



From Classroom to Sustainable Plantation: Vocational Education–Oil Palm Industry Partnerships for Building Skills, Professionalism, and Sustainable Plantation Management in Indonesia-A Review

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ABSTRACT

Indonesia's transition toward sustainable oil palm production depends not only on regulation, certification, technology, and corporate commitments but also on the competence of people who translate sustainability principles into everyday plantation decisions. This qualitative literature review examines the strategic role of plantation-based vocational education in developing such human capital and assesses how structured cooperation between vocational institutions and oil palm companies can enhance graduate competence and professionalism. Drawing on recent literature published predominantly between 2020 and 2026, the review integrates scholarship on sustainable palm oil, vocational education and training, work-integrated learning, green skills, agricultural competencies, digitalization, and graduate employability. The thematic synthesis identifies seven interrelated findings. Sustainable oil palm has become increasingly competency-intensive; graduates require multidimensional technical, environmental, digital, social, managerial, safety, and ethical capabilities; industry collaboration can reduce education–workplace mismatches; work-integrated learning supports professional identity formation; teaching factories and authentic industry projects can improve occupational currency; partnership quality matters more than workplace exposure alone; and vocational–industry collaboration can produce sustainability benefits extending beyond individual companies. The paper proposes a Sustainable Plantation Vocational Partnership framework linking sustainability requirements, curriculum design, authentic workplace learning, competency assessment, professional formation, and plantation outcomes. The review concludes that plantation vocational education should be treated as part of Indonesia's sustainability infrastructure and recommends institutionalized, accountable, inclusive, and sustainability-oriented partnerships among education providers, plantation companies, government, certification bodies, smallholders, and communities

INTRODUCTION

Indonesia's oil palm industry occupies an unusual position in the global sustainability debate. Oil palm generates significant economic value, supports rural livelihoods, creates employment, provides raw materials for food and non-food industries, and contributes to regional development. At household and landscape levels, oil palm expansion has also reshaped farm welfare, labor allocation, and land-use relations, underscoring that sustainability cannot be reduced to a single environmental or economic indicator (Mehraban et al., 2021; Ngadi and Nagata, 2022). At the same time, the rapid historical expansion of plantations has generated concerns regarding deforestation, biodiversity loss, greenhouse-gas emissions, peatland conversion, land conflict, labor conditions, and uneven distribution of economic benefits. The contemporary policy challenge is therefore no longer whether oil palm should simply expand or contract, but how production can be intensified, governed, monitored, and renewed in ways that reconcile economic development with ecological and social objectives (Purnomo et al., 2020; Qaim et al., 2020; Xin et al., 2022).

This sustainability challenge has increasingly been translated into operational requirements at plantation level. Certification systems, good agricultural practices, zero-deforestation commitments, biodiversity conservation, traceability, replanting, appropriate fertilizer management, occupational health and safety, waste utilization, greenhouse-gas management, community engagement, and increasingly sophisticated digital technologies all require people who can interpret information and act competently. Sustainability is therefore not only a question of policies and standards; it is a question of whether managers, assistants, supervisors, technicians, field workers, smallholders, and service providers have sufficient capabilities to implement those standards in routine operational decisions. Studies of Indonesian smallholders consistently show that insufficient knowledge, organizational capacity, access to extension, technical support, and training can impede adoption of certification and good agricultural practices (Nurliza, 2020; Ernah et al., 2020; Watts et al., 2021; Petri et al., 2024; Reich and Musshoff, 2025).

The importance of human competence becomes particularly visible where formal sustainability requirements encounter complex realities in the field. RSPO and ISPO-related requirements may specify desirable practices, but compliance requires people who understand documentation, agronomy, environmental risks, labor standards, and traceability. Research involving Indonesian smallholders has shown that certification barriers are differentiated and may include structural disadvantages, limited institutional capacity, insufficient knowledge, and inadequate support systems (Apriani et al., 2020; Watts et al., 2021; Muchlis et al., 2026). More recent evidence also indicates that certification alone does not necessarily guarantee comprehensive adoption of Good Agricultural Practices, reinforcing the need for continuous capability formation rather than one-off compliance interventions (Syahputra et al., 2026).

Plantation-based vocational education consequently deserves greater attention in the sustainable palm oil agenda. Vocational education is specifically designed to connect education with occupations, production systems, workplace

practices, and applied competencies. In a plantation setting, its potential role extends from producing agronomic technicians to developing field supervisors, sustainability personnel, laboratory technicians, machinery operators, digital-agriculture specialists, safety practitioners, and future plantation managers. Yet the contribution of vocational education should not be conceptualized narrowly as supplying labor. Its larger function is to create the human capability needed to translate sustainability objectives into operational routines, consistent with contemporary scholarship that positions VET and skills systems as important components of socially just and sustainable transitions (McGrath and Ramsarup, 2024; Ramsarup et al., 2024).

This perspective is especially relevant as plantation work itself changes. Precision agriculture, remote sensing, artificial intelligence, Internet-of-Things devices, big-data systems, digital traceability, drones, mechanization, and sensor-based decision support are becoming increasingly relevant to oil palm production. The technological direction of the industry implies that plantation graduates will need capabilities that combine conventional agronomy with data literacy, digital reasoning, technological adaptability, and systems thinking (Mohamad Zaki et al., 2025; Suud et al., 2026). Climate change adds another layer because future professionals need to understand water management, nutrient optimization, climate risks, carbon implications, and adaptive agronomic decisions (Safitri et al., 2026). Vocational institutions cannot develop all these competencies effectively in isolation from the workplaces where technologies, management systems, sustainability procedures, and professional norms evolve. Research on Indonesian vocational education increasingly emphasizes the role of industry in curriculum alignment, implementation, assessment, internships, and occupational relevance. Yoto et al. (2024a), for example, place industry involvement at the center of aligning and implementing Indonesia's vocational curriculum, while Yoto et al. (2024b) demonstrate the importance of "link and match" collaboration for workforce readiness. International literature similarly finds that industry linkage, work-integrated learning (WIL), and structured workplace experiences can strengthen employability, occupational capabilities, and students' understanding of professional work (Jackson and Bridgstock, 2021; Jackson and Dean, 2023; Kebede et al., 2024).

However, collaboration is not automatically effective simply because students spend time inside a company. Contemporary WIL scholarship differentiates workplace exposure from educationally integrated workplace learning. Students need appropriate tasks, mentoring, opportunities to participate, reflection, assessment, feedback, psychological and occupational safety, and explicit links between workplace activity and curriculum outcomes. Billett (2025) emphasizes the importance of integrating experiences across educational and workplace settings, while Björck and Willermark (2025) warn against conceptually reducing WIL to the physical location in which learning occurs. Recent reviews further emphasize scaffolded design, sustained external-partner engagement, adequate resourcing, purposeful assessment, and continuous evaluation as conditions for high-quality WIL (Jackson, 2024; Luk and Chan, 2024). Recent Indonesian evidence likewise supports structured

internship models involving preparation, dual supervision, workplace integration, and post-placement evaluation (Wahyuningsih et al., 2026).

A research gap therefore exists at the intersection of two substantial but often separate bodies of literature. Palm oil sustainability research focuses strongly on certification, deforestation, smallholders, supply chains, replanting, productivity, and governance. Vocational education research focuses strongly on employability, competency development, workplace learning, teaching factories, and education–industry alignment. Relatively little literature explicitly conceptualizes plantation vocational education as an implementation mechanism for sustainable oil palm management. Bridging these domains could shift the debate from “How can vocational graduates obtain plantation jobs?” toward the more strategic question: How can vocational education and oil palm company partnerships build the professional human capability required for a sustainable plantation transition? Accordingly, this article addresses six research questions: (1) What strategic role can plantation-based vocational education play in supporting sustainable oil palm management in Indonesia? (2) What competencies are increasingly required? (3) Through what mechanisms can education–company cooperation improve competence and professionalism? (4) Which partnership models are particularly relevant? (5) What risks and constraints may reduce partnership effectiveness? and (6) What integrated framework can connect vocational education, professional development, and plantation sustainability? Together, these questions connect educational design, workplace learning, professional formation, and measurable sustainability outcomes within one analytical architecture. The review aims to conceptualize plantation vocational education as human-capital infrastructure for sustainable palm oil, identify a multidimensional competency architecture for future plantation professionals, explain the mechanisms through which industrial partnership contributes to professional formation, and propose a Sustainable Plantation Vocational Partnership framework suitable for the Indonesian context. This framing treats education–industry collaboration not merely as an employability intervention, but as a potential mechanism for strengthening the implementation capacity of the wider sustainable palm oil system.

