



Youth Perspectives on Technological Modernization for Sustainable Beef Cattle Agribusiness Regeneration in Mamasa, Indonesia

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ABSTRACT

The aging livestock farmer phenomenon and low youth participation threaten the sustainability of smallholder beef cattle agribusiness. This study aims to analyze the effect of technological modernization on the regeneration interest of young livestock farmers in Mamasa Regency. An explanatory quantitative approach was employed, involving 73 youth respondents from farming families selected via purposive sampling. Primary data were collected using questionnaires and analyzed with Structural Equation Modeling-Partial Least Square (SEM-PLS). The results demonstrated that perceived operational ease through mechanization, expectation of financial gain via digital marketing, and social image improvement from modern infrastructure partially and simultaneously have a positive and significant impact on youth regeneration interest. The expectation of financial gain proved to be the most dominant pull factor. In conclusion, technological modernization serves as a robust catalyst to dismantle the stigma of manual labor and foster agribusiness succession. Therefore, it is recommended that the government transitions from providing partial agricultural assistance to developing an integrated innovation ecosystem, while rural youth are encouraged to establish millennial farmer institutions to strengthen market bargaining power.

Keywords: Agribusiness regeneration, Beef cattle, Millennial farmer, SEM-PLS, Technological modernization.

INTRODUCTION

The agricultural and livestock sectors in Indonesia are currently facing a severe structural challenge in the form of a demographic crisis known as the aging farmer phenomenon. Based on data from the 2023 Agricultural Census, the structure of the national agrarian workforce is increasingly dominated by the elderly; more than 39% of farmers are over the age of 55, with the largest concentration in Generation X (42.39%) and Baby Boomers (27.61%) (Noor & Suwandana, 2024; Badan Pusat Statistik, 2023). Conversely, the participation trend of the young workforce has continued to shrink drastically since 2013, with millennial involvement remaining at only 25.61% and Generation Z at a critical level below 3% (Badan Pusat Statistik, 2023). If left without intervention, the majority of farmers will enter an unproductive age within the next 10 to 20 years, triggering an absolute crisis threat based on the "no farmer, no food" principle (Rani, 2024). This condition directly threatens the national food production capacity amidst the projected surge in Indonesia's population, which is estimated to reach 324.05 million people by 2045 (Rani, 2024).

The reluctance of the younger generation to continue the family agribusiness succession is fundamentally triggered by strong push factors that drive them away from rural areas. The farming profession is perceived as economically unpromising, uncompetitive, and carrying a significantly higher risk of business failure compared to other sectors (Dwipradnyana, 2017). This is evidenced by the average wage of agricultural sector workers, which is only around IDR 2,000,000 per month, lagging far behind the average of industrial and service sector

workers, which ranges from IDR 2,500,000 to IDR 3,500,000 (Rani, 2024). These financial conditions are further exacerbated by an informal employment system lacking protective guarantees such as the Badan Penyelenggara Jaminan Sosial (BPJS) Ketenagakerjaan or Social Security Agency for Employment (Rani, 2024). These regeneration barriers are increasingly deep-rooted due to social stereotypes that associate the farming profession with poverty and economic instability, as well as the assumption that agriculture is purely a male-dominated domain (Oktafiani et al., 2021).

Narrowing down to the local landscape, Mamasa Regency in West Sulawesi Province is inherently endowed with geographical potential in the form of highland topography and the availability of highly strategic forage for the development of beef cattle agribusiness areas (Badan Pusat Statistik Kabupaten Mamasa, 2024). Ironically, the younger generation in this region shows high resistance to their parents' profession. The absence of adaptive youth involvement results in the cessation of the innovation diffusion process, meaning that livestock practices are still dominated by conventional technologies, which causes productivity and competitiveness to remain low (Tualar, 2019). The slow adoption of modern technology is heavily influenced by the limited technical qualifications of the rural workforce, while efforts to transition toward smart farming frequently collide with high investment costs and low acceptance levels among conservative farmers (Rachmawati, 2020).

To dismantle these stigmas and psychological barriers, normative approaches have proven ineffective, thus necessitating comprehensive interventions through technological modernization. Previous literature reviews (State of the Art) indicate a research gap between technological innovation studies and the sociology of agrarian succession. Research on agribusiness technology adoption is generally still trapped in a biometric perspective that only measures the correlation of mechanical tools to the increase in physical livestock productivity (Rahman & Hidayat, 2024). On the other hand, rural sociology literature regarding the regeneration crisis focuses more on macro determinants without explicitly positioning technological modernization as a pull factor catalyst (Ernawati et al., 2025; Tafari et al., 2024; Ali et al., 2024). Other studies, such as Herlon et al. (2024), have examined the younger generation's perception of digitalization but still utilized a qualitative descriptive approach that has not inferentially tested the causal effect between variables.

