

Actions to Strengthen Agricultural Education by Linking Students with the Rural Community

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ABSTRACT:

This study analyzes how to strengthen the Technical Agricultural High School (Bachillerato Técnico Agropecuario - BTA) through community engagement to reduce rural youth migration and inequality in Paraguay. The objective is to propose and empirically substantiate a model of innovative actions to reinforce the BTA through its connection with the rural community. The sample included third-year students selected through probabilistic sampling, a focus group of technical teachers, and interviews with directors of agricultural schools in Caazapá, Minga Guazú, and Villarrica. The method adopted a qualitative approach with quantitative support, under a non-experimental, cross-sectional design with a descriptive, analytical, comparative, and projective scope, applying methodological and source triangulation. The main findings reveal that while the BTA has a solid pedagogical foundation, it faces structural constraints, a lag in precision technology, and insufficient transversal skills that restrict territorial development. It is concluded that transforming educational management is essential to ensure youth retention, education for sustainable development, and sector modernization. To achieve this, a model of innovative actions based on a continuous improvement cycle (Group, Articulate, Strengthen, and Adapt) is proposed and structurally validated, focusing on digitalization with precision agriculture, institutionalization of alternating pedagogy, and the conversion of schools into regional innovation networks linked to the productive environment.

Keywords: rural education, educational innovation, education for sustainable development.

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Introduction

Rural Paraguay has been historically characterized by structural inequality that persists through income concentration and the deficient implementation of comprehensive public policies (Zavattiero et al., 2021). This regional disparity limits human development opportunities and affects rural youth who face conditions of vulnerability, thereby increasing informal employment, youth unemployment, and urban migration (Cohene & Rojas, 2020; Lezcano & Sanabria, 2025). In this context, the Agricultural School of the Technical Agricultural High School (*Bachillerato Técnico Agropecuario* - BTA) constitutes a priority for promoting generational turnover,

rural retention, and sustainable development (Aguilar et al., 2019; JICA, 2013).

To effectively reduce rural poverty, collective action must be fostered. In this regard, Fogel et al. (2025) note that inequality in rural Paraguay has traditionally been reproduced as a function of traditional public policies and predominant economic interests. Furthermore, these authors point out that resources, infrastructure, and educational institutions are concentrated in urban areas, whereas the rural population remains scattered in isolated settlements far from these direct spheres of influence, obstructing access to social services and preventing the transformation

of productive growth into effective poverty reduction (Fogel et al., 2025).

This territorial divide negatively impacts the life development of rural youth. According to Cohene and Rojas (2020), young people face multiple constraints due to the lack of targeted public policies, resulting in scarce job opportunities, vulnerability to exploitation, high unemployment rates, and a deep sense of displacement. Similarly, Lezcano and Sanabria (2025) warn that these adverse conditions push youth into the informal sector and urban migration. To address this dynamic, Brizuela et al. (2013) emphasize the need to tackle disparities between rural and urban institutions, arguing that beyond economic factors, the key to reducing youth exodus lies in motivating students to undertake productive projects closely linked to their communities.

In the educational sphere, Ricardi (2012) explains that Paraguay's social structure reproduces significant disparities in schooling access and quality, constraining social mobility and basic needs fulfillment. Although the educational reform launched after the 1992 Constitution aimed to bridge these gaps through principles of equity (Barrios & Vuyk, 2024), the link between technical training and regional development remains limited. This issue is compounded when considering SDG 1 commitments on poverty reduction, highlighting that national economic growth has not automatically translated into structural improvements for vulnerable sectors (Boccia, 2024). Moreover, high levels of informal employment hinder the productive inclusion of youth, in line with SDG 8, which promotes decent work and economic growth (Boccia, 2024).

