



Integrating Science and Entrepreneurial Character Among Islamic Boarding School Students Through an Integrated Agribusiness Model

Afiful Ihwan^{1*}, Wahidmurni¹, Jamiluddin Yacub¹

¹ UIN Raden Fatah Palembang, Palembang, Indonesia.

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Corresponding Author:

Afiful Ihwan

afifulihwan995@gmail.com

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Abstract: This study analyzes the integration of scientific knowledge and entrepreneurial character development among *santri* (Islamic boarding school students) through an integrated agribusiness model at two *pesantren* in East Ogan Komering Ulu, Indonesia. Using a qualitative case study approach with interviews, observation, and document analysis, findings reveal that both institutions systematically combine scientific agricultural practices—such as hydroponics, organic cultivation, and sustainable resource management—with Islamic ethical principles like *amanah* (trustworthiness) and *muamalah fiqh*. Three core strategies emerged: value-infused mentorship, reflective practice, and community-engaged learning, which collectively cultivate a distinctive "santripreneur" identity wherein scientific literacy, economic agency, and spiritual accountability mutually reinforce one another. *Santri* demonstrated enhanced entrepreneurial self-efficacy, innovation orientation, evidence-based decision-making, and ethical reasoning. The study concludes that integrated agribusiness models effectively internalize entrepreneurial character when grounded in experiential learning, science-based pedagogy, and value-based instruction. However, scalability requires addressing systemic constraints—including technological access, market linkages, and educator capacity—through coordinated multi-stakeholder support. These insights offer a replicable framework for Islamic educational institutions seeking to cultivate ethically grounded, scientifically literate, and economically resilient graduates capable of contributing to sustainable rural development.

Keywords: Boarding school; Entrepreneurial Character; Islamic; Science.

Introduction

Islamic boarding schools (*pesantren*) in Indonesia have historically served as foundational institutions for religious, moral, and character education (Ikuemonisan et al., 2022; Romani et al., 2023). Beyond their spiritual mission, their strategic placement in rural regions, access to agricultural land, and concentration of young learners position them as potential hubs for science-based economic innovation (Conte et al., 2025; Houser et al., 2026; Machado et al., 2024). In an era demanding scientific literacy, ecological sustainability, and economic adaptability, equipping *santri* with both ethical grounding and practical competencies in agricultural science and entrepreneurship has become

essential (Calafat-Marzal et al., 2025; Melo et al., 2026; Ngarava, 2026). Integrating scientific knowledge—such as agronomic principles, integrated resource management, hydroponic systems, and data-informed production planning—into entrepreneurial character development offers a viable pathway to cultivate resilient, innovative, and values-driven graduates who can contribute to regional food security and sustainable rural economies (Olivera et al., 2022; Prioli Duarte et al., 2023; Uyar et al., 2024).

Despite this potential, many *pesantren* face challenges in systematically embedding scientific inquiry and entrepreneurial values into their daily educational routines (Carbajal et al., 2025; Modica et al., 2025; Shen et al., 2026). The absence of structured

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pedagogical models that seamlessly align Islamic ethics, agricultural science, and market-oriented thinking often limits the effectiveness of character internalization (Adeniji et al., 2025; Jin et al., 2022; Tanaka et al., 2025). Additionally, constraints such as limited technical expertise, inadequate access to modern scientific tools, and fragmented curricular design hinder the consistent development of scientifically literate, entrepreneurial mindsets among students (Dohou et al., 2026; Ramos Collin et al., 2024; Zhang et al., 2025). Addressing these gaps requires a deliberate, context-sensitive approach that bridges spiritual formation, experiential science learning, and practical agribusiness engagement (Amoabeng-Nimako et al., 2025; Bakas et al., 2025; Duncan et al., 2026).

This study aims to analyze how scientific knowledge and entrepreneurial character are integrated among *santri* through an integrated agribusiness model. Focusing on Pondok Pesantren Nurussalam and Darul Falah in East Ogan Komering Ulu, the research seeks to identify the educational strategies, curricular integrations, and practical implementations employed to foster scientific literacy, entrepreneurial attitudes, and ethical decision-making. By examining how these institutions combine Islamic values with science-based agribusiness training, this work clarifies the operational dynamics that enable effective character development, providing a foundational reference for institutions aiming to cultivate independent, scientifically competent, and ethically grounded graduates.

