiles that combine agronomic expertise with digital, data, and sustainability competencies. These insights underscore the need for adaptable and forward-looking workforce strategies capable of responding to complex and interconnected challenges.

In addition, the analysis of training needs and organisational constraints reveals that while organisations recognise the importance of continuous professional development, time availability and operational feasibility remain critical considerations. Respondents show a clear preference for in-person, in-house, and online training formats, alongside a willingness to release employees for short to medium-duration training periods. These findings highlight the importance of designing flexible, modular, and context-sensitive training solutions that align with organisational realities while supporting effective upskilling and reskilling.

Overall, the results of the second survey iteration confirm that addressing future skills needs in the fertiliser and agriculture sector requires a holistic approach that integrates technological innovation, environmental responsibility, regulatory awareness, and workforce development. The findings provide a robust evidence base for the next phases of the ChemSkills project, particularly in the design of targeted training programmes, competence frameworks, and policy-relevant recommendations aimed at supporting a resilient, skilled, and future-ready workforce.

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