Additionally, Duarte and Samudio (2025) explain that rural students face obstacles to fully participating in community development due to a lack of transversal and socio-emotional competencies, such as leadership, perseverance, and adaptability. This challenge is further aggravated by a significant technological gap in the agricultural sector, where, as noted by Borda

(2025), precision agriculture technologies—such as sensors, drones, and GPS systems—are concentrated mainly in large agribusinesses. Meanwhile, family farming suffers from a lack of technical training and transfer, impeding the implementation of sustainable production and consumption models as outlined in SDG 12 (Dávalos-von Eckstein, 2023).

Faced with this reality, technical education programs must be transformed. Caputo (2008) highlights the importance of reforming agricultural education and advocates for integrating commercial-business models with agroecological and family farming approaches to counter the historical marginalization of smallholders (Caputo, 1994). Likewise, Parra et al. (2015) call for transitioning away from closed-school models in favor of open institutions that organize cultural activities, fairs, and services directly benefiting surrounding communities. Cagigas (2022) stresses that agricultural education must offer comprehensive training to prepare young people as local agents of change, whether through entrepreneurship or productive service provision.

Within this framework, the present study focused on implementing educational innovations within the field of Innovation and Research in Education, linking the theoretical and practical knowledge of the BTA with the Science, Technology, and Society (STS) approach. In this regard, according to Bámaca-López and De la Vega (2019), scientific and technological innovation must focus on building capabilities to solve local economic, social, and environmental problems. Furthermore, Crespo Burgos et al. (2022) emphasize that achieving a high-quality, comprehensive educational offer requires grounding pedagogical planning in a rigorous diagnosis and projective validation of territorial needs.

To comprehensively address this problem, the research sought to answer the following main question: *What conceptual and operational elements must be integrated to configure and validate a model of innovative actions aimed at strengthening the Technical*

Agricultural High School through community engagement? Consequently, the general objective was to propose and empirically substantiate a model of innovative actions to strengthen the Technical Agricultural High School through community engagement.

Regarding methodology, the study employed a descriptive, analytical, comparative, and projective approach based on a non-experimental, cross-sectional design. A qualitative method supported by quantitative data was used, adopting data and source triangulation as the primary strategy to ensure validity, analytical consistency, and the overcoming of elementary diagnostic limitations.

Data collection techniques combined surveys administered to a probabilistic sample of 59 third-year students, focus groups with technical teachers, and in-depth interviews with directors of agricultural schools in the departments of Caazapá, Alto Paraná, and Guairá. This approach allowed for contrasting curricular diagnostics against environmental demands and operationally grounding the proposed innovative model (Ocampos, 2026).

2. Methodology

The research was conducted across three public Technical Agricultural Secondary Education institutions under the Direction of Agricultural Education of the Ministry of Agriculture and Livestock of Paraguay: Caazapá Agricultural School (Caazapá District, Caazapá Department), Minga Guazú Agricultural School (Minga Guazú District, Alto Paraná Department), and Villarrica Agricultural School (Mbocayaty District, Guairá Department). These institutions represent the country's most traditional agricultural training centers and share homogeneous operational characteristics by offering the Technical Agricultural High School (*Bachillerato Técnico Agropecuario* - BTA) under a residential boarding system oriented toward the technical-productive training of rural youth (Ocampos, 2026).

The study was grounded in a predominantly qualitative approach with quantitative support,

utilizing a non-experimental, cross-sectional design with descriptive, analytical, comparative, and projective scopes (Hurtado de Barrera, 2010; Hernández-Sampieri & Mendoza, 2018). The target population consisted of all students enrolled in the third year of the BTA during the 2026 academic year ($N = 69$). Restricting the sample to final-year students followed an experiential representativeness criterion, as they are the only students who have completed the full cycle of residency within the agricultural boarding system.

For the quantitative stratum, a stratified random sampling with proportional allocation was applied (Otzen & Manterola, 2017), yielding a statistically representative sample of $n = 59$ students (20 in Caazapá, 20 in Minga Guazú, and 19 in Villarrica), calculated assuming a 5% margin of error and a 95% confidence level. The qualitative component relied on a purposive non-probabilistic sampling (Otzen & Manterola, 2017) comprising 15 technical teachers (5 per institution) with an inclusion criterion of over 10 years of seniority in the system, alongside all institutional directors ($n = 3$), selected for their strategic leadership and curricular roles.

