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Design of an Extension Program for Rorak Construction as an Approach to Coffee Land Conservation in Parbuluan District, Dairi Regency

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Abstract

The limited adoption of *rorak* as a soil and water conservation technique in coffee plantations in Parbuluan District, Dairi Regency, has been associated with farmers' limited knowledge of and attitudes toward its benefits and application. This study examined changes in farmers' knowledge, attitudes, and implementation practices following an agricultural extension program on *rorak* construction for coffee-land conservation. A descriptive quantitative pretest–posttest evaluation was conducted from January to May 2026 involving 40 coffee farmers from the Immanuel and Unggul Farmer Groups. Data were collected through observations, interviews, questionnaires, and pretest and posttest assessments. Changes in knowledge were evaluated by comparing scores obtained before and after the extension activity, whereas attitudes were measured using a Likert scale. The mean knowledge score increased from 4.75 at pretest to 8.25 at posttest, representing a 3.50-point or approximately 73.7% increase. The overall attitude score reached 86%, indicating a highly positive response to *rorak* adoption. Furthermore, 20 farmers (50%) implemented *rorak*, exceeding the initial target of 30%. These post-extension improvements suggest that the program strengthened farmers' knowledge and attitudes while encouraging the practical adoption of soil and water conservation technology. Although the design does not establish causality, the study provides context-specific evidence that locally tailored agricultural extension can support sustainable conservation practices among smallholder coffee farmers.

Keywords: Agricultural Extension; Coffee Farming; Farmer Knowledge and Attitudes; *Rorak*; Soil and Water Conservation

INTRODUCTION

Coffee is one of Indonesia's strategically important plantation commodities, particularly because coffee production is predominantly managed by smallholder farmers whose livelihoods are closely connected to the sustainability of coffee farming. Beyond serving as a source of household income, coffee occupies an important position in agricultural trade and contributes to national export earnings, making the sustainability of coffee production relevant not only to farmers but also to the broader agricultural economy (Paryanto, 2025). National plantation statistics indicate that Indonesia's coffee-growing area has continued to develop in recent years, increasing from approximately 1.26 million hectares in 2022 to 1.269.354 hectares in 2024, while production increased from 789.97 thousand tons to 807.578 tons over the same period. More than 98% of the national coffee-growing area is managed by smallholders, demonstrating that the sustainability of the coffee sector is strongly dependent on farmers' capacity to manage production resources effectively. This condition suggests that efforts to increase coffee productivity should not be limited to production expansion, but should also incorporate sustainable approaches to soil, water, and environmental management.

The importance of sustainable land management is particularly evident in North Sumatra, one of Indonesia's major coffee-producing provinces. North Sumatra has a significant role in national coffee production and is recognized as an important center for Arabica coffee development. Plantation statistics recorded approximately 98,438 hectares of coffee plantations in the province in 2023, with production reaching around 89,593 tons, while production increased to 91,695 tons of dried coffee beans in 2024. These figures illustrate the substantial economic potential of coffee while simultaneously emphasizing the need to maintain the productive capacity of the land on which coffee production depends. Dairi Regency is among the regions where agriculture and plantations occupy a strategic position in the local economy and provide an important source of livelihood for the population (Sitinjak et al., 2025). The Arabica coffee area in Dairi increased from 13.275 hectares in 2022 to approximately 13.602 hectares in 2023, accompanied by an increase in production from 14.903 tons to approximately 17.550 tons (BPS Kabupaten Dairi, 2024). Such development needs to be accompanied by sustainable land-management practices to ensure that increased production does not undermine the long-term ecological capacity of coffee-growing areas.

Parbuluan District is one of the important coffee-producing areas within Dairi Regency. Coffee production in the district is strongly dominated by Arabica, with an area of 3.486 hectares and production of 4.873 tons, while Robusta covers 15 hectares and produces approximately 4 tons. Despite this substantial production potential, coffee productivity in Parbuluan remains approximately 1.1 tons per hectare, whereas the potential productivity is estimated at 2–3 tons per hectare. This productivity gap indicates that increasing coffee output cannot depend solely on expanding cultivated areas, but requires improvements in farming practices and land management. The highland characteristics of the area and the potential for surface runoff make soil and water conservation particularly relevant to the sustainability of coffee plantations. Soil and water conservation refers to a set of land-management measures designed to control degradation, particularly erosion, improve the capacity of soil to absorb and retain water, and maintain agricultural productivity over the long term (Pambayun & Widyatama, 2025).

