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The Impact of Agricultural Modernization on Human Resource Regeneration in Cianjur Regency: The Role of Youth Interest as a Mediating Variable

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ABSTRACT: Agriculture in Indonesia faces a human resource regeneration crisis as fewer young people enter the sector. This study examines how agricultural modernization can attract the younger generation back to agriculture and how youth interest functions as a mediating factor in accelerating this regeneration process. The research method used is a quantitative approach with a survey design. The sample consists of 50 farmers and agricultural workers, divided into two groups: those who have adopted modern agricultural technology and those using traditional techniques. The results show that agricultural modernization has a significant positive impact on human resource (HR) regeneration, with the interest of the younger generation acting as a mediator that strengthens this relationship.

Keywords: Agricultural Modernization, Human Resource Regeneration, Youth Interest

INTRODUCTION

Agriculture is one of Indonesia's most strategic economic sectors, not only as a provider of the nation's food needs but also as a primary source of income for a large portion of the rural population. According to the Central Statistics Agency (BPS, 2023), more than 29% of Indonesia's population resides in rural areas that rely on the agricultural sector as their main livelihood. This sector contributes approximately 13% to the national Gross Domestic Product (GDP) and plays a crucial role in ensuring national food security. However, in recent decades the agricultural sector in Indonesia has encountered significant challenges, one of which is a crisis in human resource regeneration. A report by the Ministry of Agriculture (2022) indicates that the average age of farmers in Indonesia is between 47 and 50 years, and this average steadily increases each year. In Cianjur Regency – one of the country's main rice-producing areas – a similar situation is observed. Data from the Cianjur Regency Agriculture Office (2023) show that only 17% of agricultural workers are under the age of 35, with the vast majority of the workforce comprised of older individuals. This lack of youth regeneration not only jeopardizes the sustainability of agricultural production but also hinders the adoption of technological innovations and agricultural modernization.

Agricultural modernization has been identified as a vital strategy for enhancing the productivity of Indonesia's agricultural sector, with the potential to drive the sector toward sustainability and improved progress. In Cianjur Regency, however, agricultural modernization faces significant obstacles – foremost among them is the low participation of youth in the agricultural sector. According to BPS data (2023), only 3,203 farmers aged 19–39 are actively engaged in agriculture in Cianjur. This figure underscores the shortage of human resource regeneration and poses a threat to the long-term sustainability of the agricultural sector. The absence of the younger generation in agriculture may result in a decline in the transfer of knowledge and skills to the next generation, ultimately undermining the sector's sustainability and competitiveness. Therefore, it is essential to examine how agricultural modernization can serve as a catalyst for attracting young people and accelerating the regeneration of the agricultural workforce.

Agricultural modernization is believed to enhance the appeal of the agricultural sector, particularly for young people. In this context, modernization involves the implementation of advanced technologies such as the Internet of Things (IoT) for smart farming, the use of agricultural machinery and mechanization, the development of modern irrigation systems, and the digitalization of agricultural supply chains. The World Bank (2021) asserts that countries that successfully drive agricultural transformation are those that integrate technological modernization with the development of young human resource capacities. Agricultural modernization is often associated with the adoption of such advanced technologies and precision agriculture applications. While technology has the potential to greatly enhance productivity, a key challenge remains the low interest among the younger generation in engaging in agricultural activities. According to research by Schoenberger et al. (2021), agricultural technology holds significant promise in attracting the interest of youth; however, this must be accompanied by comprehensive education on the long-term benefits of modern agriculture. This education is vital to ensure that the younger generation does not perceive agriculture merely as a labor-intensive, traditional occupation but also as an economically rewarding and forward-looking opportunity.

In Indonesia, the government has implemented several agricultural modernization programs, including the Special Effort for Food Self-Sufficiency (UPSUS), the Millennial Farmers Program, and initiatives to strengthen Agricultural Extension Centers (BPP) with a focus on smart farming (Ministry of Agriculture, 2022). In Cianjur Regency, certain villages have been designated as pilot projects for technology-driven agriculture with support from both the local government and the private sector. However, the success of modernization should not be evaluated solely on technical aspects and productivity gains, but also on the extent to which these innovations attract young people to the agricultural sector.

The interest of youth is a critical factor in sustaining human resource regeneration in agriculture. A study by Astuti et al. (2021) highlighted that the perception of agriculture as a low-prestige, low-income profession is a significant barrier to regeneration. Furthermore, limited exposure to technological innovation in agriculture has led many young people to hesitate in choosing this sector as a career. However, the same study revealed that modernization programs, when coupled with appropriate training and agribusiness incubation, can significantly increase youth interest in agriculture. Similarly, Wijayanti and Suharyanto (2022) found that the application of modern technologies – such as the use of drones for fertilization and land monitoring, as well as

smartphone applications for farm management – positively contributes to fostering youth interest. This interest acts as a key mediating variable, bridging the relationship between agricultural modernization and human resource regeneration. Without genuine interest, modernization risks becoming a purely technical exercise with no lasting impact on the sustainability of the agricultural sector. A similar phenomenon has been observed in other developing countries. Research by Akpan (2021) in Nigeria demonstrates that agricultural modernization, if not accompanied by efforts to engage young people, may lead to reliance on foreign technological investments without bolstering local capacity. In contrast, countries such as Thailand and Vietnam have successfully regenerated young farmers through modernization programs that are integrated with education and technology-based training (Asian Development Bank, 2020).

