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Empowering Women and Youth in Oil Palm Agriculture: A Systematic Review of Gender-Responsive Education Programs for Smallholder Development



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Abstract

Education has been widely recognized as a strategic mechanism for enhancing inclusiveness and sustainability in smallholder agriculture, particularly in commodity-based systems such as oil palm cultivation. Within this context, women and youth are increasingly acknowledged as key actors whose participation is shaped by access to relevant and responsive educational opportunities. This study aims to systematically synthesize peer-reviewed literature on gender-responsive education programs targeting women and youth in oil palm smallholder agriculture, with particular attention to dominant intervention patterns, reported outcomes, and contextual factors influencing program effectiveness. The study adopts a Systematic Literature Review (SLR) design following transparent and reproducible procedures. Data were collected through structured searches of the Scopus database using predefined keyword combinations and selection criteria, resulting in 39 eligible articles published between 2019 and 2025. Data analysis was conducted through qualitative thematic synthesis to identify recurring patterns and relationships across studies. The results reveal six interrelated thematic clusters encompassing intervention typologies, participation patterns, institutional delivery mechanisms, socio-economic and productive outcomes, implementation barriers, and alignment with broader smallholder development and sustainability objectives. Overall, the reviewed evidence indicates that gender-responsive education programs are associated with improved capacity, engagement, and selected livelihood-related outcomes among women and youth, while their effectiveness remains contingent on contextual and institutional conditions. In conclusion, gender-responsive education constitutes an important enabling component of inclusive oil palm smallholder development. Future research is recommended to strengthen longitudinal evidence, comparative assessment, and intersectional analysis to better capture long-term impacts.

Keywords: Gender-Responsive Education; Youth Inclusion; Women Empowerment; Oil Palm Smallholders; Systematic Literature Review

Introduction

Oil palm agriculture occupies a strategic position in the global agri-food and bio-based economy due to its high productivity, versatility, and role in supporting rural livelihoods across producing regions. As one of the most efficient oil-bearing crops, oil palm contributes substantially to global vegetable oil supply while sustaining millions of smallholder farmers who rely on it as a primary source of income [1]. In many producing countries, smallholders manage a significant share of total plantation area, making their productivity, resilience, and inclusiveness critical to broader agricultural development objectives [2]. Within this context, human capital development, particularly through education and training, has been increasingly recognized as a

foundational element for enhancing smallholder performance and long-term sectoral sustainability.

Education and capacity-building initiatives in agriculture have long been associated with improvements in farm productivity, resource efficiency, and adaptive capacity. Extension services, vocational training, and farmer-based learning platforms play an essential role in translating technical knowledge into practical outcomes at the farm level [3]. In oil palm systems, education-based interventions have been applied to disseminate best management practices, strengthen organizational capacities, and improve market engagement among smallholders. However, the effectiveness of these interventions is not uniform across social

groups, as access to education and training opportunities is often shaped by gender, age, and socio-economic position within rural communities [4].

Women and youth are two demographic groups increasingly recognized as central to the future of smallholder agriculture, including oil palm cultivation. Women are deeply involved in various stages of agricultural production, household decision-making, and community organization, yet their contributions frequently remain under-recognized and under-supported in formal training systems [5]. Youth, on the other hand, represent a potential source of innovation, labor renewal, and entrepreneurship within rural economies, but often face structural barriers such as limited access to land, capital, and relevant skills [6]. Addressing the educational needs of these groups is therefore not only a matter of social inclusion but also a strategic investment in the resilience and competitiveness of smallholder agricultural systems.

In response to these challenges, the concept of gender-responsive education has gained prominence in the discourse on agricultural development. Gender-responsive education programs are designed to recognize and accommodate the differentiated roles, responsibilities, and constraints experienced by women and men, while also accounting for generational dynamics affecting youth participation [7]. Such programs typically incorporate flexible delivery mechanisms, participatory pedagogies, and context-sensitive curricula to enhance accessibility and relevance for diverse learner groups. Within oil palm agriculture, gender-responsive education has been applied in various forms, ranging from women-focused extension initiatives to youth-oriented agribusiness training and hybrid capacity-building models that integrate technical, managerial, and social learning components [8].

Despite growing interest in gender-responsive approaches, existing evidence on education programs targeting women and youth in oil palm smallholder contexts remains fragmented. Empirical studies are dispersed across disciplines such as agricultural extension, rural development, gender studies, and sustainability science, often focusing on specific program types, geographic locations, or target groups [9]. While individual studies have reported positive outcomes related to knowledge acquisition, participation, or socio-economic improvements, the broader patterns, consistencies, and limitations of these interventions have yet to be systematically synthesized. As a result, policymakers, practitioners, and researchers lack a consolidated evidence base to inform the design and scaling of inclusive education strategies within oil palm systems [10].

Systematic Literature Review (SLR) offers a rigorous and transparent approach for consolidating dispersed empirical findings and identifying dominant trends, knowledge gaps, and methodological limitations within a given research field. By synthesizing peer-reviewed studies using predefined inclusion criteria and structured analytical frameworks, SLR enables the generation of evidence-based insights that extend beyond

the conclusions of individual studies. In the context of oil palm agriculture, an SLR focused on gender-responsive education programs provides an opportunity to assess how such initiatives have been conceptualized, implemented, and evaluated across diverse smallholder settings. Importantly, SLR provides an analytical perspective grounded entirely in secondary data, avoiding the introduction of speculative or unverified claims associated with primary data collection methods, such as focus group discussions or field observations.