LITERATURE REVIEW

Plantation-Based Vocational Education and Human-Capital Formation

Vocational education differs from general academic education because occupational capability is central to its purpose. Its effectiveness therefore depends not only on what students know, but also on what they can demonstrate, diagnose, communicate, decide, improve, and take responsibility for in real or realistically simulated workplaces. Human-capital reasoning helps explain why this matters to plantations: competent personnel can improve productivity, reduce avoidable losses, support technological adoption, implement standards, and adapt organizational practices. The economic importance of competence becomes especially visible in complex production systems where seemingly small field-level decisions accumulate into substantial differences in yield, cost, safety, environmental performance, and product quality. Indonesian vocational policy has increasingly emphasized closer

alignment between education and industry. Empirical work identifies reciprocal school-industry cooperation, industry-responsive curriculum implementation, teaching-factory development, and practical learning as important mechanisms for reducing competency mismatch (Nahriana and Arfandi, 2020; Saputro et al., 2021; Yoto et al., 2024a; Yoto et al., 2024b). Evidence on vocational education and decent work in Indonesia also indicates that employment outcomes differ by gender and by urban-rural context, reinforcing the need for partnership models that are not only industry-relevant but also inclusive and territorially sensitive (Choi et al., 2023; Choi et al., 2024). The implication for plantation education is significant. Curricula designed mainly around stable technical routines may become obsolete when sustainability requirements, digital systems, mechanization, and traceability evolve more quickly than institutional curriculum cycles.

Plantation vocational education should therefore be understood as an occupational ecosystem rather than a collection of agricultural subjects. Core agronomic capabilities remain essential, but graduates increasingly need capabilities in environmental management, sustainability documentation, data interpretation, occupational safety, leadership, communication, and adaptive problem solving. McDonald et al. (2024) show that contemporary agricultural employers value non-technical capabilities across workforce levels, while Nyamweru et al. (2024) identify systems thinking, innovation, planning, continuous learning, leadership, interdisciplinarity, and change facilitation among competencies relevant to sustainable agriculture.

Sustainable Oil Palm Management as a Competency System

A major conceptual proposition of this review is that sustainable plantation management can be interpreted as a competency system. Every substantive sustainability commitment creates an associated human-capability requirement. A prohibition against burning requires knowledge of alternatives, fire prevention, monitoring, and emergency response. Biodiversity commitments require personnel who can recognize conservation areas, interpret maps, manage threats, monitor indicators, and communicate with neighboring communities. Traceability requires accurate records, digital literacy, data discipline, and chain-of-custody awareness. Decent work requires supervisors who understand safety, labor rights, grievance mechanisms, non-discrimination, and responsible leadership. This interpretation helps explain why sustainability performance can remain uneven even after standards have been formally introduced. Nurliza (2020) identifies strategic competencies associated with legal, environmental, organizational, and farm-management dimensions among independent smallholders. Ernah et al. (2020) demonstrate the potential economic value of sustainability-oriented farmer field schools, indicating that teaching standards can be an investment rather than simply a compliance cost. Nurliza et al. (2022) similarly highlight the role of farmer organization, environmental monitoring, and sustainable business development in generating sustainability benefits.

The same logic applies to replanting and intensification. Replanting is not simply the physical replacement of old palms; it requires decisions concerning planting materials, field design, finance, soil preparation, biodiversity, livelihood

continuity, and subsequent crop management. Petri et al. (2024) identify knowledge and proper training among major replanting constraints, while Siregar et al. (2024) and Hendrawan and Musshoff (2024) demonstrate that participation and program design depend on socioeconomic and institutional conditions. Collective organization is also important for resilient replanting pathways (Jelsma et al., 2024). Sustainability is also multidimensional. Assessments of Indonesian smallholder plantations highlight economic, environmental, social, institutional, and technological dimensions rather than a single performance criterion (Saragih et al., 2020; Supriatna et al., 2024). This multidimensionality has educational implications. A technically competent graduate who cannot understand institutional procedures, social relationships, environmental risks, or technology adoption is not fully prepared for sustainable plantation management.

Green Skills and Education for Sustainable Development

The growing literature on green skills provides a second conceptual foundation. Green skills extend beyond knowing environmental terminology. They include capacities to reduce resource use, interpret environmental impacts, solve sustainability-related problems, use cleaner technologies, manage waste, conserve resources, innovate, and incorporate long-term ecological consequences into occupational decisions. Fuchs (2024) notes that green skills are increasingly considered prerequisites for sustainability transitions, although their definitions and implementation remain fragmented. Albertz (2025) similarly demonstrates that green vocational education is shaped by diverse actors, meanings, and regional settings. The vocational education literature therefore increasingly advocates integrating sustainability across occupational curricula rather than teaching it as an isolated environmental subject. Chinedu et al. (2023) frame sustainability literacy as the capability to make technically, socially, environmentally, and economically sound decisions. Forsler et al. (2025) show that sustainable-development teaching becomes more meaningful when adapted to vocational contexts, while collaborative learning arrangements with societal actors can create space for reflexive and transformative learning around real sustainability problems (Weijzen et al., 2024). Indonesian research likewise indicates increasing recognition that sustainable vocational education should prepare future workers for technological and sustainability transitions (Suharno et al., 2025; Azahar et al., 2026).

Agriculture requires particularly contextual forms of green competence. Monavvarifard and Alibaygi (2023) argue that agricultural TVET for sustainable development needs systematically defined competencies and pedagogies. Nyamweru et al. (2025a) demonstrate that specific educational modules can strengthen students' sustainability competencies, while Nyamweru et al. (2025b) show the value of competence-based approaches in vocational agriculture. Evidence from green-skills development in other Global South vocational contexts also shows that fragmented initiatives, coordination gaps, and limited human-resource capacity can constrain effective implementation, strengthening the case for coherent institutional and industry partnerships (Owusu-Agyeman and Aryeh-Adjei, 2024). These findings support a plantation curriculum in which

environmental competence is embedded in actual occupational activities such as fertilizer planning, water management, riparian-zone protection, waste utilization, integrated pest management, replanting, biodiversity monitoring, and climate adaptation.

Work-Integrated Learning and Professional Formation

WIL is especially relevant because plantation competence contains substantial tacit and contextual knowledge. Students can learn harvesting standards, agronomic theory, sustainability indicators, or occupational-safety rules in classrooms, but professional judgment develops through encounters with variability, deadlines, organizational responsibilities, conflicting objectives, imperfect data, and real consequences. WIL literature shows that workplace learning can contribute to employability and professional readiness, but its value depends on design. Jackson and Bridgstock (2021) found that learning and work experiences differ in their employability contribution, while Jackson and Dean (2023) emphasize variation across forms of WIL. More recent work stresses that WIL should be scaffolded across the curriculum and supported by sustained partner engagement, resourcing, and evaluation (Jackson, 2024). Assessment is equally important: a systematic review by Luk and Chan (2024) identified diverse assessment methods and emphasized that assessment should support learning and the development of self-regulated, lifelong learners rather than function merely as an accountability exercise. Runcieman (2022) highlights professional identity formation through workplace participation, demonstrating that WIL exposes students to professional norms, values, beliefs, and social expectations. This is highly relevant to plantation professionalism because a technically capable graduate must also learn what it means to be accountable for people, equipment, biological assets, environmental risks, and community relations.

Recent WIL research strengthens the argument for structured integration. Rienties et al. (2023) find that WBL increasingly includes technologically mediated and project-based formats, creating opportunities beyond conventional placement models. Kligyte et al. (2024) show that work-integrated professional learning can generate value for partner organizations as well as students. Hwang et al. (2026), reviewing intervention studies in engineering WIL, identify multifaceted benefits but also methodological and contextual complexity. Thus, company partnerships should not merely “host” students; they should co-create educational experiences.

METHODOLOGY

Research Design

This study employs a qualitative, integrative literature review. It is deliberately not designed as a systematic literature review, meta-analysis, or PRISMA-based evidence synthesis. The purpose is interpretive: to connect bodies of scholarship that are often treated separately and use them to construct a conceptual explanation of how plantation vocational education and industry cooperation can support sustainable oil palm management. The qualitative review approach is suitable because the research questions concern mechanisms, conceptual relationships, institutional arrangements, competencies, and policy

implications rather than the pooled effect size of a narrowly specified intervention. Literature on palm oil sustainability, TVET, work-integrated learning, agricultural education, green skills, employability, and plantation technology uses heterogeneous methods and units of analysis. An interpretive synthesis therefore provides greater analytical flexibility than attempting to impose a homogeneous systematic-review framework on conceptually diverse evidence.