Variables and indicators were operationalized sequentially in relation to the specific objectives. The *Current State of the BTA* variable (diagnosis) was evaluated through the dimensions of curricular relevance, technical updating, rural engagement, and pedagogical approach. The *Training Requirements* variable (needs) was analyzed across training needs, territorial articulation, and institutional management dimensions. The *Training Gaps* variable measured discrepancies between current conditions and ideal requirements through structural, pedagogical, and territorial articulation dimensions. Finally, the *Innovative Model* variable (projective proposal) addressed sustainable innovative action dimensions and institutional mechanisms for school-community engagement.

For quantitative data collection, a structured questionnaire measured on a 5-point Likert scale was administered to students. Content validity

was established via expert judgment, and internal consistency was determined using Cronbach's alpha coefficient, reaching an overall value of $\alpha = 0.878$, demonstrating high reliability (Oviedo & Campo-Arias, 2005). Quantitative statistical processing was executed using computer software for matrix ordering, generating absolute frequency distribution tables, percentages, and measures of central tendency and dispersion.

For the qualitative approach, focus group sessions with technical teachers and in-depth interviews with directors were conducted using semi-structured guides. Transcripts were processed using thematic content analysis across two sequential levels: initial coding for extracting units of meaning, and axial coding for building emerging analytical categories (Strauss & Corbin, 2002).

Synthetic integration of findings was achieved through a rigorous methodological and source triangulation procedure (Benavides & Gómez-Restrepo, 2005), structured into four continuous phases: descriptive, analytical, comparative, and and percentages of the nine evaluated variables.

projective. This procedure enabled cross-referencing statistical data from students with qualitative understandings from teachers and directors, further contrasting them with official BTA regulatory and curricular documents.

The study strictly adhered to ethical principles in social and educational research, obtaining institutional authorizations, signed informed consent forms from all participants, and guaranteeing complete confidentiality and anonymity through alphanumeric coding of subjects.

3. Results

Empirical findings obtained from field data ($n=59$) are structured according to the analytical dimensions of the study, providing the necessary evidence base for the projective model phase.

Descriptive Analysis of Student Perceptions on Curriculum and Environment

Univariate analysis indicates a strong favorable trend among students toward the applicability and practical focus of the BTA curriculum. **Table 1** summarizes the frequency distribution

Table 1. *Frequency distribution and percentages of student perception variables ($n=59$)*

Variable / Evaluation Item	Criterion	Frequency (n)	Percentage (%)
Ease and speed of learning	Agree / Strongly agree	48	81.4
(Active pedagogical approach)	Neutral / Disagree	11	18.6
Safety and handling	Agree / Strongly agree	48	81.4
(Food safety and GAP)	Neutral / Disagree	11	18.6
Teacher clarity on GAP	Agree / Strongly agree	47	79.7
(Technical orientation)	Neutral / Disagree	12	20.3
Similarity with local environment	Agree / Strongly agree	46	78.0
(Practical articulation)	Neutral / Disagree	13	22.0
Use of PPE and clothing	Agree / Strongly agree	46	78.0
(Student safety)	Neutral / Disagree	13	22.0
Autonomous problem solving	Agree / Strongly agree	44	74.6

(Competency development)	Neutral / Disagree	15	25.4
Positive environmental impact	Agree / Strongly agree	44	74.6
(Environmental protection)	Neutral / Disagree	15	25.4
Relevance of technical content	Agree / Strongly agree	42	71.2
(Labor insertion)	Neutral / Disagree	17	28.8
Demand for higher technical workload	Agree / Strongly agree	40	67.8
(Opportunity for improvement)	Neutral / Disagree	19	32.2

Note. Data collected during field research (2026 academic year). GAP: Good Agricultural Practices; PPE: Personal Protective Equipment.