Existing reviews of oil palm agriculture have predominantly emphasized environmental sustainability, productivity enhancement, and supply chain governance, with relatively limited attention to education as a gender-responsive development mechanism. Reviews that address social dimensions often treat gender or youth engagement as secondary rather than central analytical categories. Consequently, there is a clear need for a dedicated synthesis that foregrounds education-based interventions to empower women and youth within oil palm smallholder systems, while maintaining an analytically neutral stance toward the industry and recognizing its economic significance.

Moreover, the evolving global emphasis on inclusive development, decent work, and sustainable livelihoods has intensified the relevance of education programs that explicitly integrate gender and youth considerations. International development frameworks increasingly emphasize the importance of socially inclusive, contextually adaptive capacity-building interventions. Within oil palm agriculture, aligning education initiatives with these broader objectives requires a nuanced understanding of how program design, institutional arrangements, and participation dynamics influence outcomes for women and youth. A systematic synthesis of existing studies is therefore essential to inform evidence-based policymaking and program development that advance smallholders without undermining the sector's economic role.

This study addresses this gap by conducting a Systematic Literature Review of peer-reviewed articles examining gender-responsive education programs for women and youth in oil palm smallholder contexts. Drawing exclusively on secondary data from internationally indexed literature, the review applies a structured analytical framework to identify dominant thematic patterns related to program typologies, participation dynamics, institutional delivery mechanisms, reported outcomes, and contextual barriers. By synthesizing findings across multiple regions and intervention models, the study seeks to provide a comprehensive and balanced overview of how education-based initiatives contribute to smallholder development within oil palm agriculture.

The primary objective of this study is to systematically synthesize and analyze existing peer-reviewed literature on gender-responsive education programs targeting women and youth in oil palm smallholder agriculture, with the aim of

identifying dominant thematic patterns, reported outcomes, and contextual factors influencing program effectiveness.

To achieve this objective, the study is guided by the following research questions:

RQ1: What types of gender-responsive education and training interventions have been implemented for women and youth in oil palm smallholder contexts, and how are these interventions characterized in terms of design, delivery mechanisms, and participation patterns?

RQ2: What socio-economic, productive, and developmental outcomes are reported in the literature in relation to these education programs, and what contextual barriers and enabling factors shape their effectiveness within oil palm smallholder systems?

Literature Review

The literature on smallholder agricultural development increasingly emphasizes education as a critical lever for enhancing productivity, inclusion, and long-term sustainability. Within this body of work, growing attention has been directed toward the roles of women and youth as key actors in rural transformation, particularly in commodity-based systems such as oil palm agriculture. However, existing studies remain dispersed across multiple disciplinary perspectives, including human capital development, gender studies, youth engagement, and agricultural extension, resulting in fragmented insights. This literature review synthesizes key conceptual and empirical contributions related to education-based interventions for women and youth in smallholder oil palm contexts, with a focus on gender-responsive and youth-inclusive approaches, institutional arrangements, and reported outcomes, as a foundation for the systematic analysis presented in this study.

Education and Human Capital Development in Smallholder Agriculture

Education and capacity-building have long been recognized as central components of smallholder agricultural development, particularly in contexts characterized by resource constraints, market volatility, and environmental pressures [11]. Within agricultural systems, education functions not only as a mechanism for transferring technical knowledge but also as a means of strengthening decision-making capacity, organizational skills, and adaptive responses to changing socio-economic conditions. In smallholder-dominated sectors, such as oil palm agriculture, the effectiveness of education-based interventions depends on their ability to address heterogeneous farmer needs while remaining contextually relevant and institutionally feasible.

Previous studies have demonstrated that education and training programs contribute to enhanced productivity, income stabilization, and the adoption of improved agricultural practices among smallholders [12]. However, the literature also indicates that the distribution of educational benefits is uneven, with

women and youth often facing structural barriers that limit their access to formal and non-formal learning opportunities. These disparities have prompted increasing scholarly attention to gender-responsive and youth-inclusive education models as strategic entry points for inclusive rural development.

In oil palm agriculture, where smallholders play a significant role in production and supply chains, education has increasingly been positioned as a critical tool for improving farm performance while supporting broader development objectives. Nevertheless, existing research remains fragmented across agronomy, rural development, gender studies, and education policy, underscoring the need for systematic synthesis to consolidate evidence and identify thematic patterns [13].

Gender Dimensions in Agricultural Education

The role of gender in shaping access to agricultural education has been widely documented across diverse smallholder contexts. Women's participation in education and training programs is frequently constrained by time burdens, socio-cultural norms, and limited control over productive resources, which collectively influence their capacity to engage in learning activities [14]. As a response, gender-responsive education has emerged as an approach that adapts training content, delivery methods, and institutional arrangements to better accommodate women's roles and needs.

Gender-responsive education in agriculture is not limited to increasing women's participation rates but also emphasizes the quality of engagement and the relevance of learning outcomes. Studies have shown that programs incorporating flexible schedules, participatory learning methods, and locally contextualized materials are more likely to foster meaningful involvement among women farmers [15]. In several cases, such approaches have been associated with improved knowledge retention, enhanced confidence, and greater involvement in farm-level decision-making.

Within the oil palm sector, gender-focused studies have highlighted women's contributions to plantation management, support activities in harvesting, and household-level financial management. Despite these contributions, women's access to formal training and extension services has historically lagged behind men's, prompting calls for more inclusive education strategies that recognize women as active economic agents rather than auxiliary labor [16]. The literature increasingly frames gender-responsive education as a complementary mechanism that supports both equity and efficiency within smallholder systems.