Literature Identification and Scope

The literature base prioritized peer-reviewed journal articles published from 2020 through September 2026. Search concepts were iteratively combined around five clusters: oil palm sustainability and Indonesia; skills, training and capacity building; vocational education and industry collaboration; WIL and professional competence; and green/digital skills for sustainable agriculture. Search terms included combinations of “oil palm”, “Indonesia”, “sustainability”, “certification”, “Good Agricultural Practices”, “training”, “skills”, “vocational education”, “TVET”, “work-integrated learning”, “industry partnership”, “teaching factory”, “green skills”, “agricultural competencies”, “digital agriculture”, and “precision agriculture”. Priority was given to reputable international peer-reviewed journals indexed through major academic databases and publisher platforms. Selected Indonesian peer-reviewed journals were included where they provided contextually important evidence that was not adequately represented in international literature, especially regarding smallholder competencies and Indonesian vocational policy.

Analytical Procedure

The synthesis used an iterative thematic process. First, literature was read for explicit statements concerning sustainability challenges, human-capability requirements, vocational competence, industry involvement, learning mechanisms, professionalism, and employment outcomes. Second, codes were clustered into higher-order themes. Third, relationships among themes were examined to identify causal and institutional pathways. Fourth, these pathways were integrated into the Sustainable Plantation Vocational Partnership framework proposed later in the paper. Rather than counting articles by theme, the analysis focused on conceptual convergence and explanatory complementarity. Palm oil studies were used to identify operational sustainability problems and capability gaps; vocational studies were used to explain curriculum and partnership mechanisms; agricultural education literature helped conceptualize sustainability competencies; and WIL research explained how authentic work participation contributes to competence and professional identity.

Trustworthiness and Limitations

Trustworthiness was enhanced through triangulation across disciplines and publication contexts. Claims concerning plantation sustainability were not inferred from education literature alone, and claims concerning vocational learning were not inferred solely from plantation studies. Instead, relationships were constructed where different research streams could logically and empirically reinforce one another. The review nevertheless has limitations. It is interpretive rather than exhaustive, and the rapidly evolving 2025–2026 literature

means that subsequent evidence may refine the framework. Evidence on direct causal links between vocational graduates and measured plantation sustainability indicators remains limited. That limitation is itself a major finding and supports the future research agenda proposed below.

RESULTS

Theme 1-Sustainable Palm Oil Has Become a Competency-Intensive Production System

The first thematic finding is that sustainable oil palm production increasingly depends upon distributed professional competence. Earlier approaches to plantation workforce development could emphasize task execution: land preparation, planting, upkeep, harvesting, and processing. Contemporary sustainability adds layers of measurement, documentation, environmental stewardship, social responsibility, risk management, and technological interpretation. Certification illustrates this transformation. Apriani et al. (2020) show that independent smallholders may have limited understanding of certification costs and requirements and rely significantly on external organizational support. Watts et al. (2021) similarly identify structural barriers that prevent many farmers from reaching certification standards. Muchlis et al. (2026) report continuing problems of readiness, knowledge, human resources, and certification interpretation. These studies collectively indicate that standards cannot implement themselves; sustainable certification is partly an education and organizational-capacity problem.

The same conclusion emerges from environmental commitments. Scriven et al. (2026) show that managing biodiversity within High Conservation Value and High Carbon Stock areas involves knowledge gaps and social-management challenges. Chandra et al. (2026), studying zero-deforestation commitments in Indonesian smallholder supply chains, report weak awareness and limited capacity building among many producers. The implication is important: future plantation professionals must be capable not only of operating estates but of translating global environmental commitments into understandable, locally workable practices. Sustainability competency is therefore relational. Plantation employees must coordinate with smallholders, auditors, contractors, communities, government officials, mills, suppliers, and certification personnel. A professional who understands agronomy but cannot explain requirements to farmers, organize records, communicate environmental risks, or resolve operational conflicts may become a bottleneck in sustainability implementation.

Theme 2-Sustainable Plantation Professionals Need a Multidimensional Competency Portfolio

A second finding is that conventional distinctions between “technical” and “soft” skills are too simplistic for sustainable plantation management. The literature instead supports at least seven interconnected competency domains. The first is technical-agronomic competence: planting materials, nursery management, nutrition, harvesting, pest and disease management, field upkeep, replanting, soil management, and yield optimization. These remain foundational because sustainable production cannot be separated from biological

productivity. Yield improvements on existing land can reduce pressure for expansion, while poor agronomy can undermine both economic and sustainability objectives (Purnomo et al., 2020; Fosch et al., 2023).

The second is environmental and climate competence. Graduates need to understand soil, water, biodiversity, carbon, waste, fertilizer efficiency, fire prevention, conservation areas, and climate adaptation. Safitri et al. (2026) demonstrate that oil palm agronomic options differ in productivity, carbon, and water-related climate-smartness, illustrating the increasingly analytical nature of field management. Remote sensing and unmanned aerial vehicles can also support sustainability assessment at plantation scale, demonstrating why future professionals need to connect environmental interpretation with geospatial and monitoring skills (Wong et al., 2023). Sustainability professionals therefore require the ability to evaluate trade-offs rather than mechanically apply generalized prescriptions. The third domain is sustainability-assurance competence. Certification and responsible sourcing require documentation, verification, traceability, legal understanding, monitoring, internal control systems, and audit readiness. Nurliza (2020) directly connects sustainable smallholder development to strategic competencies concerning legality, environmental management, farmer organization, and farm management. Sustainable plantation graduates therefore need to understand not only how production occurs but how responsible production is demonstrated.

The fourth is digital and analytical competence. Industry 4.0 technologies are increasingly being incorporated into oil palm monitoring, remote sensing, AI-supported decision-making, IoT applications, big-data analysis, and traceability (Mohamad Zaki et al., 2025). Suud et al. (2026) similarly identify precision agriculture as an important pathway for improving sustainability and productivity. Digital competence should therefore include data collection, interpretation, geospatial awareness, sensor literacy, basic analytics, and the ability to critically evaluate technological recommendations. The fifth is occupational health, safety, and social competence. Plantation management occurs in workplaces involving vehicles, machinery, chemicals, manual handling, field hazards, heat, biological risks, and dispersed work teams. Indonesian evidence among oil palm harvesters shows that unsafe actions are associated with factors including knowledge, attitudes, occupational-safety supervision, training, equipment, and workplace conditions, confirming that safety is both a technical and behavioral competency issue (Iskandar et al., 2023). Sustainable management must therefore integrate safety culture, hazard recognition, appropriate protective measures, emergency preparedness, labor rights, and humane supervision. These competencies are inseparable from professionalism because supervisors influence both practices and organizational norms.

The sixth domain comprises managerial and interpersonal capabilities. Agricultural employers increasingly value problem solving, communication, teamwork, leadership, adaptability, decision-making, and self-management (McDonald et al., 2024). Nyamweru et al. (2024) likewise highlight systems thinking, innovation, planning, interdisciplinarity, leadership, and continuous

learning. Plantation graduates entering supervisory trajectories require these capabilities from the beginning because even junior roles frequently involve coordination across workers, tasks, time, and resources. The seventh domain is professional and ethical competence. Sustainable plantation work creates decisions where economic pressures can conflict with environmental rules, safety, labor welfare, or community expectations. Professionalism therefore includes integrity, accountability, evidence-based judgment, respect, responsibility, and willingness to report or address non-conforming practices. Professional identity is not an optional “soft” outcome; it shapes how technical knowledge is used. The interaction among these competency domains is illustrated in Figure 1. Rather than positioning agronomic knowledge at the center and treating other capabilities as peripheral, the figure conceptualizes sustainable plantation professionalism as the intersection of technical, green, digital, assurance, safety-social, managerial, and ethical capabilities.

Figure 1. Multidimensional Competency Architecture for Sustainable Oil Palm Professionals



Source: Authors' conceptual synthesis based on the literature reviewed.