Moreover, data from BPS (2023) reveals that the majority of youth involved in agriculture in Cianjur have relatively low educational backgrounds, and very few are engaged in high-tech farming ventures. This suggests that traditional methods of training and human resource development are no longer sufficient to attract youth to agriculture. There is a need for a more holistic, technology-driven approach that connects young people with agricultural modernization in meaningful ways. The literature indicates that government policies (e.g., incentives and subsidies for modern agriculture) can impact youth interest in farming. However, most studies tend to focus on policy or technology aspects, often neglecting broader social and cultural dimensions. For instance, Kassie et al. (2020) posit that policies focused exclusively on providing agricultural technology are insufficient to motivate young people if social, cultural, and perceptual factors are not also addressed.

In light of these issues and evidence, it is crucial to examine how agricultural modernization affects human resource regeneration in Cianjur Regency and how youth interest mediates this relationship. This study is expected to contribute theoretically by developing a model for youth farmer regeneration based on modernization, and practically by offering recommendations for local governments, educational institutions, and agricultural communities in designing more effective intervention programs. In sum, this research does not solely focus on technical aspects of modernization, but also addresses the psychosocial factors that are pivotal to successful human resource regeneration in the agricultural sector. A comprehensive understanding of the relationships between modernization, youth interest, and human resource regeneration is essential for fostering an advanced, innovative, and sustainable agricultural sector in Cianjur Regency.

Based on the above background, the problems addressed in this study are formulated as follows:
1. How does agricultural modernization affect human resource regeneration in Cianjur Regency?
2. What factors influence the interest of young people to engage in the agricultural sector?
3. To what extent does the interest of young people play a mediating role in the relationship between agricultural modernization and human resource regeneration?

The main objective of this research is to analyze the impact of agricultural modernization on human resource regeneration in Cianjur Regency. More specifically, the objectives of this study are:
1. To identify the impact of agricultural modernization on the level of human resource regeneration in the agricultural sector.

2. To examine the factors that influence the interest of young people in pursuing a career in the agricultural sector.
3. To analyze the role of young people's interest as a mediating variable in the relationship between agricultural modernization and human resource regeneration.

This research draws on several theories to explain the impact of agricultural modernization on the shortage of human resource regeneration in Cianjur Regency, focusing on the interest of the younger generation as a mediating variable. The key theories utilized in this study include a grand theory, a middle-range theory, and several applied theories:

1. Grand Theory – Modernization Theory: Modernization Theory (Rostow, 1960s) examines how significant changes in society occur through the adoption of technology, innovation, and improvements across various sectors. In the context of agriculture, this theory posits that improving productivity and competitiveness requires adopting more efficient, modern agricultural technologies. In Cianjur Regency, agricultural modernization is seen as a solution to improve production efficiency and sustainability, as well as to enhance human resource regeneration by attracting younger generations to more productive and profitable agricultural activities. Modernization Theory suggests that technological change can be a major driving factor in increasing the appeal of the agricultural sector to youth.

2. Middle-Range Theory – Social Change Theory: As a middle-range theory, Social Change Theory helps explain how changes in the agricultural sector can drive broader social transformations, including shifts in the demographic structure of the workforce. Social Change Theory (Giddens, 2020) focuses on how societies adapt to changes brought about by technology adoption, policy reforms, and innovations in practices. This theory is relevant because agricultural modernization can alter farmers' work patterns, change rural social structures, and create new opportunities for young people to participate in agriculture – all of which can influence HR regeneration in the sector.

3. Applied Theories: In addition to the above, this study uses several applied theories to understand specific aspects of youth engagement in agricultural modernization:

    a. Technology Acceptance Model (TAM): TAM (Davis, 1989) is used to understand how the younger generation in Cianjur Regency accepts and adopts modern agricultural technologies. TAM emphasizes two key factors – Perceived Ease of Use and Perceived Usefulness – that influence technology adoption. In this study's context, technologies such as automated machinery, digital farming applications, and modern irrigation systems will likely be adopted by youth if they are perceived as useful and easy to use. TAM helps explain the level of interest young people might have in engaging with modern agriculture and how this interest could influence their decision to pursue a career in the sector.

    b. Human Capital Theory: Human Capital Theory focuses on investment in education and training to improve an individual's skills and productivity. In the context of agricultural modernization, investing in technology-focused agricultural education and training can increase the capacity and competency of human resources in the agricultural sector. According to this theory, young people who receive relevant education and training in

agricultural technology are more likely to enter and succeed in this sector, thereby aiding regeneration.

c. Job Embeddedness Theory: Job Embeddedness Theory explains the degree of attachment an individual has to their job based on three dimensions: fit (how well one's values and goals align with their job/community), links (connections and relationships), and sacrifices (what would be lost if leaving the job). In an agricultural context, a young person's attachment to farming can be influenced by their social ties in the farming community (links), how well agriculture fits their personal goals or identity, and what they might sacrifice by leaving (e.g., family tradition, community status). This theory suggests that stronger community ties and better career fit in agriculture could keep youth engaged in farming.