Method

Research Design and Approach

This study employs a qualitative research approach with a multiple case study design to investigate the model of internalizing entrepreneurial character among *santri* through an integrated agribusiness framework (Adeyanju, Mburu, Gituro, Chumo, Mignouna, & Mulinganya, 2023; Guo et al., 2024; Nogueira Dias et al., 2025). The qualitative paradigm was selected to enable an in-depth, contextual exploration of how entrepreneurial values are transmitted, practiced, and internalized within the unique socio-religious environment of Islamic boarding schools (*pesantren*). The case study design allows for a holistic examination of the phenomenon within its real-life context, facilitating the identification of patterns, processes, and underlying mechanisms that shape entrepreneurial character development.

Research Setting and Participants

The research was conducted at two purposively selected Islamic boarding schools in East Ogan

Komering Ulu (OKU Timur), Indonesia: Pondok Pesantren Nurussalam and Pondok Pesantren Darul Falah. These institutions were chosen based on their established track records in developing agribusiness-based entrepreneurial programs and their commitment to integrating Islamic values with practical economic skills. Participants included *santri* actively involved in agribusiness units, *ustadz/ustadzah* (religious teachers), program coordinators, and pesantren management staff. Purposive and snowball sampling techniques were applied to ensure the inclusion of information-rich cases capable of providing deep insights into the internalization process.

Data Collection Methods

Data were gathered through three primary techniques to ensure triangulation and depth: In-depth Interviews: Semi-structured interviews were conducted with *santri*, educators, and administrators to explore their experiences, perceptions, and reflections regarding the integration of agribusiness practices and entrepreneurial character formation. Interview guides were developed based on the research objectives and refined iteratively during fieldwork; Participatory Observation: The researcher engaged in direct observation of daily agribusiness activities, classroom sessions, extracurricular training, and community engagement events. Field notes were systematically recorded to capture behavioral patterns, interaction dynamics, and contextual nuances that might not emerge through verbal accounts alone; and Document Analysis: Relevant institutional documents—including curricula, program reports, activity logs, policy guidelines, and promotional materials—were reviewed to corroborate interview and observational data and to trace the formal structures supporting entrepreneurial character internalization.

Data Analysis Technique

Data analysis followed an inductive, thematic approach consistent with qualitative inquiry. Transcripts, field notes, and documents were systematically coded using open, axial, and selective coding procedures to identify recurring themes, categories, and relationships. The analysis focused on answering "how" and "why" questions concerning the processes, strategies, challenges, and outcomes of entrepreneurial character internalization. NVivo software assisted in organizing and managing the coding process, while manual interpretation ensured contextual sensitivity and theoretical coherence.

Trustworthiness and Rigor

To ensure credibility, transferability, dependability, and confirmability, several strategies were implemented: Triangulation: Methodological

triangulation (interviews, observation, documents) and source triangulation (multiple participant groups) were employed to cross-validate findings; Member Checking: Preliminary interpretations were shared with key participants to verify accuracy and resonance with their lived experiences; Thick Description: Detailed contextual accounts were provided to enable readers to assess the applicability of findings to similar settings; and Reflexivity: The researcher maintained a reflexive journal to document assumptions, positionalities, and decision-making processes throughout the study.

Result and Discussion

The study identified structured approaches to embedding scientific knowledge into entrepreneurial character internalization at both *pesantren*. Scientific practices were not taught in isolation but operationalized through daily agribusiness activities that required *santri* to apply empirical reasoning, environmental monitoring, and evidence-based management.

Science-Embedded Curriculum and Training

At Pondok Pesantren Nurussalam, *santri* engaged in cyclical agricultural practices grounded in agronomic science, including soil fertility testing, organic compost formulation, integrated pest management, and seasonal crop rotation. Theoretical instruction in plant physiology and microclimate management was directly applied to field production, with mentors guiding students to record yield data, adjust inputs, and evaluate outcomes scientifically (Adeyanju, Mburu, Gituro, Chumo, Mignouna, Mulinganya, et al., 2023; Karimi et al., 2026; Machado et al., 2024). Pondok Pesantren Darul Falah emphasized technology-integrated agriculture, utilizing hydroponic systems, nutrient solution calibration, pH/EC monitoring, and digital inventory tracking. *Santri* were trained to interpret scientific metrics to optimize growth conditions, reduce waste, and forecast market supply, fostering a culture of data-driven entrepreneurship (Adeyanju et al., 2024; Awad, 2023; Ikuemonisan et al., 2022).