Figure 1. Multidimensional Competency Architecture for Sustainable Oil Palm Professionals

Figure 1 emphasizes complementarity rather than substitution. Digital skills cannot compensate for poor agronomy, and agronomic competence cannot compensate for unsafe or unethical behavior. Similarly, certification literacy without environmental understanding may generate paperwork rather than substantive sustainability. The educational objective should therefore be integrated professional capability.

Theme 3-Industry Collaboration Can Reduce the Curriculum–Workplace Gap

The literature strongly supports education–industry interaction where occupational practices evolve quickly. Indonesian studies indicate that industries can contribute to curriculum alignment, curriculum implementation, student assessment, internships, teacher development, and realistic learning environments (Nahriana and Arfandi, 2020; Yoto et al., 2024a; Yoto et al., 2024b). This has direct relevance to plantations because companies possess current technologies, production data, workplace procedures, sustainability systems,

professional staff, and authentic operational problems that educational institutions cannot fully reproduce.

However, curriculum alignment should not mean allowing companies simply to dictate narrow job-specific content. Vocational curricula have a broader public responsibility: to prepare graduates who are transferable across employers, capable of lifelong learning, able to understand sustainability beyond a single corporate procedure, and prepared to challenge unsafe or irresponsible practices. The partnership should therefore combine occupational currency with educational independence. One particularly useful mechanism is joint curriculum mapping. Companies and educators can periodically map occupational tasks against competencies. For instance, fertilizer management can be mapped to plant nutrition, soil science, cost analysis, environmental risk, digital recording, worker supervision, and sustainability documentation. A single real-world task thereby becomes a multidisciplinary learning unit. A second mechanism is industry practitioner teaching. Agronomists, sustainability managers, GIS specialists, safety practitioners, mill engineers, human-resource professionals, auditors, and experienced field assistants can expose students to current organizational practices. Their participation is most valuable when coordinated with lecturers rather than replacing them. Industry professionals bring current practice; educators provide pedagogical structure, theory, critical reflection, and transferable understanding. A third mechanism is teacher and lecturer industrial attachment. Curriculum relevance cannot depend exclusively on bringing practitioners into classrooms. Vocational educators themselves require occupational currency. Regular industrial attachment allows teachers to understand new equipment, updated standards, digital systems, changing work organization, and current competency gaps, which can then be incorporated into teaching.

Theme 4-Work-Integrated Learning Builds Professional Identity as Well as Skills

Internships are common in vocational education, but their potential is often underestimated. High-quality WIL exposes students to what professional responsibility feels like. Students observe how experienced practitioners prioritize tasks, respond to uncertainty, communicate with workers, handle safety violations, interpret data, document decisions, and balance targets with standards. Runcieman (2022) emphasizes that professional identity formation occurs through engagement with workplace norms and socialization. Björck (2021) further cautions against treating theory and practice as separate worlds bridged only by placement. Billett (2025) instead conceptualizes integration as learners constructing meaning across educational and workplace experiences. These perspectives imply that plantation internships should include structured reflection: What did the student observe? Why was a decision made? What sustainability principle was involved? What alternative action was possible? What would the student do differently? Recent Indonesian WIL development reinforces the need for structure. Wahyuningsih et al. (2026) propose an internship model consisting of preparation, workplace integration with dual supervision, and post-internship evaluation. Díaz et al. (2026) likewise emphasize scaffolding and clear arrangements between universities and

companies, while recent WIL scholarship highlights the importance of flexible design, sustained partner engagement, inclusion, and systematic evaluation (Jackson, 2024). Such evidence supports replacing the common “placement and attendance” model with a competency-driven architecture. Figure 2 summarizes how authentic industry experience can become professional competence. The central argument is that exposure alone is insufficient: learning depends on a sequence of preparation, meaningful participation, mentoring, reflection, assessment, and feedback.

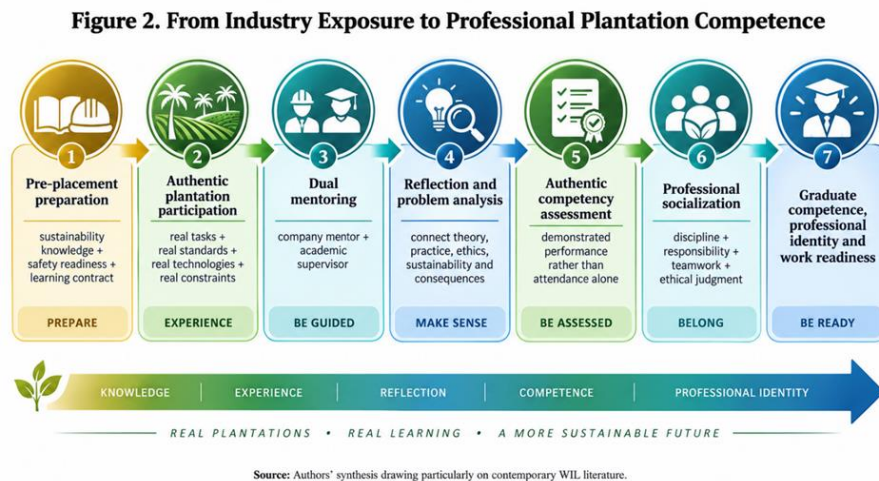


Figure 2. From Industry Exposure to Professional Plantation Competence
Source: Authors' synthesis drawing particularly on contemporary WIL literature.

The figure makes explicit why poorly designed placements may fail. If students are assigned only repetitive low-skill activities, lack access to mentors, are excluded from decision processes, or receive no feedback, they may spend substantial time in industry without developing advanced competence. WIL quality should therefore be judged by learning opportunity and competency achievement rather than placement duration alone.

Theme 5-Teaching Factory and Authentic Projects Can Increase Occupational Currency

Teaching factory approaches provide another mechanism for connecting education with production. Their significance lies in creating environments where students must meet realistic requirements related to quality, time, workflow, teamwork, documentation, customer or production specifications, and continuous improvement. Saputro et al. (2021) report positive evidence concerning teaching factory implementation in Indonesia, while more recent work proposes increasingly adaptive multi-industry teaching-factory models for strengthening occupational competence (Sudarsono et al., 2026). A plantation-oriented teaching factory need not replicate a large commercial estate. It may

consist of an educational plantation block, nursery, composting unit, laboratory, digital-mapping exercise, small mechanization workshop, demonstration conservation area, or data-driven crop-management center. What matters is that students experience an integrated workflow governed by measurable standards.

Authentic company projects can supplement these facilities. Students might analyze fertilizer records, map drainage, design a biodiversity-monitoring protocol, evaluate PPE compliance, analyze harvesting losses, build a simple dashboard, examine traceability gaps, or propose waste-utilization improvements. Such projects align well with emerging vocational approaches that integrate computational thinking, green skills, and project-based learning (Vitalocca et al., 2026).

Theme 6-Partnership Quality Matters More Than Partnership Existence

A recurrent finding in WIL and vocational partnership research is that partnership effectiveness depends on design and governance. Simply signing a memorandum of understanding does not ensure curriculum relevance, meaningful student learning, or employment outcomes. Similarly, sending students to companies is not equivalent to integrating workplace learning into education. Kebede et al. (2024) identify curriculum-industry linkage as an important response to skills mismatch but show that effective linkage depends on institutional conditions. Kligyte et al. (2024) demonstrate that partnerships can produce learning benefits for participating organizations when engagement is genuinely collaborative. Em and Khampirat (2026) identify both employability benefits and contextual constraints of cooperative education in developing countries. Jackson (2024) similarly argues that the benefits of WIL depend on sustained external-partner engagement, adequate resourcing, inclusion, and ongoing evaluation rather than on placement provision alone. For plantation vocational education, at least six risks require explicit governance. First, students may be used as inexpensive labor rather than learners. Second, placements may expose students to hazards without adequate preparation. Third, curricula may become excessively tied to one company's operating model. Fourth, partner companies may differ in sustainability performance, exposing students to practices inconsistent with educational values. Fifth, high-quality placements may disproportionately benefit students located near large estates. Sixth, the partnership may prioritize immediate employer recruitment needs at the expense of transferable competence and lifelong adaptability. These risks justify formal learning agreements. Each placement should identify learning outcomes, authorized activities, safety provisions, supervision arrangements, assessment methods, student rights, confidentiality boundaries, and procedures for reporting unsafe or unethical situations. The objective is neither academic domination of industry nor industrial domination of education, but accountable co-production of professional learning.