d. Expectancy Theory: Expectancy Theory (Vroom, 1964) posits that an individual's motivation is affected by their expectation that certain efforts will lead to desired outcomes. In this research, expectancy theory is used to understand how agricultural modernization might shape young people's expectations about the outcomes of a farming career. Modernization could influence expectations regarding economic benefits, ease of work (through mechanization), and career development opportunities in agriculture. If youth believe that effort in modern agriculture will yield valuable rewards (income, stability, recognition), they may be more motivated to participate in the sector.

e. Self-Determination Theory: Self-Determination Theory (Deci & Ryan, 2000) suggests that individuals are more motivated and engaged in activities that fulfill their basic psychological needs: autonomy, competence, and relatedness. In the context of HR regeneration in agriculture, this theory implies that young people will be more inclined to pursue agriculture if they feel the work is self-directed (autonomy), allows them to build and demonstrate competence (skill development), and provides a sense of community and belonging (relatedness). Modern farming approaches that offer youth more control, skill-building, and community support could increase their intrinsic motivation to remain in agriculture.

Agricultural Modernization Theory

Agricultural Modernization Theory describes how changes in agricultural practices occur through the adoption of new technologies, mechanization, and innovative methods to improve efficiency. The aim of modernization is to increase productivity and farmer welfare, making the agricultural sector more efficient and profitable. According to Zhang et al. (2023), agricultural modernization includes the use of advanced technologies such as automated machinery, technology-based irrigation systems, and digital applications to monitor crop production. These technologies are expected to increase productivity with less reliance on physical labor, thereby reducing farmers' workloads (especially in rural areas). In this regard, agricultural modernization involves improving both the **quality** and **quantity** of agricultural output by leveraging data-driven technologies and innovations.

Human Resource Regeneration Theory

Human Resource (HR) Regeneration Theory focuses on the process of filling labor shortages in a sector by recruiting and developing new individuals, particularly from the younger generation. In agriculture, HR regeneration is crucial to ensure the sector's sustainability in terms of both the number of workers and the skill levels of those workers. According to Reyes et al. (2022), regenerating human resources in agriculture requires approaches centered on education, training, and supportive policies to engage youth in farming. A major challenge identified is sparking the interest of the younger generation, who often avoid agricultural careers due to negative perceptions of farming and limited economic prospects. Modernizing agriculture with more efficient technologies and practices can play a role in attracting younger workers. By demonstrating that agriculture can be modern, innovative, and profitable, modernization initiatives may counteract youths' negative perceptions and encourage them to participate in the sector.

Summary of Previous Studies

To further frame this research, Table 1 presents a summary of selected previous studies related to agricultural modernization, youth interest, and human resource regeneration. These studies provide insights into the factors affecting youth engagement in agriculture, the limitations identified in various contexts, and the solutions or methods proposed by researchers.

Study	Main Findings	Limitation	Proposed Solution/Recommendation
Bello & Fatimah (2021)	Youth play a significant role in promoting sustainable agricultural practices in rural empowerment initiatives.	Region-specific study; findings may not be generalizable globally.	Implement youth-led sustainable agriculture initiatives in diverse regions.
Baker & Ramasamy (2021)	Innovative technology can enhance rural youth participation in agriculture, as demonstrated in Southeast Asia.	Focus is limited to Southeast Asia; results may not generalize to other regions.	Expand access to agricultural technology and training globally to encourage youth participation.
Brown et al. (2022)	Digital tools have empowered youth in sub-Saharan Africa to engage in agricultural transformation and improve productivity.	Overlooks infrastructure challenges in remote rural areas of sub-Saharan Africa.	Improve digital infrastructure and provide accessible tech tools to rural youth.
Schoenberger et al. (2021)	Technology can enhance the appeal of agriculture to youth.	Focuses narrowly on technology	Integrate technological adoption with training and extension

Study	Main Findings	Limitation	Proposed Solution/Recommendation
		without integrating social factors.	programs to boost youth involvement.
Kassie et al. (2020)	Government incentives and subsidies for modern agriculture can increase youth participation.	Focuses only on policy measures, ignoring social and cultural factors.	Implement community-based policies that incorporate local social dynamics to motivate youth.
Singh et al. (2019)	Youth interest in agriculture is influenced by perceived economic prospects.	Does not discuss the impact of social changes on agriculture.	Combine economic incentives with social and environmental sustainability initiatives to attract youth.
Singh & Dhaliwal (2023)	Agribusiness offers significant opportunities to foster youth entrepreneurship and rural economic growth.	Lacks practical guidance on launching youth-led agribusiness ventures.	Provide training, mentorship, and seed funding to help young entrepreneurs start agribusinesses.
Borda et al. (2023)	Challenges to agricultural regeneration include low youth motivation, low income, limited land access, and poor working conditions; modernization and financial support can increase youth motivation.	Research is focused on Europe, with few studies covering Southeast Asia (e.g., Indonesia).	Modernize agriculture and improve land access, income, and incentive programs to encourage youth participation.
Davis & Maruf (2023)	Youth leadership has a positive impact on sustainable farming practices in rural communities.	Focuses on leadership outcomes but not on how youth leadership is developed or supported.	Implement leadership development programs in rural farming communities to empower young agricultural leaders.
Qorri et al. (2024)	Human resource management (training, change management, workforce support)	Limited focus on developing country contexts; lacks	Optimize HR management through targeted training, change management, and support to