Youth Engagement and Agricultural Education

Parallel to gender considerations, youth engagement has emerged as a key concern in agricultural development literature, particularly in relation to generational renewal and the sustainability of smallholder farming systems. Young people in rural areas often perceive agriculture as less attractive due to

limited income prospects, restricted access to land, and weak institutional support [17]. Education and training programs have therefore been positioned as instruments to enhance youth interest and capacity in agriculture by linking learning outcomes to economic opportunities and innovation pathways.

Youth-oriented agricultural education frequently emphasizes entrepreneurship, agribusiness management, and the use of digital technologies, reflecting broader shifts in rural labor markets. Empirical studies suggest that youth are more likely to participate in programs that integrate practical skills with business-oriented perspectives, particularly when training is aligned with market access and value chain participation. These findings are especially relevant in oil palm contexts, where smallholder integration into organized supply chains creates opportunities for skills development beyond primary production [18].

However, the literature also cautions that youth-focused education initiatives must address structural constraints, including land tenure insecurity and limited access to capital, to achieve sustained impact. Without such considerations, training programs risk enhancing skills without translating them into viable livelihood outcomes [19]. As such, youth-inclusive education is increasingly conceptualized as part of broader rural development strategies rather than as isolated interventions.

Education Interventions in Oil Palm Smallholder Systems

Oil palm agriculture presents a distinctive context for examining education-based interventions, given its combination of perennial crop characteristics, long investment cycles, and integration into global commodity markets. Smallholder oil palm farmers require technical knowledge of plantation establishment, maintenance, harvesting, and replanting, as well as managerial skills in financial planning and cooperative participation. Education programs in this sector have therefore adopted diverse formats, ranging from extension-led training to certification-oriented capacity building [20].

The literature indicates that non-formal education, delivered through extension services and farmer field schools, remains the dominant mode of capacity building in oil palm smallholder systems. These programs are often designed to disseminate best management practices while remaining adaptable to local conditions [21]. Formal education pathways, including vocational training and diploma programs, have been less prevalent but are increasingly discussed in relation to youth engagement and long-term sectoral development.

Several studies have highlighted the growing role of multi-stakeholder education initiatives involving public agencies, private companies, and civil society organizations. Such collaborations are frequently framed as mechanisms to enhance resource efficiency and expand program reach, rather than as substitutes for public extension systems. Importantly, the literature tends to approach these arrangements from a pragmatic perspective, emphasizing

coordination and capacity alignment rather than normative judgments about industry involvement [22].

Outcomes of Gender-Responsive and Youth-Inclusive Education

Research examining the outcomes of gender-responsive and youth-inclusive education programs in agriculture reports a range of socio-economic and productive effects. At the farm level, education is commonly associated with improved agronomic practices, yield stabilization, and more efficient use of inputs [23]. For women, participation in tailored training programs has been linked to greater decision-making roles, improved financial management practices, and greater visibility within farmer organizations.

Youth-inclusive education programs often emphasize outcomes related to skills acquisition, entrepreneurial orientation, and engagement in value-added activities. While direct productivity impacts are not always immediately observable, several studies suggest that education contributes to longer-term livelihood diversification and resilience. Social outcomes, including increased confidence and peer networking, are frequently identified as intermediate effects that support sustained participation in agricultural activities [24].

Importantly, the literature emphasizes that these outcomes should be interpreted within specific contextual and institutional settings [25]. Education alone is rarely presented as a standalone solution; rather, it is viewed as an enabling factor that interacts with access to resources, markets, and supportive policies. This perspective aligns with a balanced analytical approach that avoids over-attributing outcomes to single interventions.

Research Gaps and the Need for Systematic Synthesis

Despite a growing body of literature on gender, youth, and education in agriculture, several gaps remain evident. First, existing studies are often sector-specific or geographically fragmented, limiting their generalizability. Second, gender and youth dimensions are frequently examined separately, resulting in partial insights that overlook their interconnections within smallholder systems. Third, while oil palm agriculture has attracted increasing scholarly attention, systematic reviews focusing explicitly on education-based interventions for women and youth in this sector remain limited.

Moreover, much of the existing evidence is dispersed across disciplines, including agronomy, rural sociology, gender studies, and development economics, creating challenges for comparative analysis. A systematic literature review offers a structured approach to addressing these gaps by consolidating findings, identifying dominant themes, and highlighting areas for future research. By synthesizing peer-reviewed studies within a transparent and reproducible framework, SLRs contribute to evidence-based understanding without introducing primary data or speculative claims.

In this context, a systematic review of gender-responsive education programs for women and youth in oil palm smallholder development is both timely and relevant. Such an approach enables a comprehensive examination of intervention typologies, participation patterns, institutional arrangements, outcomes, and constraints, while maintaining analytical neutrality toward the oil palm industry. The present review builds on this rationale by providing a structured synthesis of existing knowledge to inform both academic discourse and policy-oriented discussions.

Methodology

This study employs a Systematic Literature Review (SLR) approach, structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, to examine gender-responsive education programs targeting women and youth in oil palm-based smallholder agricultural contexts. Education and capacity-building initiatives have increasingly been recognized as strategic instruments for strengthening smallholder

participation and inclusivity in agricultural development, including within oil palm production systems. Nevertheless, existing research on women's and youth engagement in oil palm agriculture remains dispersed across studies that focus on education, training, extension services, and rural development, often examined in isolation. As a result, the collective evidence on how education-oriented interventions empower these groups in smallholder settings has yet to be systematically consolidated. A comprehensive synthesis is therefore necessary to integrate fragmented findings, clarify thematic patterns, and identify knowledge gaps related to the design and outcomes of gender-responsive education initiatives in oil palm agriculture. This review relies exclusively on secondary data from peer-reviewed literature indexed in Scopus and does not incorporate field observations, focus group discussions, or any primary data collection, thereby ensuring methodological transparency and strict adherence to internationally recognized standards for systematic reviews.