Theme 7-Vocational-Industry Partnerships Can Produce Broader Sustainability Value

The final theme extends the unit of analysis beyond graduate employment. Plantation vocational education can generate benefits for companies by improving recruitment pipelines, reducing onboarding costs, supporting innovation projects, and developing future supervisors. Educational

institutions gain access to technology, expertise, facilities, real data, and current occupational knowledge. Students gain competence and professional networks.

However, the larger public value emerges when knowledge diffuses beyond individual companies. Smallholder challenges repeatedly involve access to knowledge, organization, training, finance, technology, and certification support (Ernah et al., 2020; Watts et al., 2021; Reich and Musshoff, 2025). Vocational institutions can become regional knowledge hubs supporting farmer training, demonstration plots, youth extension, digital literacy, replanting assistance, and applied problem solving. Company partnerships can help mobilize the resources for this broader mission. Such a role is particularly important because smallholder sustainability remains heterogeneous. Supriatna et al. (2024) identify differences across economic, social, environmental, institutional, and technological dimensions, while Hasmin et al. (2026) show that digital inclusion is associated with readiness for sustainability-oriented change. Vocational education can therefore help connect formal sustainability standards to local learning ecosystems.

DISCUSSION

Reframing Vocational Education as Sustainability Infrastructure

The central analytical conclusion of this review is that vocational education should be treated as sustainability implementation infrastructure. Indonesia can strengthen regulations, certification, traceability, monitoring, and digital systems, but each requires competent human actors. Sustainability outcomes are partly determined by whether people at operational interfaces understand what needs to be done, possess the skills to do it, recognize consequences, and have professional norms supporting responsible action. This reframing alters how education investment is evaluated. The conventional outcome indicator is often employment: how many graduates obtain jobs? Employment remains important, but sustainability-oriented vocational systems require additional measures. Do graduates recognize environmental risks? Can they implement GAP? Can they interpret sustainability records? Can they supervise safely? Can they work with digital systems? Can they communicate with smallholders and communities? Can they identify non-compliance? Can they propose technically and economically feasible improvements? Such a perspective also reconciles economic and sustainability objectives. Sustainable practices are sometimes discussed as costs imposed upon production. Yet evidence indicates that improved knowledge, appropriate training, better agronomy, replanting, and organizational capability can simultaneously improve productivity, resilience, and sustainability (Ernah et al., 2020; Petri et al., 2024; Jelsma et al., 2024). The relevant issue is not “production versus sustainability,” but the competence required to manage trade-offs intelligently.

From Compliance Training to Professional Capability

A second analytical implication is the need to move beyond compliance training. Short courses explaining certification checklists can be useful, but they cannot substitute for professional formation. A professional needs to understand the rationale behind requirements, diagnose context-specific problems, adapt

principles without undermining standards, and exercise judgment when procedures do not directly answer a novel situation. Green-skills literature reinforces this argument. Fuchs (2024) emphasizes the heterogeneous and transformational character of green skills, while Albertz (2025) shows that green VET involves multiple actors and interpretations. Sustainable plantation education should consequently develop systems thinking. A fertilizer decision is simultaneously agronomic, financial, environmental, logistical, and climatic. A replanting decision affects future productivity, household cash flow, biodiversity design, labor requirements, and potentially land-use pressure. Competence-based agricultural education offers useful parallels. Nyamweru et al. (2024, 2025a, 2025b) show that sustainability competence can be explicitly identified, designed into curricula, and developed through contextual learning. Indonesian plantation education could similarly define national or sectoral competency outcomes for sustainable palm oil professionals that complement existing occupational standards.

Why Company Cooperation Can Accelerate Professionalization

Company cooperation contributes through several mechanisms. First, it provides occupational currency. Industry partners reveal which technologies, standards, and problems are actually emerging. Second, cooperation creates authenticity: students face real constraints and consequences. Third, companies provide professional role models. Students learn not only from tasks but from observing how experienced practitioners behave. Fourth, partnerships can create feedback loops. Employers can identify recurring graduate weaknesses and institutions can adjust learning activities. Fifth, companies can help provide equipment, datasets, training facilities, field sites, guest practitioners, and mentors that educational institutions may struggle to maintain independently. Sixth, partnership can generate applied research, turning students and lecturers into problem-solving resources for plantations. Indonesian research on industry-responsive vocational education supports this integrated approach. Yoto et al. (2024a) emphasize industry involvement not only in placements but in curriculum alignment, implementation, and evaluation. Sudarsono et al. (2026) extend teaching-factory thinking toward multi-industry exposure and adaptive occupational competence. Wahyuningsih et al. (2026) demonstrate that internship effectiveness can be increased through structured preparation, dual supervision, and evaluation. These approaches collectively suggest that the strongest partnership is a longitudinal ecosystem rather than a single internship event, a conclusion consistent with broader evidence that WIL quality depends on scaffolded curriculum design and sustained external engagement (Jackson, 2024).

The Sustainable Plantation Vocational Partnership Framework

The synthesis leads to the proposed Sustainable Plantation Vocational Partnership (SPVP) Framework. The framework integrates sectoral pressures, changing competency requirements, curriculum design, industry partnership, authentic learning, professional formation, and plantation-level outcomes within a single feedback-oriented model. Figure 3 integrates the findings into a complete pathway from sustainability pressures to plantation outcomes. It includes a

feedback loop because competencies cannot remain static while technology, climate, regulation, markets, and sustainability expectations change.

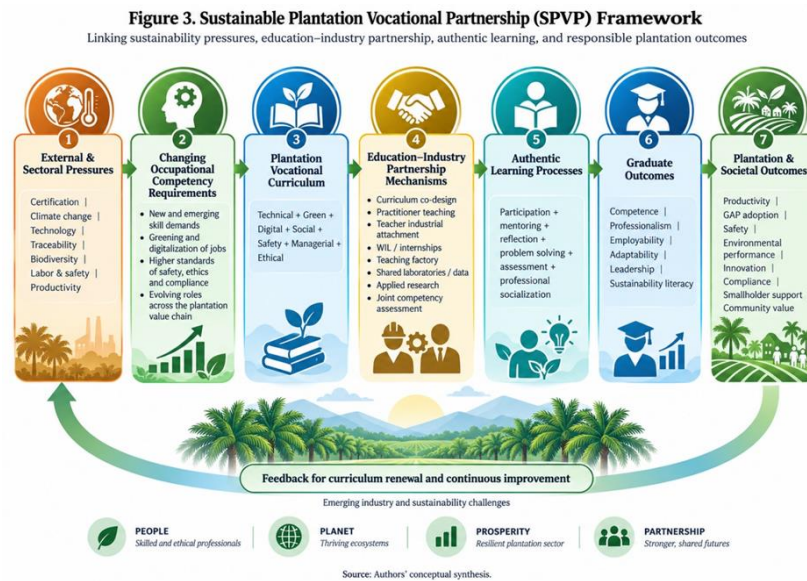


Figure 3. Sustainable Plantation Vocational Partnership (SPVP) Framework
Source: Authors' conceptual synthesis.

The SPVP framework contains five important propositions. First, partnership should start from future competency requirements, not from institutional convenience. Second, competence is multidimensional. Third, industry partnership is an educational mechanism, not an end in itself. Fourth, professional formation requires authentic participation plus mentoring and reflection. Fifth, the ultimate objective includes plantation and societal outcomes rather than employment alone.

A Partnership Continuum for Indonesian Plantation Education

In practical terms, institutions and companies could develop partnership depth progressively. The continuum proposed here moves from relatively light-touch consultation toward shared infrastructure, applied innovation, and multi-stakeholder ecosystem governance. At the most basic level, consultative partnerships involve employers in reviewing curriculum and identifying emerging skills. This is relatively easy to establish but has limited transformative effect. The second level involves curriculum co-design and practitioner participation, where industry experts help convert occupational changes into learning modules and authentic cases. For example, traceability teams could help design exercises linking field records, digital data, supply-chain documentation, and audit procedures. The third level consists of structured WIL, with explicit competency contracts, dual mentoring, rotational exposure, reflection assignments, and authentic assessment. Rotation is particularly useful in plantations because sustainable operations connect agronomy, harvesting, transport, mills, sustainability, laboratories, safety, human resources, and community functions. The fourth level is shared learning infrastructure—educational estates, teaching factories, laboratories, equipment, digital platforms,

and jointly managed demonstration sites. These can reduce the gap between simulated practice and current industrial systems.