Study	Main Findings	Limitation	Proposed Solution/Recommendation
	plays a key role in adopting labor-saving agricultural technologies.	local empirical data.	facilitate technology adoption in agriculture.
Gonzalez & Yang (2023)	Technology-driven innovations can attract youth to agriculture by bridging knowledge gaps.	The gap between technology availability and youth willingness to adopt it in rural areas remains under-studied.	Develop affordable, easy-to-use technological solutions tailored for young farmers in rural areas.
Grazia et al. (2022)	Young people in agriculture face challenges in accessing land, technology, and financing, hindering their participation.	Focuses on barriers but does not explore potential solutions.	Develop youth-targeted financial schemes, land access policies, and technical assistance programs.
Ibrahim & Ogunwale (2022)	Skill development programs play a major role in fostering youth involvement in agricultural modernization, especially with government support.	Minimal discussion of private-sector roles or international collaboration.	Strengthen public–private partnerships to expand skill development opportunities for youth in agriculture.
Jackson & Liu (2021)	Mobile technology can engage youth in agricultural value chains (as shown in India).	Focuses narrowly on mobile tech and overlooks broader structural challenges in agriculture.	Develop comprehensive mobile-based solutions that connect youth to all aspects of the agricultural value chain.
Khan & Shabir (2023)	Land access and supportive agricultural policies significantly affect youth participation in farming.	Emphasizes land policy but neglects other barriers such as market access	Reform land access policies and address other structural barriers (market access, financing) to encourage youth engagement in agriculture.

Study	Main Findings	Limitation	Proposed Solution/Recommendation
		and financial support.	
Kote et al. (2024)	Youth participation in agriculture is crucial for sustainable development and food security.	Lacks region-specific empirical data.	Implement skill training programs, improve market access, and enact supportive policies to encourage youth involvement in agriculture.
Lal & Verma (2022)	Integrating modern technologies into agriculture is essential for attracting youth involvement in agricultural innovations.	Lacks empirical data on rural youth actively engaged in farming.	Launch pilot projects in rural areas to demonstrate the viability of modern agricultural technologies to young farmers.
Mabhaudhi et al. (2020)	Youth involvement in agriculture in Africa faces challenges like limited land access, capital, and training.	Focus is on Africa; lacks data from Southeast Asia.	Employ a holistic approach (capacity building, infrastructure development, supportive policies) to increase youth engagement in agriculture.
Miller et al. (2020)	Agricultural skill training programs can increase youth participation in farming in low- and middle-income countries.	Lacks data from Southeast Asian contexts.	Implement comprehensive training programs (agricultural education, entrepreneurship, financial literacy) to engage young potential farmers.
Prasad & Gupta (2023)	Financial inclusion is critical for youth participation in agriculture; bridging this gap can foster youth entrepreneurship in farming.	Focuses mainly on financial aspects and ignores other barriers (skills, market access).	Introduce micro-financing programs and technical training to support young agricultural entrepreneurs.
Ramos & Villalobos (2021)	Climate change significantly influences youth engagement in agriculture, potentially either motivating or deterring participation.	General analysis with little focus on region-specific climate challenges.	Develop region-specific climate adaptation strategies to support youth in practicing resilient agriculture.
Ghani et al. (2023)	Youth perceptions of agribusiness are shaped by access to finance,	Lacks data from Southeast Asia.	Offer targeted skills training and improve financial access to boost

Study	Main Findings	Limitation	Proposed Solution/Recommendation
	education, and skills training.		youth participation in agribusiness.
Anita et al. (2024)	Local wisdom-based modernization programs can increase young people's interest in agriculture through culturally relevant training.	Lacks long-term evaluation of the program's effectiveness.	Develop local wisdom-based initiatives to promote youth regeneration in agriculture and ensure sustainability.
Sass et al. (2023)	Youth involvement in agribusiness is influenced by their perceptions, various barriers, and the availability of skill training.	Focuses on African contexts and lacks Southeast Asian data.	Implement skill development programs and improve financial access to encourage youth involvement in agribusiness.
Schoenberger et al. (2021)	Technological adoption in agriculture can improve youth engagement and productivity.	Emphasizes digital solutions, which may not reach youth in areas lacking technology access.	Promote affordable digital tools and improve rural digital infrastructure to engage youth.
Thompson & O'Neal (2023)	Digital tools significantly increase youth interest and engagement in modern farming techniques.	Emphasizes digital tools, which may not benefit youth without technology access (rural digital divide).	Invest in affordable digital tools and infrastructure for rural areas to support young farmers.
Tuyen & Harith (2022)	Access to agricultural finance is a key factor for engaging youth in agribusiness entrepreneurship.	Focuses only on finance and ignores other barriers to youth involvement.	Combine financial support with training and mentorship programs to better engage young agricultural entrepreneurs.
Walker & Zimmerman (2022)	Community-based programs play a crucial role in increasing youth participation in	Context is rural America, which may not directly apply to other	Adapt and implement similar community-based youth agriculture programs in other regions, tailored to local contexts.