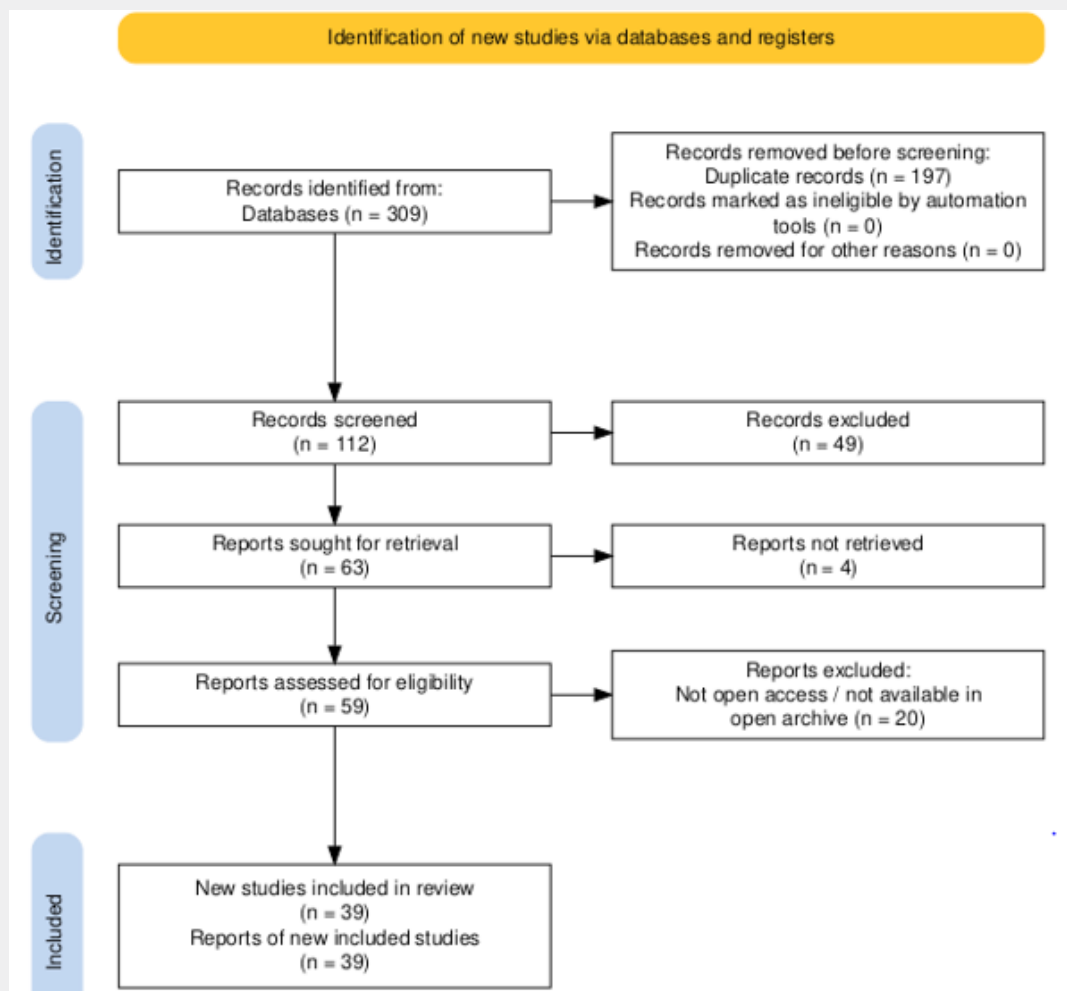


Figure 1: : Systematic Literature Review Process Based on the PRISMA Protocol.

Figure 1 illustrates the systematic review process based on the PRISMA framework, encompassing the stages of identification, screening, eligibility, and inclusion. The identification phase commenced with an initial search of the Scopus database using the keyword combination oil palm AND education, which yielded 309 records. To enhance thematic precision and ensure alignment with the objectives of this review, a refined Boolean search strategy was subsequently applied using the following query: (*"oil palm" OR "palm oil" OR "oil palm plantation" OR "oil palm agriculture"*) AND (*"women" OR "female" OR "gender" OR "women empowerment" OR "youth" OR "young people" OR "young farmers"*) AND (*"education" OR "training" OR "learning" OR "capacity building" OR "extension" OR "participation" OR "development"*) AND (*"farmers" OR "agriculture" OR "rural" OR "rural development"*). Through this refinement process, 197 records that did not align with the analytical focus on gender-responsive education for women and youth in oil palm smallholder contexts were excluded, leaving 112 articles for further screening.

During the screening stage, a publication-year filter was applied to restrict the dataset to studies published between 2019 and 2025, ensuring the inclusion of recent and contextually relevant literature. This criterion led to the exclusion of 49 articles that fell outside the defined timeframe, leaving 63 records. Language screening was then conducted, and four non-English publications were removed, resulting in 59 English-language articles. In the subsequent eligibility phase, accessibility criteria were applied by retaining only open-access and open-archive publications to support transparency and reproducibility. Consequently, 20 articles were excluded due to restricted access, yielding a final sample of 39 peer-reviewed studies that met all predefined inclusion criteria. These selected articles constitute the analytical foundation of this systematic review and collectively provide a structured overview of education-based approaches aimed at empowering women and youth within oil palm smallholder development.