The fifth level is innovation partnership. Students and lecturers jointly solve problems identified by companies, farmer organizations, or communities. This can include low-cost digital tools, yield-loss analysis, safety interventions, composting, biodiversity monitoring, smallholder extension, replanting models, or water management. The sixth and deepest level is an ecosystem partnership, where vocational institutions, several companies, government, smallholder groups, professional associations, and certification bodies jointly develop regional skills systems. Multi-company participation is preferable to exclusive dependence on a single company because it broadens student exposure and reduces the risk of over-specialization.

Professionalism as the Transmission Mechanism

The framework places professionalism between education and sustainable outcomes for a specific reason. Knowledge does not automatically become responsible practice. Employees face production pressure, cost constraints, organizational hierarchies, uncertainty, and competing interests. Professional identity influences whether graduates apply standards conscientiously, communicate problems, prioritize safety, question poor practices, and continue learning. WIL can contribute to this identity formation if workplaces provide responsible role models. Conversely, it can normalize poor practices if students observe shortcuts or unsafe behavior without guided reflection. This is why academic supervision remains critical. The student should learn to compare “what is practiced” with “what should be practiced,” rather than assuming that every existing industry routine represents best practice. Björck (2021) warns against simplistic theory–practice dualism, and Runcieman (2022) demonstrates how professional identity is negotiated through workplace participation. Contemporary WIL design therefore increasingly emphasizes reflection, integration, and scaffolding rather than passive exposure (Billett, 2025; Díaz et al., 2026; Hwang et al., 2026). These insights should become foundational principles for plantation internships.

Digital and Green Skills Must Be Developed Together

Another major implication is that digitalization and sustainability should not become separate curriculum modernization projects. Precision agriculture can support input efficiency, yield monitoring, traceability, environmental surveillance, and decision support. Yet digital technology only contributes to sustainability when users understand what data mean and which objectives technology serves. Vitalocca et al. (2026) propose integrating computational thinking with green skills through contextual and project-based vocational learning. This logic is highly applicable to plantations. A student could use GIS to evaluate riparian buffers, drones to identify field heterogeneity, digital records to analyze harvesting losses, sensors to support water management, or dashboards to detect fertilizer inefficiency. In each case, the educational task combines technical, digital, environmental, and analytical capabilities. This integration is increasingly important as Industry 4.0 technologies become more prominent in oil palm production (Mohamad Zaki et al., 2025). If vocational curricula modernize only by adding software or drone operation, they may

produce tool users without systems understanding. If they teach sustainability without digital competence, graduates may struggle to operate emerging traceability and decision-support systems. The two transitions must therefore be curricularized together.

Linking Vocational Education with Smallholder Transformation

Indonesia's palm oil landscape cannot be transformed solely through large-company workforce development. Independent and scheme smallholders represent a critical component of production, and numerous studies identify persistent challenges in certification, GAP adoption, replanting, institutional organization, and access to knowledge (Apriani et al., 2020; Watts et al., 2021; Oliphant and Simon, 2022; Reich and Musshoff, 2025). Vocational institutions located in plantation regions could therefore have a second mission as regional capability hubs. Students could participate in supervised extension projects, replanting support, record-keeping assistance, basic digital mapping, nursery demonstrations, soil and fertilizer education, safety campaigns, or sustainability documentation. This would simultaneously strengthen student learning and provide community service. Evidence that sustainability training can generate economic value for smallholders (Ernah et al., 2020) makes this particularly attractive. The benefit is not simply social outreach. Students learn to communicate professional knowledge to non-specialists, recognize farm heterogeneity, work under resource constraints, and understand sustainability beyond corporate estates.

Governance Conditions for Effective Partnerships

For the SPVP framework to function, partnerships need explicit governance principles. These principles are intended to protect educational quality, learner welfare, transferable competence, sustainability integrity, and equitable access while preserving the practical value of industry participation. First, educational purpose must remain primary. Work placements should be selected for learning value, not simply availability. Second, transferable competence must be protected. Company-specific procedures are useful examples but should be linked to broader scientific, professional, and sustainability principles. Third, students require protection. Occupational safety, appropriate insurance arrangements, clear supervision, grievance channels, and realistic workload expectations should be non-negotiable. Fourth, partnership quality should be measured. Evaluation should include demonstrated competencies, mentor quality, task diversity, student reflection, employer feedback, graduate outcomes, and curriculum improvements. Fifth, sustainability integrity matters. Institutions should establish minimum criteria for partner companies and should not treat industry participation as evidence that every observed practice is academically or ethically acceptable. Sixth, partnerships should be inclusive. Opportunities should not be concentrated among a small group of high-performing students or institutions located near major corporations. Digital WIL, regional company networks, shared training centers, and multi-company consortia may help reduce access inequality. Rienties et al. (2023) show that technologically mediated work-based learning is

increasingly feasible, although it should complement rather than entirely replace physical plantation experience.

Policy Implications

For government, the main implication is that vocational policy and sustainable palm oil policy should be connected. Sustainability standards commonly specify requirements for production systems but pay less attention to how the necessary occupational competence is produced. Ministries and agencies responsible for education, plantations, labor, certification, and human-resource development could jointly define competency priorities. For vocational institutions, curriculum review should begin from sustainability and technology scenarios rather than relying only on historical job descriptions. Institutions should map every major sustainability requirement to related competencies, learning activities, assessment methods, and possible industry partners. For oil palm companies, educational partnership should be treated as long-term human-capital investment. Companies could contribute mentors, field sites, practitioners, datasets, equipment, professional certification, teacher attachment, scholarships, and applied-research challenges. Importantly, partnerships should involve sustainability departments and not only human-resource recruitment teams. For certification and professional bodies, there is an opportunity to develop more explicit occupational competency frameworks connecting certification principles with roles performed by plantation technicians and supervisors. Such frameworks could make sustainability competencies assessable and portable across employers. For smallholder organizations, partnerships with vocational institutions could increase access to extension and young technical talent. This may be particularly valuable during replanting and digital transition, where knowledge, finance, organization, and technology interact strongly (Petri et al., 2024; Hendrawan and Musshoff, 2024; Hasmin et al., 2026).

CONCLUSIONS AND RECOMMENDATIONS

Indonesia's transition toward sustainable oil palm production is fundamentally a human-capability challenge as well as a technological, regulatory, and environmental challenge. Certification standards, climate-smart practices, biodiversity management, digital traceability, precision agriculture, occupational safety, replanting, and responsible community engagement ultimately depend on people capable of understanding and implementing them. Plantation-based vocational education therefore has a strategic role that extends well beyond supplying workers. It can function as the human-capital infrastructure through which sustainability principles become operational competence. To perform that function, however, conventional narrow technical training is insufficient. Future plantation professionals require an integrated capability portfolio combining agronomic expertise, environmental and climate competence, sustainability assurance, digital literacy, occupational safety, communication, leadership, management, ethics, and adaptive learning.

Cooperation with oil palm companies can substantially strengthen this capability because companies provide access to authentic problems, current technologies, professional mentors, production systems, sustainability

procedures, and organizational realities. Yet partnership effectiveness depends on its educational design. Internships without learning outcomes, mentoring, reflection, assessment, and student protection risk producing workplace exposure without meaningful professional development. The Sustainable Plantation Vocational Partnership framework proposed in this review therefore conceptualizes partnership as a continuum linking sustainability pressures to competency requirements, curriculum design, industry-integrated learning, professional identity formation, graduate outcomes, and plantation sustainability performance. The framework also incorporates a feedback loop so that technological, regulatory, environmental, and occupational changes continuously renew the curriculum. Several practical recommendations follow. Plantation vocational curricula should explicitly embed sustainability, green, digital, safety, social, and professional competencies. Companies should participate in curriculum co-design, WIL, teaching factories, practitioner teaching, teacher industrial attachment, authentic assessment, and applied research. Internship quality should be governed through learning contracts and dual mentoring. Partnerships should involve multiple companies and stakeholders where possible, reducing dependence on company-specific practices. Educational benefits should also extend toward independent smallholders and surrounding plantation communities.