Therefore, this study offers a paradigm novelty by positioning technological modernization—encompassing operational mechanization via chopper machines, marketing digitalization, and biogas barn infrastructure sanitation—as a pull factor capable of engineering social perceptions and youth behavioral intentions (Putra et al., 2022). Theoretically, this research adapts and expands the Technology Acceptance Model (TAM) framework by Mohr and Köhl (2021) into the locus of traditional livestock demographic succession. Based on this problem formulation, this study aims to describe the perceptions of farmers' children in Mamasa Regency regarding the urgency of implementing livestock technological modernization, measure the level of regeneration interest in smallholder beef cattle agribusiness, and empirically analyze the effect of such technological modernization on increasing the regeneration interest of young farmers. The proposed hypotheses include testing the partial and simultaneous effects of perceived operational ease, financial gain, and social image improvement on the interest in smallholder beef cattle agribusiness regeneration in Mamasa Regency.

RESEARCH METHODS

This study employed a quantitative approach with an explanatory research design that is descriptive-associative in nature. The research was conducted in Ralleanak Village, Aralle Subdistrict, Mamasa Regency, West Sulawesi Province, over a period of two months. The population in this study comprised the biological children of active smallholder beef cattle farmers, with a total recorded population of 264 individuals. The sampling technique utilized was *purposive sampling* based on specific inclusion criteria: aged 16-35 years, residing permanently in the research location, and having parents with a minimum ownership of 2 beef cattle. The determination of the minimum sample size was calculated using Slovin's formula with a 10% margin of error.

$$n = \frac{N}{1 + N \cdot e^2} \dots \dots \dots (1)$$

Where,

- n = Sample size
- N = Total of population,
- e = Margin of error.

Based on Eq. (1), from a total population of 264 youths, a representative sample of 73 respondents was obtained. Primary data collection was carried out through observation, in-depth interviews, and the distribution

of structured questionnaires. The questionnaire was measured using a 5-point Likert Scale to evaluate the instruments of Perceived Operational Ease (), Perceived Financial Gain (), Perceived Social Image Improvement (), and Agribusiness Regeneration Interest ().

The data analysis method employed was *Structural Equation Modeling - Partial Least Square* (SEM-PLS) using SmartPLS software. The statistical model evaluation was divided into two stages: the measurement model (*outer model*) and the structural model (*inner model*). In the *outer model* evaluation, the questionnaire instrument is declared to have convergent validity if the *Loading Factor* > 0.70 and the *Average Variance Extracted* (AVE) > 0.50. Discriminant validity was measured using the *Fornell-Larcker* criterion. Meanwhile, the reliability of the instrument was tested through *Cronbach's Alpha* and *Composite Reliability* values, with an acceptable threshold of > 0.70.

In the *inner model* evaluation, partial hypothesis testing (H1, H2, and H3) was analyzed using the *bootstrapping* procedure. The decision criterion for accepting the hypothesis is if the *t-statistics* value > 1.96 and the *p-value* < 0.05 at a 5% significance level. Furthermore, because the PLS software algorithm does not automatically generate an F-Test, the simultaneous hypothesis testing (H4) was proven through a mathematical derivation of the determination coefficient () value using the following *Pseudo F-test* formula (2) :

$$F = \frac{R^2/k}{(1 - R^2)/(n - k - 1)} \dots\dots\dots(2)$$

Where

- F = Calculated F-value,
- R^2 = Coefficient of determination
- K = Number of independent variables,
- N = Total number of respondents.

The decision criterion for the simultaneous test established that hypothesis H4 is accepted if the calculated F-value obtained from Eq. (2) is greater than the F-table value at a 95% confidence level.

RESULT AND DISCUSSION

Respondent Characteristics

This study involved 73 respondents representing the younger generation (farmers' children) in Ralleanak Village, Mamasa Regency. The demographic characteristics of the respondents serve as a crucial foundation for understanding their readiness and rationality in responding to agribusiness technological innovations. The complete profile of the respondents is presented in Table 1.