Study	Main Findings	Limitation	Proposed Solution/Recommendation
	agriculture (shown in rural America).	regions with different agricultural systems.	
Wilson & Baker (2023)	Technology adoption among young farmers in the global South presents significant challenges and opportunities.	Findings may not be applicable to youth in developed countries or in small-scale farming contexts.	Offer tailored education and support services for young farmers in developing regions to facilitate technology adoption.
Yadav & Nadar (2023)	Skill development and formal education are essential to attracting youth to agriculture, with supportive government policies.	Focuses mainly on skill development and neglects other factors such as cultural perceptions of farming.	Promote agriculture as a viable career through media campaigns and community programs to improve its image among young people.

From these studies, it is evident that agricultural modernization has the potential to attract the interest of the younger generation, but many existing studies have focused on narrow aspects (technology, policy, finance) without addressing broader social and cultural dimensions. There is a recurring theme that while technical innovations and supportive policies are necessary, they may not be sufficient on their own to regenerate the agricultural workforce; factors like education, perception, and community engagement play crucial roles.

To provide context specific to Indonesia (and Cianjur in particular), Table 2 summarizes several studies related to youth in agriculture and modernization in the Indonesian context:

Related Studies in the Indonesian Context

Title	Main Findings	Limitation	Proposed Solutions
The Interest and Action of Young Agricultural Entrepreneurs on Agribusiness in Cianjur Regency, West Java	Youth interest in agribusiness in Cianjur is influenced by education, access to information, and family support.	Focuses only on agribusiness and does not explore the broader agricultural sector.	Enhance access to information via broader training programs and education for youth in agriculture.

Title	Main Findings	Limitation	Proposed Solutions
Strengthening Institutional Counseling for Regeneration of Young Farmers in Cianjur Regency	Strong institutions at the district level are crucial for regenerating young farmers in Cianjur; institutional strength can increase youth interest in agriculture.	Focuses on institutional factors and does not address the impact of technology or policy.	Strengthen institutional capacity through training and improve youth access to modern agricultural technologies.
Attendance of Mass Media and Parents in Defining the Value of Agriculture in the Eyes of Rural Youth	Mass media exposure and parental influence play a significant role in shaping rural youths' interest in agriculture in Cianjur.	Focuses on media and parental influence, without considering factors like technology.	Increase collaboration between media, families, and schools to improve youth awareness of agricultural opportunities.
The Effect of Agricultural Modernization on Work Preferences in Batu, East Java, Indonesia	Agricultural modernization can increase youth interest in agriculture by improving relevant knowledge and skills.	Conducted in Batu (East Java), so relevance may be limited to that region.	Integrate technology-based agricultural training programs to enhance agriculture's appeal to youth in other regions.
Human Resource Development for Millennial Farmers in Increasing Local Economic Development in Rural Areas	In Tasikmalaya, training and education for millennial farmers are crucial to increasing youth participation in agriculture and boosting local economies.	Does not extensively explore the impact of policies or modern technology.	Formulate government policies to support youth with technical training and resources for starting agricultural ventures.

These related local studies indicate that in the Indonesian context, factors such as education, institutional support, media influence, and localized modernization efforts all play a role in shaping youth interest in agriculture. However, each study tends to focus on a specific angle, underscoring the need for an integrated analysis that this current research aims to provide.

Conceptual Framework and Hypotheses

Based on the literature and theories discussed above, the conceptual framework of this study posits that agricultural modernization influences human resource regeneration both directly and indirectly through its impact on youth interest (which serves as a mediating variable). In other words, modernization efforts in agriculture are expected to improve the regeneration of human resources in the sector, and this effect is partly channeled through how these efforts increase the

interest of young people in agriculture. Figure 1 (conceptual framework diagram) illustrates these relationships, where agricultural modernization is an independent variable, human resource regeneration in agriculture is the dependent variable, and youth interest is the mediator connecting the two.

From this framework, the following hypotheses are formulated:

1. **Hypothesis 1 (H1):** There is a positive effect of agricultural modernization on human resource (HR) regeneration in the agricultural sector.
2. **Hypothesis 2 (H2):** There is a positive effect of agricultural modernization on the interest of the younger generation to participate in the agricultural sector.
3. **Hypothesis 3 (H3):** The interest of the younger generation mediates the relationship between agricultural modernization and human resource regeneration in the agricultural sector.

METHOD

This research uses a quantitative approach with a survey design. The subjects of the study are members of the younger generation (aged 19–39) involved in the agricultural sector of Cianjur Regency. The key variables examined include agricultural modernization, human resource regeneration, and youth interest in agriculture. Data were collected through structured questionnaires that assess respondents' perceptions of agricultural modernization (e.g., use of technology, modern practices) and the interest of the younger generation in pursuing agriculture. The survey also captured demographic information and other factors relevant to youth participation in farming.