Mechanisms of Science-Character Integration

Three interlocking mechanisms facilitated character internalization: (1) *Science-infused mentorship*, where educators explicitly linked experimental rigor, accuracy, and sustainable resource use to Islamic virtues like *amanah* (stewardship) and *ikhlas* (integrity); (2) *Reflective scientific practice*, wherein *santri* documented observations, analyzed production variables, and discussed failures as opportunities for iterative improvement, reinforcing resilience and intellectual

humility; and (3) *Community science-engagement*, where students applied scientific agribusiness solutions to local farming challenges, positioning innovation as a form of social responsibility (Krova et al., 2025; Widiastuti et al., 2024; Zhou et al., 2026).

Outcomes in Scientific and Entrepreneurial Competency

Qualitative evidence indicated significant growth in *santri's* scientific reasoning and entrepreneurial self-efficacy (Kovshov et al., 2023; Mambile et al., 2025; Ramaano, 2024). Participants demonstrated increased ability to diagnose crop stressors, calibrate technical inputs, and adapt production models based on environmental feedback. Entrepreneurial behaviors such as cost-benefit analysis, risk mitigation through scientific forecasting, and ethical pricing aligned with sustainable yield emerged organically from their science-based training (Oppong-Kyeremeh et al., 2024; Tarihoran et al., 2023; Zomorodi et al., 2024). Alumni trajectories further suggested that graduates were more likely to initiate evidence-based agribusiness ventures or adopt sustainable farming practices in their communities, reflecting a durable integration of scientific literacy and entrepreneurial character (Almeida et al., 2025; Ferreras-Garcia et al., 2020; Lopatka, 2021).

The internalization of entrepreneurial character within Islamic boarding schools emerges not as a byproduct of vocational training, but as a deliberate pedagogical synthesis of spiritual formation, applied agricultural science, and experiential learning (Ramoglou et al., 2026; Samenjo, 2025; Vesper et al., 2024). This study demonstrates that when scientific agribusiness practices are systematically aligned with Islamic ethical frameworks, *santri* develop a resilient "santripreneur" identity characterized by dual accountability: to economic viability and spiritual integrity. Rather than treating ethics as a supplementary module, the observed model embeds moral reasoning directly into production cycles, resource management, and market engagement (Kim et al., 2026; Nassar, 2025; Satar et al., 2025). This positions *pesantren* not merely as religious institutions or skill-training centers, but as living laboratories for value-driven economic innovation, challenging the conventional dichotomy between moral education and entrepreneurial competency (Hagerer, 2025; Niva et al., 2026; Portuguese-Castro & Ramirez-Montoya, 2025).

A critical insight from this study lies in the triadic mechanism that enables effective internalization: value-infused mentorship, reflective scientific practice, and community-engaged innovation. Mentorship proves pivotal not as mere knowledge transfer, but as moral scaffolding (Hulyadi et al., 2025; Martínez-Martínez et

al., 2025; Oliver et al., 2025). When *ustadz* and program facilitators explicitly frame risk-taking, resource efficiency, and fair pricing as expressions of Islamic stewardship (*khilafah*) and trustworthiness (*amanah*), entrepreneurial behaviors transition from external requirements to embodied dispositions (Battaglia et al., 2026; Listopadzka et al., 2025; Vitti et al., 2025). Simultaneously, the integration of agricultural science—soil testing, hydroponic calibration, yield forecasting, and data-driven planning—transforms routine farming into applied inquiry (Mannevaara et al., 2024; Rabelo Neto et al., 2024; Tsoutsas et al., 2024). *Santri* learn to diagnose variables, iterate solutions, and treat failure as empirical feedback, fostering intellectual resilience and adaptive innovation. When coupled with structured reflection, these experiences cultivate entrepreneurial self-efficacy grounded in evidence rather than intuition, addressing a persistent gap in informal vocational settings where technical training and character development are often siloed (Bragelien & Nazar, 2026; Franco et al., 2023).