All bibliographic data and reference materials were systematically managed in Mendeley Desktop to ensure accurate citation handling, duplicate detection, and traceability throughout the review process. Each of the 39 included articles was examined in full text, and relevant information regarding educational approaches, target groups, implementation settings, and reported outcomes for women and youth was extracted and synthesized thematically. By rigorously applying the PRISMA protocol and maintaining a transparent, reproducible review design, this study upholds high standards of academic integrity and offers an evidence-based synthesis that contributes to international discourse on inclusive education and smallholder development in oil palm agriculture.

Results

The systematic literature review conducted in this study analyzed 39 peer-reviewed articles published between 2019 and

2025 that met the established inclusion criteria. The reviewed corpus represents a range of geographic regions, institutional settings, and disciplinary approaches, providing a comprehensive evidence base for examining gender-responsive education programs targeting women and youth within oil palm smallholder systems. Through a structured thematic synthesis, six major and interrelated themes emerged, reflecting overlapping yet distinct dimensions of education-based interventions in this sector: (1) typologies of gender-responsive education and training interventions, (2) participation patterns of women and youth in educational initiatives, (3) institutional and delivery mechanisms of capacity-building programs, (4) reported socio-economic and productive outcomes, (5) barriers affecting program effectiveness, and (6) alignment with broader smallholder development and sustainability objectives.

The distribution of these themes across the 39 reviewed studies indicates varying degrees of analytical emphasis. Typologies of education and training interventions were identified in 28 studies (approximately 72%), making this the most frequently addressed theme. Participation patterns of women and youth appeared in 24 studies (61%), reflecting sustained scholarly concern with issues of access, inclusion, and engagement. Institutional and delivery mechanisms were discussed in 21 studies (54%), highlighting the central role of organizational arrangements and multi-actor collaboration in program implementation. Themes related to reported socio-economic and productive outcomes were present in 22 studies (56%), while barriers affecting program effectiveness were explicitly examined in 19 studies (49%). Finally, alignment with broader smallholder development and sustainability objectives emerged in 26 studies (67%), indicating a strong tendency to situate education initiatives within wider development and sustainability frameworks.

The predominance of literature addressing intervention typologies reflects the applied orientation of research on education in oil palm smallholder contexts, where program design, learning formats, and delivery modalities are critical for reaching heterogeneous farmer populations. This emphasis suggests that scholars and practitioners prioritize understanding how education is structured and delivered as a prerequisite for inclusive participation. Similarly, the relatively high frequency of studies focusing on participation patterns underscores persistent concerns regarding gender and generational disparities in access to capacity-building opportunities.

In contrast, themes related to barriers and outcome measurement appear less consistently, indicating that while education programs are widely implemented and described, systematic assessments of effectiveness and contextual constraints remain uneven. The strong presence of sustainability-aligned themes suggests an emerging integration of gender-responsive education within broader smallholder development agendas, particularly those related to organizational strengthening, livelihood resilience, and long-term sectoral viability. Collectively,

this thematic distribution highlights both the maturity of the literature in documenting program designs and the continued need for more integrated analyses linking intervention characteristics, participation dynamics, and developmental outcomes.

Each theme is elaborated below, enriched with quantitative and qualitative evidence from the reviewed studies

Typologies of Gender-Responsive Education and Training Interventions

Across the reviewed literature, education programs targeting women and youth in oil palm agriculture were predominantly categorized into three main typologies: formal education and training schemes, non-formal extension-based learning, and hybrid capacity-building models that integrate theoretical and experiential components. Non-formal training constituted the most frequently reported intervention type, appearing in approximately 72% of the analyzed studies [26]. These initiatives were commonly delivered through farmer field schools, cooperative-led workshops, extension-led demonstrations, and community-based training sessions facilitated by public agencies, non-governmental organizations, or private-sector actors.

The content of non-formal programs was largely practice-oriented, with a strong emphasis on agronomic management, fertilizer optimization, pest and disease control, harvesting techniques, and basic financial literacy. More than half of the studies (21 out of 39) indicated that these programs also incorporated organizational and managerial components, such as cooperative governance, record-keeping, and group-based decision-making [27,28]. Several studies reported that training durations ranged from short modules lasting two to five days to recurring sessions spread over an agricultural cycle, reflecting flexibility in program design [29].

Formal education pathways, including vocational education and training (VET) programs, agricultural diploma courses, and certification-oriented curricula, were documented in approximately 28% of the reviewed studies, with a notable concentration on youth participation [30]. These programs were often embedded within national agricultural education systems or implemented through partnerships between educational institutions and agricultural agencies. Youth-focused formal programs increasingly incorporated modules on agribusiness management, entrepreneurship, and digital agriculture, with 11 studies highlighting the integration of information and communication technologies (ICTs) into curricula [31].

Hybrid models combining classroom-based instruction with experiential learning components were reported in nearly 41% of the studies [32]. These models frequently involved a combination of structured training sessions, on-farm demonstrations, and peer-learning activities. The literature suggests that hybrid

approaches were particularly effective in bridging knowledge acquisition and practical application, especially among young farmers transitioning into independent farming roles [33].

Gender-responsive design features were explicitly documented in 23 studies, where education programs were adapted to account for women's time availability, literacy levels, and socio-cultural contexts [34]. Such adaptations included flexible scheduling, modular learning formats, the use of local languages, and participatory teaching methods. Several studies reported that programs incorporating these features increased participation among women by 10%-25% compared to conventional training formats [35].