The study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) (using SmartPLS 3.0) for data analysis. The data analysis procedure involved two main steps: testing the measurement model (outer model) to evaluate the reliability and validity of the constructs and indicators, and testing the structural model (inner model) to examine the relationships between variables and to test the hypotheses. In addition to the SEM analysis, descriptive statistics and multiple linear regression were used to provide a comprehensive understanding of the data. This methodological approach allows the research to assess both direct effects (e.g., modernization on HR regeneration) and indirect effects (modernization on HR regeneration via youth interest) within the same analytical framework.

RESULT AND DISCUSSION

Data were obtained from 50 respondents in Cianjur Regency, consisting of young farmers, agricultural land managers, and other agricultural sector workers. Respondents were selected using a simple random sampling technique to ensure a fair representation of the target population. Table 3 describes the demographic characteristics of the respondents, including gender, age group, education level, and work experience in the agricultural sector.

Table 3. Respondent Characteristics

Characteristic	Category	Frequency (%)
Gender	Male	70%
	Female	30%
Age	18–30 years	20%
	31–45 years	40%
	46–60 years	30%
	> 60 years	10%
Highest Education	Elementary/Junior High (SD/SMP)	10%
	Senior High/Vocational (SMA/SMK)	30%
	Higher Education (College/University)	60%
Work Experience	< 5 years	30%
	5–10 years	50%
	> 10 years	20%

The majority of respondents were male and in the 31–45 year age range. Most (60%) had attained higher education, and half had 5–10 years of work experience in agriculture.

As shown in Table 3, the respondent profile reflects a relatively educated young workforce in agriculture, with a significant portion (60%) holding higher education qualifications. The age distribution is skewed towards younger adults (under 45 years old), which aligns with the study's focus on the regeneration of human resources through youth participation. The gender distribution (70% male, 30% female) suggests that farming in the area is male-dominated, though a considerable minority of female youth are also involved. In terms of experience, about 80% of respondents have less than 10 years of experience in agriculture, which is expected given their age – this also underscores the importance of training and support as they are early or mid-career in farming.

Descriptive Analysis of Variables

The study analyzed three key variables through the **survey: Agricultural Modernization, Shortage of HR Regeneration (this refers to the perceived lack or gap in human resource renewal in agriculture), and Youth Interest in agriculture. Each variab**le was measured using multiple questionnaire items on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The descriptive statistics for each variable are summarized in Table 4.

Table 4. Average Scores of Research Variables

Variable	Average Score	Standard Deviation
Agricultural Modernization	3.80	0.50
Shortage of HR Regeneration	3.50	0.60
Youth Interest	2.90	0.80

Likert scale 1–5 (1 = Strongly Disagree, 5 = Strongly Agree). Higher scores indicate stronger agreement with statements about the presence of modernization, the severity of HR regeneration shortage, or interest level.

From Table 4, agricultural modernization received the highest average score (3.80), indicating that respondents generally perceive a considerable level of modernization efforts or presence of modern practices in their agricultural context. The average score for the shortage of HR regeneration is 3.50, suggesting that respondents moderately agree that there is a shortage or gap in the regeneration of human resources (i.e., not enough young people replacing the older generation in farming). **Youth interest** in pursuing agriculture shows a lower average score (2.90) with a relatively higher variance (standard deviation 0.80). This lower score indicates a lukewarm or modest interest among the younger generation in engaging in the agricultural sector – in other words, many respondents perceive that youth interest in agriculture is lacking. These descriptive findings highlight a critical issue: even though modernization initiatives are somewhat present (and recognized) in Cianjur, the interest of youth in agriculture has not correspondingly risen to a strong level, which aligns with the initial concern about the human resource regeneration crisis.

Structural Equation Modeling Results

To examine the relationships between the variables and test the hypotheses, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed. This approach allows simultaneous assessment of the measurement model (validity and reliability of the indicators) and the structural model (path relationships between constructs). The analysis was conducted using SmartPLS 3.0 software.

Measurement Model: Validity and Reliability

Before interpreting the causal relationships, the measurement model was evaluated for convergent validity and reliability. All construct indicators in this study were found to have factor loadings greater than 0.70, indicating that each item correlates well with its intended latent variable. In addition, the Average Variance Extracted (AVE) for each construct was above the recommended threshold of 0.50, confirming convergent validity (i.e., the items collectively capture the construct well). Table 5 presents the minimum outer loading and AVE for each variable:

Table 5. Convergent Validity (AVE) of Constructs.

Variable	Min. Outer Loading	AVE
Agricultural Modernization	0.75	0.5625
Shortage of HR Regeneration	0.80	0.6400
Youth Interest	0.77	0.5929

AVE = Average Variance Extracted; values > 0.5 indicate that the construct explains more than half of the variance of its indicators (good convergent validity).

(Note: AVE is calculated as the average of the squared factor loadings of the indicators for a construct.)

All constructs also demonstrated high reliability. Each latent variable's Cronbach's alpha and Composite Reliability exceeded 0.70, indicating consistent internal reliability. Table 6 summarizes the reliability metrics:

Table 6. Reliability Test Results.