Table 1. Characteristics of Livestock Farmers' Children Respondents in Mamasa Regency

Characteristics	Category	Frequency	Percentage (%)
Age (Years)	16 – 23	37	50.69
	24 – 35	36	49.31
Gender	Male	46	63.01
	Female	27	36.99
Last Education	Junior High School / Equivalent	12	16.44
	Senior High School / Equivalent	43	58.90
	Bachelor's Degree (S1) / Diploma	18	24.66
Cattle Ownership Scale	2 – 3 Head	14	19.18
	4 – 9 Head	59	80.82

Source: Primary Data processed, 2026.

Based on Table 1, the majority of respondents are in a productive age crucial for determining long-term career orientation. The education level, dominated by Senior High School to Bachelor's Degree graduates (83.56%), indicates that today's rural youth possess adequate literacy capital to adopt both digital and mechanical technologies. However, the scale of parental livestock ownership, which predominantly falls into the medium-subsistence level (4-9 head), presents a challenge to economic rationality, triggering hesitation among the youth to make farming their primary occupation.

Measurement Model Evaluation (Outer Model)

Prior to hypothesis testing, the research instrument must meet the requirements of validity and reliability through the *outer model* evaluation using the PLS algorithm. A summary of the convergent validity (*Loading Factor* and *AVE*) and construct reliability (*Cronbach's Alpha* and *Composite Reliability*) testing results is presented in Table 2.

Table 2. Measurement Model Evaluation Results (Outer Model)

Variables	Loading Factor (Range)	AVE	Cronbach's Alpha	Composite Reliability
Perceived Operational Ease (X1)	0.780 – 0.845	0.654	0.824	0.883
Perceived Financial Gain (X2)	0.828 – 0.865	0.712	0.865	0.908
Perceived Social Image Improvement (X3)	0.760 – 0.835	0.642	0.815	0.877
Agribusiness Regeneration Interest (Y)	0.745 – 0.825	0.625	0.802	0.869

Source: Primary Data processed (SmartPLS), 2026.

The test results in Table 2 demonstrate that all questionnaire indicators have a *Loading Factor* value > 0.70 and an *Average Variance Extracted* (AVE) value > 0.50. This proves that the instrument has met the convergent validity criteria. Furthermore, the *Cronbach's Alpha* and *Composite Reliability* values for all variables are > 0.70, proving that the measuring instrument is highly reliable and consistent. Discriminant validity testing using the *Fornell-Larcker* criterion also showed that the square root of the AVE for each variable is greater than its correlation values with other variables, thus declaring the model feasible to proceed to structural testing.

Structural Model Evaluation (Inner Model) and Hypothesis Testing

The predictive power of the model is evaluated through the Coefficient of Determination (R-squared). The data processing results show an R-squared value of 0.685. This indicates that 68.5% of the variance in Agribusiness Regeneration Interest (Y) can be collectively explained by the variables of perceived operational, financial, and infrastructure technology, while the remaining 31.5% is influenced by external factors outside the model. Furthermore, the partial and simultaneous hypothesis testing is presented in Table 3.

Table 3. Hypothesis Testing Results (*Bootstrapping Path Coefficients*)

Hypothesis	Influence Path	Path Coefficient	T-Statistics	P-Values	Decision
H1	X1 → Y	0.285	2.845	0.004	Accepted
H2	X2 → Y	0.415	4.120	0.000	Accepted
H3	X3 → Y	0.210	2.150	0.032	Accepted
H4	Simultaneous (X1, X2, X3 → Y)	-	50.01*	< 0.05	Accepted

Source: Primary Data processed (SmartPLS), 2026. (*Note: F-calculated value via Pseudo F-test).

Discussion

Based on the test results in Table 3, all research hypotheses are proven to be empirically accepted. A comprehensive explanation of these findings, synthesized with the *Technology Acceptance Model* (TAM) and previous research, is detailed below:

The Effect of Operational Ease on Regeneration Interest

Statistical results prove that perceived operational ease has a positive and significant effect on agribusiness regeneration interest ($0.004 < 0.05$). In the hilly topography of Mamasa Regency, the daily routine of manually harvesting and carrying forage is highly time-consuming and physically draining for traditional farmers. This extreme physical fatigue has historically acted as a major *push factor*, creating deep reluctance among the younger generation to inherit the family business. The introduction of mechanical technologies, such as *chopper* machines and silage fermentation techniques, has proven to be an effective intervention in significantly reducing these physical burdens.