FURTHER STUDY

Future empirical research should move beyond measuring student satisfaction with internships. Longitudinal studies should examine whether industry-integrated plantation education improves graduate competence, employment quality, professional behavior, retention, and career progression. More ambitiously, research should test whether graduates from sustainability-oriented vocational programs contribute measurably to GAP adoption, yield efficiency, safety performance, environmental compliance, digitalization, and certification outcomes within plantations. Comparative research across vocational institutions, provinces, company types, and smallholder landscapes would further clarify which partnership models produce the strongest and most inclusive outcomes. The larger implication is straightforward: sustainable oil palm plantations require sustainable professional capability. Indonesia's vocational institutions and oil palm companies therefore should not operate as separate systems connected only at recruitment. They should become co-developers of the knowledgeable, technically capable, digitally literate, environmentally responsible, ethically grounded, and adaptable professionals upon whom the future sustainability of the industry increasingly depends.

REFERENCES

- Albertz, A. (2025) 'Green alignment, green vocational education and training, green skills and related subjects: A literature review on actors, contents and regional contexts'
- Apriani, E., Kim, Y-S., Fisher, L.A. and Baral, H. (2020) 'Non-state certification of smallholders for sustainable palm oil in Sumatra, Indonesia', *Land Use*

- Policy, 99, 105112.
- Azahar, R., Hariyanto, V.L., Prayogo, W. and Fitria, L. (2026) 'Fostering green skills in vocational students: The impact of learning environment, attitudes, and competence', *Indonesian Journal on Learning and Advanced Education*, 8(1).
- Billett, S. (2025) 'Constituting integration in work-integrated education and learning', *Studies in Continuing Education*, 47(3), pp. 513–530.
- Björck, V. (2021) 'Taking issue with how the work-integrated learning discourse ascribes a dualistic meaning to graduate employability', *Higher Education*, 82, pp. 307–322.
- Björck, V. and Willermark, S. (2025) 'Where is the "WIL" in work-integrated learning research?', *Studies in Continuing Education*, 47(3), pp. 531–545.
- Chandra, A., Grabs, J., Meemken, E-M., Hidayat, N.K., Dharmawan, A.H., Mardiyarningsih, D.I. et al. (2026) 'Limited reach of zero-deforestation commitments to Indonesian oil palm smallholders', *Nature Sustainability*.
- Chinedu, C.C., Saleem, A. and Wan Muda, W.H.N. (2023) 'Teaching and learning approaches: Curriculum framework for sustainability literacy for technical and vocational teacher training programmes in Malaysia', *Sustainability*, 15(3), 2543.
- Choi, S., Li, H. and Ogawa, K. (2023) 'Upper secondary vocational education and decent work in Indonesia: A gender comparison', *International Journal of Educational Development*, 101, 102833.
- Choi, S., Li, H., Ogawa, K. and Tanaka, Y. (2024) 'Secondary vocational education and decent work in Indonesia: Differences between urban and rural areas', *International Journal of Training Research*, 22(2), pp. 125–146.
- Díaz, B., Delgado, C., Han, K. et al. (2026) 'A scaffolding model for designing and implementing work-integrated learning experiences based on the analysis of the university and company's arrangements', *Higher Education*, 91, pp. 1–14.
- Em, S. and Khampirat, B. (2026) 'Cooperative education: A mini review of benefits and challenges for the developing countries', *Frontiers in Education*, 11, 1794804.
- Ernah, Parvathi, P. and Waibel, H. (2020) 'Will teaching sustainability standards to oil palm smallholders in Indonesia pay off?', *International Journal of Agricultural Sustainability*, 18(2), pp. 196–211.
- Forsler, A., Nilsson, P. and Walan, S. (2025) 'Teaching for sustainable development in vocational education', *Journal of Biological Education*, 59(2), pp. 268–281.
- Fosch, A., Ferraz de Arruda, G., Aleta, A. et al. (2023) 'Replanting unproductive palm oil with smallholder plantations can help achieve Sustainable Development Goals in Sumatra, Indonesia', *Communications Earth & Environment*, 4, 378.
- Fuchs, M. (2024) 'Green skills for sustainability transitions', *Geography Compass*.
- Hasmin, H., Salman, D., Demmallino, E.B., Nurung, J. and Darhamsyah, D. (2026) 'Digital inclusion and ecosystem-based incentives as predictors of smallholder readiness for sustainability-oriented change in Indonesian oil palm landscapes', *Discover Environment*, 4, 134.

- Hendrawan, D. and Musshoff, O. (2024) 'Smallholders' preferred attributes in a subsidy program for replanting overaged oil palm plantations in Indonesia', *Ecological Economics*, 224, 108278.
- Hwang, W., Aguinalde, P., Crippen, K.J., Shin, J. and Carroll, B.F. (2026) 'Systematic review of work-integrated learning in undergraduate engineering education', *Journal of Engineering Education*, 115(1), e70050.
- Iskandar, Wahyudiono, Y.D.A., Widajati, N. and Zulkifli (2023) 'Factors related with unsafe action in palm oil harvesters at PT. Priatama Riau Kebun Rupert Island', *The Indonesian Journal of Occupational Safety and Health*, 12(2), pp. 246-255.
- Jackson, D. (2024) 'Work-integrated learning: opportunities and challenges in Australia', *Higher Education Research & Development*, 43(3), pp. 767-773.
- Jackson, D. and Bridgstock, R. (2021) 'What actually works to enhance graduate employability? The relative value of curricular, co-curricular, and extra-curricular learning and paid work', *Higher Education*, 81, pp. 723-739.
- Jackson, D. and Dean, B.A. (2023) 'The contribution of different types of work-integrated learning to graduate employability', *Higher Education Research & Development*, 42(1), pp. 93-110.
- Jelsma, I., Turinah, Gay, F., Ollivier, J. and Rapidel, B. (2024) 'Collective action, replanting and resilience: Key lessons from 40 years of smallholder oil palm cultivation in the Ophir plantation, Indonesia', *Agricultural Systems*, 213, 103801.
- Kebede, A., Asgedom, A. and Asfaw, A. (2024) 'Is linking technical and vocational training with industry a bridge to employability? Lessons from a literature review for Ethiopia', *Cogent Education*, 11(1), 2406721.
- Kligyte, G., Bowdler, B., Baumber, A., Pratt, S., Allen, L., Buck, A., Le Hunte, B., Melvold, J. and Key, T. (2024) 'Work-integrated professional learning: Shifting paradigms through transdisciplinary engagement', *Studies in Continuing Education*, 46(3), pp. 396-413.
- Luk, L.Y.Y. and Chan, C.K.Y. (2024) 'Assessing student learning in work-integrated learning (WIL): A systematic review on assessment methods and purposes', *Studies in Educational Evaluation*, 81, 101345.
- McDonald, N., Luke, J. and Cosby, A. (2024) 'Non-technical skills needed for the current and next-generation agricultural workforce', *Agriculture*, 14(7), 1106. Available at: <https://doi.org/10.3390/agriculture14071106>.
- McGrath, S. and Ramsarup, P. (2024) 'Towards vocational education and training and skills development for sustainable futures', *Journal of Vocational Education & Training*, 76(2), pp. 247-258.
- Mehraban, N., Kubitza, C., Alamsyah, Z. and Qaim, M. (2021) 'Oil palm cultivation, household welfare, and exposure to economic risk in the Indonesian small farm sector',
- Mohamad Zaki, M.A.B., Ooi, J., Ng, W.P.Q., How, B.S., Lam, H.L., Foo, D.C.Y. and Lim, C.H. (2025) 'Impact of Industry 4.0 technologies on the oil palm industry: A literature review', *Smart Agricultural Technology*, 10, 100685.
- Monavvarifard, F. and Alibaygi, A. (2023) 'TVET model for building safety and sustainable agriculture in Iran by 2030 and beyond', *Environmental*