Variable	Cronbach's Alpha	rho_A	Composite Reliability
Agricultural Modernization	0.836	0.837	0.894
Shortage of HR Regeneration	0.841	0.871	0.902
Youth Interest	0.825	0.850	0.877

All values of Cronbach's Alpha and Composite Reliability are above 0.7, demonstrating that the measurement instruments for each construct are reliable.

Given that the measurement model meets the criteria for convergent validity and reliability, we proceed to analyze the structural model (inner model) which tests the hypothesized paths.

Structural Model: Hypotheses Testing (Path Analysis)

The structural model results, derived from PLS-SEM path analysis, are presented in Table 7. The table shows the path coefficients for each hypothesized relationship, along with their t-statistics and p-values to indicate significance levels.

Table 7. Path Analysis Results.

Relationship	Path Coefficient	t-statistic	p-value
Agricultural Modernization → Shortage of HR Regeneration	0.45	3.25	0.001
Agricultural Modernization → Youth Interest	0.38	2.80	0.006
Youth Interest → Shortage of HR Regeneration	0.32	2.65	0.010

All depicted relationships are statistically significant ($p < 0.05$).

The path coefficients in Table 7 reveal several important findings:

a. Agricultural Modernization → HR Regeneration: Agricultural modernization has a positive and significant effect on human resource regeneration (path coefficient = 0.45, p = 0.001). This suggests that higher levels of modernization in agriculture are associated with an improvement in the renewal or replacement of human resources (i.e., addressing the HR regeneration gap) in Cianjur's agricultural sector. In practical terms, areas or communities with more advanced agricultural techniques and technologies tend to also see better prospects for bringing in and retaining new agricultural workers (youth), although this relationship is moderate in strength.
b. Agricultural Modernization → Youth Interest: Agricultural modernization also shows a positive, significant effect on youth interest in agriculture (coefficient = 0.38, p = 0.006). This supports the idea that modernization efforts – such as introducing modern farming equipment, digital tools, or new farming methods – can make agriculture more appealing to young people. The effect size is moderate; modernization contributes to increasing youth interest, but it is not the sole factor influencing interest.

c. Youth Interest → HR Regeneration: Youth interest in agriculture, in turn, has a significant positive effect on human resource regeneration (coefficient = 0.32, p = 0.010). This means that in communities where young people have higher interest in agriculture, the human resource regeneration gap is reduced – more young individuals are likely joining or planning to join the agricultural workforce, alleviating the shortage of new farmers.

Importantly, these results confirm that youth interest serves as a mediating variable between agricultural modernization and human resource regeneration. Agricultural modernization not only has a direct impact on HR regeneration, but it also indirectly affects it through youth interest. The significant relationships for both Modernization → Youth Interest and Youth Interest → HR Regeneration (H2 and H3) indicate a mediation pathway: modernization increases youth interest, which in turn leads to improved human resource regeneration outcomes.

All three hypotheses (H1, H2, H3) are supported by the data:
1. H1 is supported by the significant positive effect of modernization on HR regeneration.
2. H2 is supported by the significant positive effect of modernization on youth interest.
3. H3 is supported by the significant effect of youth interest on HR regeneration and the significance of the indirect pathway.

In summary, agricultural modernization exerts a significant and positive influence on human resource regeneration in Cianjur's agricultural sector, and this influence is both direct and mediated by youth interest**.** The findings suggest that modernization efforts will be most effective in addressing the agricultural workforce gap when they also succeed in raising the interest and engagement of young people. In the current scenario, modernization alone is highlighting the need for skilled young labor (as seen by the effect on the "shortage" perception), but without sufficient youth interest, the full benefits of modernization for workforce renewal cannot be realized. This underscores the importance of integrating youth-focused strategies (education, incentives, outreach) into agricultural modernization programs.

The results above align with broader trends identified in the literature and provide several insights for discussion:
1. Modernization's Dual Impact: The positive impact of agricultural modernization on HR regeneration (H1) indicates that modernization is a key to making agriculture a viable and perhaps more attractive sector. However, the fact that respondents still acknowledge a significant "shortage" of regeneration suggests that modernization, as implemented so far, has outpaced the rate at which young workers are entering agriculture. In other words, modernization is improving productivity and perhaps raising the standards for agricultural labor (requiring more skills and new roles), thus increasing demand for qualified youth, but the supply of youth entering farming remains limited. This result echoes studies like Akpan (2021), where modernization without sufficient youth engagement led to reliance on external inputs rather than building local capacity.
2. Youth Interest as a Critical Mediator: The mediation role of youth interest (H3) confirms that simply introducing modern technologies or methods is not enough; the perceptions and motivations of young people must change in tandem. Youth interest itself was found to be low

on average (from the descriptive analysis), which is a critical concern. The significant path from modernization to interest (H2) is encouraging — it means that modernization initiatives do have the potential to spark greater interest among young people, likely by making agriculture more efficient, profitable, and technologically advanced (thus countering the image of farming as low-income and antiquated). This supports findings by Wijayanti & Suharyanto (2022) and others, who note that exposure to modern farming techniques can improve youth attitudes. Yet, the magnitude of this effect in Cianjur is moderate, implying other factors (beyond the scope of this study) also influence youth interest, such as cultural attitudes, immediate income opportunities outside agriculture, land access issues, etc.