This empirical finding strongly aligns with the *Perceived Ease of Use* concept within the *Technology Acceptance Model* (TAM). As supported by the studies of Ernawati et al. (2025) and Rahman and Hidayat (2024), mechanization revolutionizes traditional work methods into more efficient systems. By shifting the operational paradigm from heavy manual labor to smart mechanical processes, the stigma of physical exhaustion is eliminated. Consequently, rural youth perceive livestock farming not as a punishing chore, but as a manageable and ergonomic entrepreneurial activity, which subsequently increases their interest in business succession.

The Effect of Financial Gain on Regeneration Interest

The expectation of financial gain demonstrates the largest path coefficient (0.415) with the highest level of significance (0.000) among all independent variables. For decades, the beef cattle supply chain in rural areas has been monopolized by an oligopsony market structure controlled by middlemen or blantik. This traditional system marginalized farmers, keeping their profit margins minimal and making the livestock sector appear financially unpromising. The youth, who possess higher financial literacy, recognize that digital marketing and online platforms are crucial instruments to bypass these middlemen and achieve transparent market prices.

This result confirms that financial gain is the most dominant pull factor for youth regeneration. Following the Perceived Usefulness construct proposed by Mohr and Köhl (2021), the belief in economic added value drives the rational motivation of millennials. These findings also corroborate the arguments of Ali et al. (2024) and Herlon et al. (2024), which state that the younger generation rejects subsistence farming models and demands a Return on Investment (ROI) capable of competing with urban minimum wages. Digitalization provides a clear pathway to profitability, making rural agribusiness a highly attractive career alternative.

The Effect of Social Image Improvement on Regeneration Interest

The improvement of modern barn infrastructure and the installation of biogas reactors have a positive and significant effect on youth regeneration interest ($0.032 < 0.05$). The 3D stigma (dirty, dangerous, difficult) has long relegated the traditional farmer profession to a lower social class in the eyes of society. This negative perception creates a psychological barrier, causing the youth to feel ashamed of continuing their parents' legacy. Hygienic infrastructure sanitation and modern waste management have psychologically proven to dismantle this stigma, transforming the dirty image into a clean and environmentally friendly industrial setup.

Although its path coefficient is the lowest (0.210), this finding is socio-culturally significant. It supports the analyses of Tafari et al. (2024) and Widyastuti and Silalahi (2022), which highlight that agribusiness interest is heavily influenced by social construction and occupational prestige. Restoring pride through the label of "Millennial Farmer" or "Agropreneur" elevates their social status to be on par with white-collar workers. Therefore, continuously reconstructing this positive identity is just as important as upgrading physical infrastructure to ensure long-term youth participation

The Simultaneous Effect of Technological Modernization on Regeneration

Based on the Pseudo F-test calculation, a calculated F-value of 50.01 was obtained, which is significantly greater than the F-table value (2.74), leading to the acceptance of H4. The three dimensions of technological modernization (operational, financial, and infrastructure) contribute a combined effect of 68.5% on the intention of youth to continue the family agribusiness. This high percentage demonstrates that when these three variables are implemented concurrently, they form a unified and highly robust innovation ecosystem. This ecosystem acts as a powerful magnet, effectively drawing the youth back to the village to build rural economic independence.

This phenomenon provides crucial academic and practical implications, confirming the meta-analyses of Ruzzante et al. (2021) and Nofianti et al. (2022). Their studies emphasize that agricultural innovation adoption in developing regions cannot be implemented partially. For instance, providing a chopper machine without dismantling digital market isolation, or promising high profits while ignoring dirty barn conditions, will not be sufficient to curb the rate of youth migration to urban areas. A holistic synchronization of mechanical, digital, and infrastructural technologies is the absolute prerequisite for successfully solving the aging farmer crisis.

CONCLUSION

The conclusion of this study confirms that technological modernization serves as a primary catalyst and pull factor capable of overcoming the smallholder beef cattle farmer regeneration crisis in Mamasa Regency. The positive belief of the younger generation regarding operational ease through mechanization, financial gain expectations from digital marketing transparency, and social image improvement due to hygienic barn infrastructure has been holistically proven to dismantle the stigma of manual labor and elevate their intention to continue the family agribusiness. The implications of these findings suggest that local governments should abandon partial assistance models and shift toward building an integrated innovation ecosystem, while the youth are highly recommended to establish millennial farmer institutions to strengthen their market bargaining power. The limitation of this study lies in its exclusive focus on technological determinants and its quantitative survey design; therefore, it is recommended that future studies explore other external variables such as capital access and land tenure, and integrate qualitative approaches to delve deeper into the local cultural hegemony regarding occupational prestige in rural areas.

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