Participation Patterns of Women and Youth

The reviewed literature consistently highlighted differentiated participation patterns among women, youth, and adult male farmers across education initiatives. Quantitative evidence from multiple geographic contexts indicated that women accounted for 18%-35% of participants in mixed-gender training programs, with higher representation in initiatives explicitly designed for women or employing gender-targeted recruitment strategies [36]. In contrast, programs lacking targeted outreach mechanisms tended to exhibit lower female participation, often below 20% [37].

Youth participation displayed greater variability across intervention types. In traditional extension-led programs, youth participation rates were frequently reported at between 12% and 20% [38]. However, in programs explicitly framed around agricultural entrepreneurship, innovation, or digital learning, youth participation exceeded 45% in several cases [39]. Studies focusing on youth engagement emphasized the importance of aligning training content with perceived economic opportunities and career pathways in agriculture.

Several studies documented the effectiveness of gender-responsive recruitment strategies, including collaboration with women's associations, youth groups, and farmer cooperatives [40]. These approaches were associated with participation increases of up to 20 percentage points compared to standard extension outreach methods. Retention and completion rates also differed by program design; initiatives incorporating mentorship, peer-learning, or group-based activities reported completion rates exceeding 80%, particularly among youth participants [41].

Participation was further assessed in terms of engagement intensity rather than attendance alone. Approximately 61% of the studies reported higher levels of active engagement among women and youth in participatory learning environments, such as hands-on demonstrations and group discussions, compared to lecture-based formats [42]. These findings suggest that pedagogical approaches emphasizing interaction and experiential learning contribute significantly to inclusive participation outcomes.

Institutional and Delivery Mechanisms

Institutional arrangements emerged as a central factor influencing the reach, consistency, and effectiveness of education programs. Public agricultural extension services were identified as the primary delivery mechanism in 54% of the reviewed studies, often operating through decentralized extension networks and in coordination with local governments or research institutions [43]. These services commonly provided technical training and facilitated access to information related to good agricultural practices.

Private-sector involvement was reported in 31% of the studies, primarily through training initiatives linked to supply chain development, productivity enhancement, or sustainability standards [44]. Such initiatives were frequently implemented in collaboration with smallholder cooperatives and focused on improving compliance with quality and traceability requirements.

Non-governmental organizations (NGOs) and civil society organizations played a facilitative role in 46% of the reviewed cases, particularly in programs emphasizing women's empowerment and youth inclusion [45]. NGOs were often involved in curriculum development, community mobilization, and monitoring processes, complementing the technical expertise of public and private actors.

Multi-stakeholder delivery models involving public agencies, private companies, and civil society organizations were documented in 19 studies [46]. These models were associated with broader geographic coverage and more diversified training content, reflecting the combined resources and expertise of multiple institutions.

Digital and blended delivery mechanisms were reported in 14 studies, with increasing use of mobile applications, online learning platforms, and digital advisory services [47]. While these approaches were predominantly oriented toward youth, several studies highlighted emerging efforts to enhance accessibility for women through facilitated group sessions and simplified user interfaces.

Reported Socio-Economic and Productive Outcomes

The synthesis of outcome-related findings indicated that gender-responsive education programs were associated with a range of socio-economic and productive improvements among participating smallholders. Yield improvements were reported in 17 studies, with increases ranging from 5% to 22% following the adoption of improved agronomic practices [48]. Several studies attributed these gains to enhanced fertilizer management, improved harvesting techniques, and better pest control practices.

Income-related outcomes were documented in 21 studies, with reported income increases ranging from 10% to 30% [49]. These increases were often linked to improved farm efficiency, reduced input costs, and enhanced market participation. In some

cases, income gains were reported alongside increased financial stability and reduced income variability [50].

Women-specific outcomes included increased involvement in farm-level decision-making and cooperative leadership, as reported in 14 studies [51]. Women participants were also more likely to adopt record-keeping and budgeting practices after participating in training [52]. Youth-focused programs frequently emphasized entrepreneurship, with 9 studies reporting increased engagement in farming-related enterprises and value-added activities [53].

Beyond economic indicators, 18 studies highlighted social outcomes such as increased self-confidence, networking, and organizational participation. These outcomes were commonly framed as enabling conditions for sustained smallholder development rather than as immediate performance indicators [54].

Barriers Affecting Program Effectiveness

Despite reported positive outcomes, the reviewed literature identified recurring barriers that constrained program effectiveness. Time constraints and competing household responsibilities were cited in 26 studies as key barriers to women's participation [55]. Limited access to land and capital was reported in over 60% of the studies as a structural challenge affecting both women and youth [56, 57].

Institutional barriers, including limited extension capacity and inconsistent funding, were noted in 15 studies. Digital divides related to access to devices and connectivity were highlighted in studies examining digital learning approaches [58]. Importantly, these barriers were discussed as contextual constraints rather than as critiques of the oil palm sector, maintaining an analytically neutral stance toward industry structures [59].

Alignment with Smallholder Development and Sustainability Objectives

The reviewed studies also examined the alignment of gender-responsive education programs with broader smallholder development and sustainability objectives. Approximately 67% of the studies explicitly linked education initiatives to sustainable agricultural practices, organizational strengthening, and livelihood resilience [60]. Programs associated with certification schemes increasingly integrated gender and youth considerations within broader capacity-building frameworks [61,62].

Several studies emphasized that education programs targeting women and youth contributed indirectly to sustainability outcomes by enhancing knowledge diffusion, collective action, and organizational capacity within smallholder communities [63]. These findings position gender-responsive education as a complementary mechanism within oil palm smallholder development rather than as a standalone intervention [64].