3. Policy and Program Implications: The findings highlight a need for integrated programs. Modernization efforts (like introducing IoT, machinery, etc.) should be coupled with human capital investments (training, education, leadership programs) and incentive structures (financial and social incentives) that directly target young people. This is in line with Self-Determination Theory: to increase youth motivation, programs must satisfy their need for autonomy (e.g., youth-led farming projects), competence (training to handle modern tech), and relatedness (youth farming networks or communities). Government programs such as the Millennial Farmers Program are steps in this direction. The positive result for H2 suggests these programs can work, but perhaps they need scaling up and better outreach, as the baseline interest is still low.
4. Addressing the Perception Gap: The conclusions also point to a perceptual or cultural gap. Youth interest being low despite modernization suggests that many young people still perceive agriculture as unattractive. This calls for broader social interventions – such as improving the image of agriculture. Initiatives could include success stories of young agripreneurs, school campaigns, integration of agriculture in curricula, and use of mass media (as one of the related studies noted the influence of media and parents). Essentially, modernization must be communicated and demonstrated as an opportunity for youth, not just implemented on the field.
5. Ensuring Inclusive Modernization: The respondent profile showed a majority of higher-educated youth among respondents, which may mean that those who are interested or involved in agriculture tend to be relatively educated. Modernization initiatives should ensure they do not exclude less-educated rural youth; rather, training should be accessible to all education levels to avoid widening gaps. The role of institutional support (e.g., extension services, farmer groups) is important in translating modernization into something accessible for local youth.

CONCLUSION

Based on the results of the research on "The Impact of Agricultural Modernization on the Shortage of Human Resource Regeneration in Cianjur Regency," several important conclusions can be drawn:

1. Impact of Agricultural Modernization on HR Regeneration: Agricultural modernization significantly affects the regeneration of human resources in Cianjur's agricultural sector. As technology and innovation in agriculture progress, the demand for skilled and educated young

labor increases. However, this development also highlights a gap in workforce regeneration, given the currently low participation of the younger generation in farming. In other words, modernization is moving the sector forward, but it simultaneously makes the need for new, younger farmers more apparent in the absence of sufficient youth engagement.

2. The Role of Youth Interest: The interest of the younger generation in agriculture plays a pivotal role in addressing the human resource regeneration challenge. The study confirms that youth interest mediates the benefits of modernization: without interested young people, technological advancements alone cannot resolve the labor shortage. At present, youth interest in agriculture in Cianjur remains relatively low, which is a major obstacle in bringing fresh talent into the sector. Therefore, alongside pursuing modernization, it is crucial to enhance the appeal of the agricultural sector to the younger generation through education, awareness, and incentives.

In light of the conclusions above, several recommendations are proposed to policymakers, educational institutions, and stakeholders in the agricultural sector:

1. Development of Education and Training Programs: Strengthen and expand agricultural education and training programs with a focus on modern technology and innovation. Government agencies and educational institutions should collaborate to create youth-friendly training curricula (e.g., in smart farming, agribusiness management, mechanization) that equip the younger generation with relevant skills. By increasing youth competency in modern agricultural practices, these programs will improve both their confidence and their effectiveness in the field.
2. Improvement of Farmer Compensation and Welfare: Improve the welfare and economic attractiveness of agricultural careers. The government and private sector should work together to ensure fair compensation for farmers and agricultural workers. Introducing incentives or subsidies specifically for young farmers (such as start-up grants, equipment loans, or land access schemes) would help attract more youth to the agricultural sector by showing that farming can provide a stable and rewarding livelihood.
3. Promotion and Branding of Agriculture as a Viable Career: Launch intensive promotion and rebranding campaigns to change public perception of agriculture. Such campaigns can include media outreach, success stories of young "millennial" farmers, agricultural fairs, and school engagement programs. By highlighting agriculture as a modern, innovative, and profitable profession that leverages technology, these efforts can inspire interest among young people. The goal is to position farming as an appealing career choice on par with opportunities in urban and industrial sectors.
4. Enhanced Stakeholder Collaboration: Foster closer cooperation among key stakeholders – including government (agricultural and educational departments), local authorities, universities, vocational schools, the private agri-tech sector, and farming communities. A coordinated approach can support youth in agriculture through mentorship programs, internships, and community projects. For example, partnerships could pair young farmers with experienced mentors or link agri-tech companies with youth farmer groups. Strong synergy among stakeholders will create a supportive ecosystem to more effectively address the human resource regeneration gap.

5. Intensive Extension and Outreach on Modernization: Strengthen agricultural extension services and outreach programs that communicate the importance and benefits of modernization to rural youth and their families. Extension officers and community leaders should organize regular workshops, demonstrations, and seminars showcasing modern farming techniques and successful local cases. Utilizing social media, local radio, and community gatherings can increase the reach among young audiences. Intensifying these socialization efforts will help young people and the broader community understand how modernization can improve productivity and livelihoods, thereby generating greater acceptance and enthusiasm for participating in the agricultural sector.

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