- Education Research, 29(3), pp. 423–450.
- Muchlis, F., Destiarni, R.P., Napitupulu, D.M.T., Zainuddin, A., Aziz, M.A. and Meilin, A. (2026) 'The sustainability of palm oil farming by certified independent smallholders in Jambi', *Frontiers in Sustainability*, 7, 1717610.
- Nahriana, N. and Arfandi, A. (2020) 'The cooperation of vocational high schools and industries in achieving graduates competence', *Journal of Educational Science and Technology*, 6(3).
- Ngadi, N. and Nagata, J. (2022) 'Oil palm land use change and rice sustainability in South Sumatra, Indonesia', *Land*, 11(5), 669.
- Nurliza, N. (2020) 'Creating strategic competence of independent smallholders for sustainable palm oil', *Jurnal Penyuluhan*, 16(1), pp. 1–15.
- Nurliza, N., Nugraha, A., Muthahhari, M., Pamela and Suyatno, A. (2022) 'Do sustainability standards provide environmental, social and economic benefits for independent oil palm smallholders?', *Jurnal Penyuluhan*.
- Nyamweru, J.C., Ndayitwayeko, W.M., Kessler, A. and Biemans, H. (2024) 'Fostering sustainable agriculture in Burundi: Which competencies for change-agents should vocational agriculture education prioritize?', *The Journal of Agricultural Education and Extension*, 30(3), pp. 341–361.
- Nyamweru, J.C., Ndayitwayeko, W.M., Kessler, A. and Biemans, H. (2025a) 'Fostering students' competencies in sustainability in vocational agriculture education in Burundi: Effects of a Participatory Integrated Planning module', *International Journal of Training and Development*.
- Nyamweru, J.C., Ndayitwayeko, W.M., Kessler, A. and Biemans, H. (2025b) 'Competence-based vocational agriculture education for sustainability in Burundi: Perspectives from different educational stakeholders', *Journal of Vocational Education & Training*, 77(4), pp. 1166–1188.
- Oliphant, E. and Simon, A.C. (2022) 'The cost of sustainable palm oil: Should an Indonesian smallholder pursue RSPO-certification?', *World Development Perspectives*, 26, 100432.
- Owusu-Agyeman, Y. and Aryeh-Adjei, A.A. (2024) 'The development of green skills for the informal sector of Ghana: towards sustainable futures', *Journal of Vocational Education & Training*, 76(2), pp. 406–429.
- Petri, H., Hendrawan, D., Bähr, T., Musshoff, O., Wollni, M., Asnawi, R. and Faust, H. (2024) 'Replanting challenges among Indonesian oil palm smallholders: A narrative review', *Environment, Development and Sustainability*, 26, pp. 19351–19367.
- Purnomo, H., Okarda, B., Dermawan, A., Ilham, Q.P., Pacheco, P., Nurfatriani, F. and Suhendang, E. (2020) 'Reconciling oil palm economic development and environmental conservation in Indonesia: A value chain dynamic approach', *Forest Policy and Economics*, 111, 102089.
- Qaim, M., Sibhatu, K.T., Siregar, H. and Grass, I. (2020) 'Environmental, economic, and social consequences of the oil palm boom', *Annual Review of Resource Economics*, 12, pp. 321–344.
- Ramsarup, P., McGrath, S. and Lotz-Sisitka, H. (2024) 'A landscape view of emerging sustainability responses within VET', *Journal of Vocational Education & Training*, 76(2), pp. 259–280.

- Reich, C. and Musshoff, O. (2025) 'Oil palm smallholders and the road to certification: Insights from Indonesia', *Journal of Environmental Management*, 375, 124303.
- Rienties, B., Divjak, B., Iniesto, F., Pažur Aničić, K. and Žižak, M. (2023) 'Online work-based learning: A systematic literature review', *International Review of Education*, 69, pp. 551–570.
- Runcieman, A. (2022) 'Developing students' professional identities through work integrated learning: "Small story" research from an ethnographic perspective', *Journal of Education and Work*, 35(5), pp. 559–571.
- Safitri, L., Galdos, M.V., Pradiko, I., Comber, A. and Challinor, A. (2026) 'Assessing climate-smartness of agronomic practices in oil palm production under changing climate conditions', *European Journal of Agronomy*, 174, 127966.
- Saputro, I.N., Soenarto, Sofyan, H., Riyanita, M.C., Rebia, P.S. and Listiana, A. (2021) 'The effectiveness of teaching factory implementation in vocational education: Case studies in Indonesia', *Universal Journal of Educational Research*, 9(11), pp. 1841–1856.
- Saragih, I.K., Rachmina, D. and Krisnamurthi, B. (2020) 'Analisis status keberlanjutan perkebunan kelapa sawit rakyat Provinsi Jambi', *Jurnal Agribisnis Indonesia*, 8(1), pp. 17–32.
- Scriven, S.A., Butarbutar, R.B., de Vos, R.E., Newing, H., Scholtz, O., Lasmana, F.P.S., Meijaard, E. and Hill, J.K. (2026) 'Addressing the challenges of managing and monitoring biodiversity in High Conservation Value areas and High Carbon Stock forests within oil palm landscapes', *Ecological Solutions and Evidence*, 7(1), e70162.
- Siregar, A.A., Halimatussadiyah, A., Moeis, F.R., Anky, W.A.K. and Nainggolan, D. (2024) 'The oil palm replanting imperative: Are smallholder farmers willing to participate?', *Forest Policy and Economics*, 169, 103362.
- Sudarsono, B., Ghozali, F.A. and Saputra, W.N.E. (2026) 'Bridging the education-industry gap: A rolling-cycle teaching factory model to occupational competence development in vocational schools', *Higher Education, Skills and Work-based Learning*, pp. 1–15.
- Suharno, S., Ihsan, F., Himawanto, D.A., Pambudi, N.A. and Rizkiana, R. (2025) 'Sustainability development in vocational education: A case study in Indonesia', *Higher Education, Skills and Work-based Learning*, 15(3), pp. 668–689. Available at: <https://doi.org/10.1108/HESWBL-01-2024-0018>.
- Supriatna, J., Djumarno, D., Saluy, A.B. and Kurniawan, D. (2024) 'Sustainability analysis of smallholder oil palm plantations in several provinces in Indonesia', *Sustainability*, 16(11), 4383.
- Suud, H.M., Defrian, A., Puspito, A.N. and Ginting, A.S. (2026) 'Precision agriculture implementation to improve sustainability and productivity of oil palm plantations in Indonesia: A review', *Journal of Oil Palm Research*, 38(1), pp. 35–52.
- Syahputra, A.R., Nurkhoiry, R., Amalia, R. and Pradiko, I. (2026) 'Limitations of sustainability certification on Good Agricultural Practices adoption among certified and noncertified oil palm smallholders', *Jurnal AGRISEP*,

25(1), pp. 289–306.

- Vitalocca, D., Suherman, A., Rohendi, D., Yulia, C. et al. (2026) 'Integrating computational thinking and green skills in vocational education through the bridging learning green informatics framework', *Discover Education*, Wahyuningsih, S.E., Rachmawati, R., Saptariana, Sholikhah, R., Karend, K.A.A., Tumangger, M.H. and Ghazali, A. (2026) 'PRIGEL: A work-integrated learning model for collaborative and professional competence in vocational education', *Frontiers in Education*, 11, 1812349.
- Watts, J.D., Pasaribu, K., Irawan, S., Tacconi, L., Martanila, H., Wiratama, C.G.W., Musthofa, F.K., Sugiarto, B.S. and Manvi, U.P. (2021) 'Challenges faced by smallholders in achieving sustainable palm oil certification in Indonesia', *World Development*, 146, 105565.
- Weijzen, S.M.G., Onck, C., Wals, A.E., Tassone, V.C. and Kuijer-Siebelink, W. (2024) 'Vocational education for a sustainable future: Unveiling the collaborative learning narratives to make space for learning', *Journal of Vocational Education & Training*, 76(2), pp. 331–353. Available at: <https://doi.org/10.1080/13636820.2023.2270468>.
- Wong, Y.B., Gibbins, C., Azhar, B., Phan, S.S., Scholefield, P., Azmi, R. and Lechner, A.M. (2023) 'Smallholder oil palm plantation sustainability assessment using multi-criteria analysis and unmanned aerial vehicles', *Environmental Monitoring and Assessment*, 195(5), 577. Available at: <https://doi.org/10.1007/s10661-023-11113-z>.
- Xin, Y., Sun, L. and Hansen, M.C. (2022) 'Oil palm reconciliation in Indonesia: Balancing rising demand and environmental conservation towards 2050', *Journal of Cleaner Production*, 380, 135087. Available at: <https://doi.org/10.1016/j.jclepro.2022.135087>.
- Yoto, Marsono, Suyetno, A., Mawangi, P.A.N., Romadin, A. and Paryono (2024a) 'The role of industry to unlock the potential of the Merdeka curriculum for vocational school', *Cogent Education*, 11(1), 2335820. Available at: <https://doi.org/10.1080/2331186X.2024.2335820>.
- Yoto, Suyetno, A., Wibawa, A.P., Paryono and Romadin, A. (2024b) 'Unveiling the distinctive impact of vocational schools link and match collaboration with industries for holistic workforce readiness', *Open Education Studies*, 6(1), 20240045. Available at: <https://doi.org/10.1515/edu-2024-0045>.