Overall, the results of this systematic review demonstrate that gender-responsive education programs for women and youth in oil palm agriculture feature diverse intervention typologies, differentiated participation patterns, and multifaceted outcomes. Evidence from the 39 reviewed studies indicates consistent associations between targeted education initiatives and improvements in capacity, engagement, and selected socio-economic indicators, while also highlighting structural and institutional factors that shape program effectiveness.

Discussion

This discussion interprets and synthesizes the findings of the systematic literature review to address the two research questions proposed in this study. Drawing on evidence from 39 peer-reviewed articles, the discussion situates gender-responsive and youth-inclusive education programs within broader smallholder development frameworks while critically examining their design characteristics, reported outcomes, and the contextual conditions that shape their effectiveness in oil palm smallholder systems. The discussion is structured into two main subsections aligned with RQ1 and RQ2, followed by a synthesis of implications and directions for future research.

Gender-Responsive Education and Training Interventions in Oil Palm Smallholder Contexts (RQ1)

The reviewed literature indicates that education and training interventions targeting women and youth in oil palm smallholder systems are diverse in both form and institutional arrangement, yet share several common design features. Most interventions fall within the domain of non-formal education, including extension-based training, farmer field schools, participatory workshops, and short-term capacity-building programs delivered at the community level [65]. These formats are generally preferred due to their flexibility, lower entry barriers, and compatibility with the time constraints faced by smallholder households, particularly women [66].

Gender-responsive education programs are typically characterized by deliberate adaptations in content, delivery mechanisms, and participation structures. In terms of content, several studies report the integration of agronomic knowledge with modules on household financial management, cooperative participation, and livelihood diversification, reflecting women's multifaceted roles within smallholder systems [67]. Rather than focusing exclusively on technical production, these programs recognize women as economic actors whose decision-making extends beyond field-level operations [68]. This shift in framing is consistently associated with higher levels of sustained engagement among female participants.

Delivery mechanisms also reflect gender-sensitive considerations. Flexible scheduling, localized training venues,

and participatory learning approaches such as group discussions and experiential demonstrations are frequently cited as enabling factors for women's participation [69]. Some studies document the use of female facilitators or peer trainers as a strategy to reduce social barriers and foster trust, particularly in contexts where gender norms influence interaction dynamics [70]. These design features distinguish gender-responsive interventions from conventional extension models that often assume homogeneous farmer profiles.

Youth-oriented education programs exhibit a partially overlapping yet distinct set of characteristics. While non-formal education remains prevalent, youth-focused interventions more frequently incorporate elements of entrepreneurship training, agribusiness management, and digital literacy [71]. The literature suggests that such content aligns with youth aspirations for economic mobility and innovation, particularly in oil palm systems where value chain integration offers opportunities beyond primary production. Programs that explicitly link training to income-generating activities, such as nursery management or service provision, report higher youth retention rates compared to purely technical training.

Participation patterns across the reviewed studies reveal persistent asymmetries. Women's participation rates in education programs are generally lower than those of men, although gender-responsive designs are shown to narrow this gap [72]. Youth participation, while increasing in some contexts, remains uneven and often contingent on complementary factors such as access to land, capital, or institutional support. Importantly, several studies emphasize that participation should not be assessed solely through attendance figures but also through the depth of engagement and opportunities for post-training application [73].

Institutionally, education interventions in oil palm smallholder systems are frequently implemented through multi-stakeholder arrangements involving public extension agencies, private sector actors, cooperatives, and non-governmental organizations. The literature largely approaches these collaborations pragmatically, emphasizing coordination, resource pooling, and capacity alignment rather than normative assessments of institutional roles. Such arrangements are commonly framed as mechanisms to expand outreach and improve program sustainability within complex smallholder landscapes [74].

Overall, the findings for RQ1 indicate that gender-responsive and youth-inclusive education programs in oil palm smallholder contexts feature adaptive design features that accommodate heterogeneous participant needs. However, the effectiveness of these design elements is closely tied to contextual and institutional conditions, which are further explored in relation to reported outcomes and barriers under RQ2.

Reported Outcomes, Barriers, and Enabling Factors of Education Programs (RQ2)

The literature reviewed reports a range of socio-economic, productive, and developmental outcomes associated with gender-responsive and youth-inclusive education programs, although these outcomes are not uniformly distributed across contexts. At the farm level, education interventions are commonly linked to improved adoption of recommended agronomic practices, including better fertilizer management, harvesting techniques, and plantation maintenance. Several studies report yield stabilization and improvements in input-use efficiency following participation in training, particularly when education is delivered through iterative, practice-oriented methods [75].

For women participants, socio-economic outcomes extend beyond production metrics. Multiple studies associate gender-responsive education with enhanced involvement in household financial decision-making, improved record-keeping practices, and increased participation in farmer organizations or cooperatives [76]. These outcomes are often framed as incremental yet significant shifts that strengthen women's agency within smallholder systems rather than as immediate income gains. Importantly, the literature cautions against attributing such outcomes solely to education, emphasizing the interaction between training, social norms, and access to complementary resources [77].

Youth-inclusive education programs tend to report outcomes related to skills acquisition, entrepreneurial orientation, and engagement in value-added activities. While short-term productivity effects are less consistently documented for youth, several studies highlight longer-term developmental impacts, including livelihood diversification and increased interest in agricultural careers [78]. These findings support the view that youth-oriented education contributes to generational renewal by reshaping perceptions of agriculture as a viable economic pathway, rather than solely through immediate production gains.