The divergence between the two case sites further underscores a vital principle for scalability: effective internalization frameworks must be context-responsive rather than standardized (Kolajo et al., 2026; Mudjahidin et al., 2024; Vögele, 2025). While one institution emphasized agroecological practices and the other prioritized technology-integrated cultivation, both achieved character internalization by maintaining a consistent pedagogical linkage between scientific practice, economic decision-making, and ethical reflection (Gao, 2026; Hilarowicz et al., 2023; Yi & Park, 2024). This suggests that replication across diverse *pesantren* contexts should prioritize capacity-building in value-based pedagogy and experiential curriculum design over prescriptive technological adoption. Strategic partnerships with agricultural universities, agri-tech enterprises, and local cooperatives can bridge resource constraints while preserving institutional autonomy and spiritual identity (Gonzalez-Tamayo et al., 2025; Kurniasari et al., 2026; Sancho et al., 2026).

The findings carry significant theoretical, practical, and policy implications (Duong et al., 2025; Huang et al., 2026; Žilka et al., 2024). Theoretically, they advance character education and Islamic entrepreneurship literature by demonstrating how moral dispositions are cultivated through structured, science-informed practice rather than didactic instruction (Alshebami et al., 2025; Bastidas et al., 2023; Xiang et al., 2026). Practically, the study offers a replicable framework for *pesantren* leaders to redesign learning ecosystems that harmonize agricultural science, business management, and ethical pedagogy into cohesive daily routines (Bechthold et al., 2022; Lazarte-Aguirre, 2025; Tao, 2026). For

policymakers, the results advocate for targeted support in educator upskilling, digital infrastructure, and market linkage programs that formally recognize *pesantren* as legitimate nodes in national agricultural innovation and rural development networks. Overlooking this potential perpetuates an outdated separation between religious education and economic modernization (Alfaifi et al., 2022; Alvarez-Icaza et al., 2025; Karimi et al., 2026).

While this qualitative case study provides rich contextual insights, its findings are bounded by the specific socio-geographic and institutional characteristics of two rural *pesantren*. Future research should employ longitudinal designs to track graduate trajectories, business sustainability, and community economic impact over time (Blanka et al., 2022; Ramírez-Montoya et al., 2024; Sleiman et al., 2025). Comparative studies across urban, coastal, and digitally focused boarding schools would further test the model's transferability. Additionally, developing validated metrics to quantify the "santripreneur" identity construct and its correlation with entrepreneurial performance would strengthen empirical generalizability (Hayter, 2026; Martín-Gutiérrez et al., 2025; Zuo et al., 2025).

Ultimately, the integrated agribusiness model examined here redefines the pedagogical mission of Islamic boarding schools in the contemporary era (Albrecht et al., 2025; Audretsch & Belitski, 2025; Nguyen-Van et al., 2025). By harmonizing scientific literacy, entrepreneurial agility, and Islamic ethics, *pesantren* can cultivate a new generation of leaders who view economic agency not as a departure from spiritual values, but as their practical expression. Strengthening this nexus offers a sustainable pathway toward rural empowerment, food system resilience, and morally grounded economic development, positioning Islamic educational institutions as critical contributors to Indonesia's sustainable development agenda.

Conclusion

This study confirms that integrating agricultural science into entrepreneurial training effectively internalizes entrepreneurial character among *santri*. At Pondok Pesantren Nurussalam and Darul Falah, the deliberate coupling of scientific practices—such as agronomic management, hydroponic technology, data monitoring, and sustainable resource planning—with Islamic ethical principles cultivates a "santripreneur" identity where scientific literacy, economic agency, and spiritual accountability reinforce one another. Character internalization is most robust when grounded in experiential science learning, reflective empirical practice, and value-infused mentorship. Practically, the findings affirm that *pesantren* can serve as dynamic

incubators for science-driven, values-based entrepreneurship. However, long-term scalability requires addressing systemic constraints through targeted capacity building, technological access, and multi-stakeholder partnerships that bridge religious education, agricultural science, and market ecosystems. Future research should explore longitudinal impacts of science-based entrepreneurship on graduate livelihoods, ecological sustainability metrics, and the transferability of this model to urban or digitally focused pesantren. Strengthening the nexus between scientific education, entrepreneurial training, and character formation offers a sustainable pathway toward developing resilient, innovative, and ethically grounded leaders for Indonesia's agricultural and economic future.

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