Over four-fifths of students confirm that the active approach facilitates learning (81.4%) and enhances awareness of product safety (81.4%). Likewise, nearly 80.0% perceive clarity in teacher guidance on Good Agricultural Practices (GAP) and observe consistency between field tasks and local production reality. The highest opinion dispersion lies in the need to increase hours dedicated to specific technical subjects (32.2% neutral or disagree).

Triangulation of Key Stakeholder Perceptions on the Curriculum

Quali-quantitative integration comparing perceptions among directors (DIR-01 to DIR-03), focus group teachers (DOC-01 to DOC-15), and students (EST-01 to EST-59) reveals convergence regarding farm practice valuation, while highlighting critical gaps in equipment and innovation. **Table 2** compiles these perspectives.

Table 2. *Perception triangulation matrix among directors, teachers, and students*

Variable / Dimension	Directors (n=3)	Technical Teachers (n=15)	Students (n=59)
Technical Relevance	Articulation with agribusinesses and fairs to monitor local demands.	Perceive acceptable alignment, but warn of market lag.	71.2% confirm topics correspond to real field demands.
Technological Updating	Managing corporate agreements to access modern machinery.	Identify gaps in automation, drones, and GPS navigation.	78.0% perceive learning technologies suited to current environment.
Pedagogical Approach	Promoting "Learn to Earn" model and project-based research.	Value "learning by doing," but criticize traditional written exams.	81.4% value active methodology for facilitating fast learning.
Sustainable Development	Measuring environmental protection as a production efficiency indicator.	Report lack of infrastructure (e.g., fertigation) for continuous practice.	83.1% validate acquiring non-polluting production habits.
Key Competencies	Prioritize digital farm administration and	Observe progress in associativity, but lags in precision agriculture.	74.6% report confidence in autonomously solving farm contingencies.

	agricultural credit management.		
Territorial Articulation	Promoting agricultural fairs as commercial exchange hubs.	Observe disconnect when teaching theory in areas lacking power or water.	78.0% affirm practices align with local farmers' tasks.
Improvement Opportunities	Recommend incorporating agrimarketing, logistics, and digital finance.	Request reducing classroom workload to increase field immersion.	67.8% request higher technical workload relative to general curriculum.

Note. DOC: Focus Groups of Technical Teachers.

Evaluation of Gaps Between Current Condition and Training Requirements

Contrasting installed capacity across agricultural educational centers (EAG-1, EAG-2, and EAG-3) with socioeconomic demands identifies technical, logistical, and methodological limitations that justify the proposed design. **Table 3** summarizes this comparative assessment.

Table 3. *Comparative gap analysis between observed current condition and required target condition in the BTA*

Analytical Subcategory	Observed Current Condition	Required Target Condition
Community Engagement	Engagement restricted to administrative internships (240 h) and formal curriculum.	Transition to alternating pedagogy and execution of the PLADIPRO plan.
GAP Training	Theoretical instruction based on simplified guides due to resource scarcity.	Digital traceability via mobile applications and external supervisions.
Food Safety	Basic cleaning and artisanal handling in the Consumption Warehouse.	Industrial standards of food safety and processing within Innovation Networks.
Student Safety	Resistance to PPE use due to local habits; theoretical instruction.	Risk simulators, associative purchasing, and rigorous teacher modeling.
Environmental Sustainability	Input conservation restricted to controlled school plots.	Student leadership in precision agriculture and bio-input production.

Note. BTA: Technical Agricultural High School; GAP: Good Agricultural Practices; PLADIPRO: Productive Pedagogical Plan; PPE: Personal Protective Equipment.

Discursive evidence confirms that the shortage of advanced equipment (automated fertigation systems, personal protective equipment, safety protocols, and global positioning technology) restricts the comprehensive application of competency-based assessments in the field, creating an operational gap relative to agrotechnological standards.