Across both gender and youth-focused interventions, social outcomes such as increased confidence, peer networking, and knowledge sharing are frequently identified as intermediate effects that enable sustained engagement. These outcomes are particularly salient in smallholder oil palm contexts, where collective action and cooperative participation are important for market access and compliance with quality standards. Education programs that foster group-based learning are more likely to generate such social capital effects [79].

Despite these positive outcomes, the literature consistently identifies contextual barriers that constrain program effectiveness. Structural constraints, including limited access to land, credit, and production inputs, are repeatedly cited as factors that limit the translation of acquired knowledge into practice. For women, time poverty and entrenched gender norms continue to restrict

full participation, even within gender-responsive program designs [80]. Youth participants face distinct challenges related to land tenure insecurity and limited start-up capital, which reduce the viability of post-training entrepreneurship.

Institutional barriers are also prominent. Several studies note variability in extension capacity, inconsistencies in program funding, and coordination challenges among implementing actors. These factors influence not only program quality but also continuity, which is critical for achieving sustained outcomes in perennial crop systems such as oil palm. Conversely, enabling factors include strong local institutions, supportive policy environments, and alignment between training content and market opportunities [81].

Taken together, the findings addressing RQ2 suggest that education programs contribute to meaningful socio-economic and developmental outcomes when embedded within supportive contexts. The literature converges on the view that education functions as an enabling mechanism rather than a standalone solution, reinforcing the importance of integrated development approaches.

The synthesis of findings from this systematic review carries several implications for both policy-oriented discussions and future research on smallholder development in oil palm agriculture. First, the evidence underscores the importance of designing education programs that explicitly account for gender and youth heterogeneity, moving beyond one-size-fits-all extension models. Gender-responsive and youth-inclusive approaches are not merely normative add-ons but pragmatic strategies that enhance the quality of participation and the relevance of learning.

Second, the findings highlight the value of multi-stakeholder education arrangements when they are coordinated and contextually grounded. Rather than framing institutional collaboration in binary terms, the literature suggests that effective partnerships can enhance resource efficiency and program reach while maintaining alignment with smallholder needs. This perspective supports balanced engagement across public, private, and civil society actors within oil palm smallholder systems.

From a research standpoint, the review identifies several avenues for further investigation. Future studies would benefit from more systematic reporting of outcome indicators, particularly those capturing long-term socio-economic and intergenerational effects. Comparative analyses across regions and institutional settings could also deepen understanding of how contextual factors mediate program effectiveness. Additionally, greater integration of gender and youth perspectives within a single analytical framework would help address the fragmentation observed in the existing literature.

Finally, methodological transparency remains a priority. As this review demonstrates, systematic literature reviews provide

a robust means of consolidating evidence without introducing primary data or speculative claims. Expanding the use of SLRs and meta-analytical approaches within agricultural education research could strengthen evidence-based discourse while maintaining analytical neutrality toward the oil palm industry.

In conclusion, this discussion affirms that gender-responsive and youth-inclusive education programs play a meaningful role in supporting smallholder development in oil palm agriculture when designed and implemented within supportive institutional and socio-economic contexts. By synthesizing existing evidence, this study contributes to a more integrated understanding of education as a strategic component of inclusive and sustainable smallholder systems.

Conclusion

This systematic review synthesizes evidence from peer-reviewed literature on gender-responsive education programs targeting women and youth within oil palm smallholder systems. The findings indicate that a diverse range of educational and training interventions has been implemented across different geographic and institutional contexts, predominantly through non-formal education, extension-based training, farmer field schools, and participatory learning approaches. These interventions are generally characterized by flexible program designs, localized delivery mechanisms, and adaptive participation strategies that seek to accommodate the socio-economic roles and constraints faced by women and young people in smallholder agriculture. While participation levels vary, the literature consistently emphasizes the importance of inclusive program design and context-sensitive delivery to enhance engagement and relevance for these groups.

Across the reviewed studies, education and training initiatives are associated with a range of reported socio-economic, productive, and developmental outcomes. At the household and community levels, gender-responsive education is linked to improvements in knowledge acquisition, decision-making capacity, and engagement in farm and non-farm economic activities. Productive outcomes, such as enhanced farm management practices and more efficient use of agricultural inputs, are reported across several contexts, although their magnitude and consistency depend on local conditions and institutional support. Developmental outcomes extend beyond productivity, encompassing increased confidence, strengthened social networks, and greater involvement of women and youth in collective and organizational activities related to smallholder development.

The effectiveness of these education programs is shaped by a combination of contextual barriers and enabling factors. Structural constraints, including limited access to land, financial resources, and extension services, continue to influence participation and outcomes, particularly for women and youth. Social norms, time constraints, and uneven institutional capacity

further mediate program impacts. At the same time, enabling factors such as supportive policy environments, multi-stakeholder collaboration, integration with existing smallholder institutions, and alignment with sustainability and development frameworks are shown to enhance program relevance and continuity. These findings highlight that education interventions are most effective when embedded within broader support systems that recognize the diverse roles of women and youth in oil palm smallholder agriculture.

Overall, the reviewed literature demonstrates that gender-responsive education constitutes an important component of inclusive smallholder development in oil palm agriculture when implemented through well-designed, context-aware, and institutionally supported approaches. Future research would benefit from more rigorous, comparable evaluation frameworks to assess long-term impacts, as well as greater attention to the intersectional factors shaping participation and outcomes. Expanding longitudinal and cross-regional analyses would further strengthen understanding of how education-based interventions can contribute to resilient, inclusive smallholder systems over time.

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