Structuring and Substantiation of the Innovative Action Model

To mitigate identified gaps and provide the study with genuine projective and intervention scope, qualitative and quantitative data were articulated into a model grounded in the continuous improvement cycle: **Group, Articulate, Strengthen, and Adapt**. Table 4 systematizes the operational components formulated from key stakeholder requirements.

Table 4. *Operational structure of the Innovative Action Model for the BTA*

Strengthening Actions	Continuous Improvement Cycle Phases	Specific Operational Components
1. Rural Associativity	Group (Rural Administration with Rural Associativity)	• Document, accounting, and statutory organizing of local farmer associations. • Diagnostic and technical adaptation interventions on family farms. • Transfer of adapted precision agriculture (sensors/drones). • Assistance in community food security projects.
2. Consumption Warehouse	Articulate (Rural Associativity with Consumption Warehouse)	• Post-harvest management, sorting, and preservation protocols. • Joint storage and marketing strategies for smallholders. • Primary processing for value addition at origin. • Digitalized inventory control and input supply.
3. Agreements & Alliances	Strengthen (Consumption Warehouse with Agreements & Alliances)	• Implementation of "On-Farm Classrooms" and community field days. • Articulation with public procurement and insertion into local markets. • Promotion of rural products via digital platforms and networks. • Consolidation of Regional Agricultural Innovation Networks.
4. Rural Administration	Adapt (Agreements & Alliances with Rural Administration)	• Support in adopting electronic invoicing and accounting records. • Integration of e-wallets and digital payment transfers. • Formulation of technical folders for graduate agricultural credit access. • Coordination of agribusiness roundtables and agricultural fairs.

Note. Structure developed and validated based on needs detected across EAG-1, EAG-2, and EAG-3 centers.

4. Discussion

The fundamental purpose of this research was to propose and substantiate a model of innovative actions to strengthen the Technical Agricultural High School (BTA) through community engagement. As a study with descriptive, analytical, comparative, and projective scopes, the discussion extends beyond diagnostic descriptions to analyze the viability and theoretical-operational foundation of the proposal based on triangulated empirical evidence across evaluated agricultural schools (EAG-1, EAG-2, and EAG-3).

Findings demonstrate that strengthening the BTA depends not on purely theoretical reforms, but on resolving the operational gap between field instruction and real market demands. While the "learning by doing" principle constitutes the identity strength of the institution, its impact is neutralized by a traditional written evaluation system that fails to measure actual field competencies, as noted by León et al. (2025). Furthermore, the persistent "technological distance" (Borda, 2025) and lack of competencies in digital management and agrimarketing confirm the need to transition toward a pedagogical model that adds value at origin and democratizes market intelligence access for family farming (Lacki, 1996).

In this context, evidence unanimously supports that community engagement cannot remain restricted to passive administrative internships. Findings direct management toward adopting alternating pedagogy and establishing communities of practice (Araya-Crisóstomo & Urrutia, 2022). Through the concept of "reverse

innovation internships," students become active agents of technology transfer, positioning the school as an articulating hub for territorial development capable of promoting youth retention (Brizuela et al., 2013; Cohene & Rojas, 2020).

5. Conclusion

In strict correspondence with the general objective of the study (*To propose and empirically substantiate a model of innovative actions to strengthen the Technical Agricultural High School through community engagement*), the following integrative conclusions are established:

- **Substantiation and Viability of the Innovative Action Model:** Comprehensive strengthening of the BTA is achieved through implementing the model structured around the **Group, Articulate, Strengthen, and Adapt** cycle, which overcomes diagnostic limitations by providing an empirically validated projective response to address evaluation, infrastructure, financial management, and digitalization gaps observed in the field.
- **Transformation of Community Engagement:** Fulfilling the general objective requires converting isolated agricultural schools into **Regional Agricultural Innovation Networks**. This transformation, articulated with the productive environment, constitutes a valid projective response to mitigate rural youth exodus, promote education for sustainable agricultural development, and guarantee economic viability through training qualified young technicians who act as genuine local agents of change.

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7. Author Declaration

- Confirm originality of work
- State no conflicts of interest