The conservation challenge in coffee plantations is also associated with the management of organic residues generated by farming activities. Fallen leaves, pruning residues, weeds, and other organic materials can serve as valuable sources of organic matter when properly managed, but may become environmental problems when accumulated without appropriate treatment (Diansari & Muzaifa, 2024). Unmanaged coffee residues may also represent a loss of organic matter and nutrients that could otherwise be returned to the soil to support soil fertility (Risdawati, 2021). Appropriate management of coffee organic residues can improve important soil physical properties, including porosity, aeration, and water infiltration capacity. Consequently, organic waste management in coffee plantations should not be viewed merely as an environmental-cleanliness issue, but as part of a broader opportunity to improve soil quality and optimize resources already available within the farming system.

One relatively simple technology that can integrate soil and water conservation with organic-residue management is the use of infiltration pits or rorak. Rorak refers to a simple pit or dead-end channel constructed around perennial crops and generally positioned along contour lines to slow surface runoff while capturing sediment and organic materials transported by water (Satibi et al., 2019). In coffee plantations, rorak can serve as a temporary water-storage structure, providing additional time for rainfall to infiltrate into the soil. Its application is also consistent with soil and water conservation principles in coffee cultivation because it can reduce runoff, improve infiltration, and provide a site for organic-matter decomposition. These characteristics make rorak particularly relevant for smallholder coffee systems because the technology is relatively simple, can utilize locally available materials, and can be incorporated into routine plantation maintenance.

The potential benefits of rorak extend beyond surface-water control to improvements in soil physical and chemical conditions. Research on rorak effectiveness in coffee plantations found that soils under rorak management had higher porosity and soil moisture content than soils without rorak, accompanied by improved nutrient conditions (Asrizal et al., 2022). These findings indicate that rorak can contribute to the soil's capacity to retain water while supporting nutrient availability for coffee plants. Research on Arabica coffee has further reported positive effects of rorak application on several indicators of plant growth and production, including stem diameter, leaf area, and coffee yield (Sulistiani et al., 2023). Rorak can therefore be understood not merely as a mechanical conservation structure, but as an integrated component of coffee plantation management that connects soil conservation, organic-matter utilization, and sustainable crop productivity.

However, the availability of an appropriate technology does not automatically guarantee its adoption. The success of agricultural innovation is also influenced by farmers' understanding of the technology, their perceptions of its benefits, and their willingness and ability to implement it. Knowledge constitutes an important basis for behavior because an individual's understanding of an object can influence decision-making and acceptance of innovation (Pakpahan et al., 2021). Higher levels of knowledge can also strengthen farmers' capacity to adopt new technologies and develop a more positive and receptive orientation toward agricultural innovation. Attitude is equally important because it represents an individual's tendency to evaluate and respond to an object or innovation (Zulfiana et al., 2022). Consequently, introducing rorak as a conservation technology requires an educational process capable of strengthening not only farmers' technical knowledge but also their attitudes toward the relevance and feasibility of the technology.

Agricultural extension therefore occupies a strategic position in translating technological recommendations into farmers' practical capabilities. Under Indonesia's agricultural extension framework, extension is understood as a learning process intended to strengthen the capacity of primary actors and agricultural businesses to improve their livelihoods while maintaining environmental sustainability. Extension should consequently be understood as more than a one-way transfer of information because it is expected to facilitate behavioral change through improvements in knowledge, attitudes, and skills. The objectives of an extension program should be formulated according to the SMART principle, namely specific, measurable, actionable, realistic, and time-bound objectives. The ABCD framework further requires the objectives to clearly identify the audience, expected behavior, conditions, and degree of achievement, thereby translating broad extension aspirations into observable behavioral outcomes.

A contextualized extension design is particularly important because farmers' characteristics, environmental conditions, and agricultural problems vary across locations. Regional Potential Identification (IPW) is therefore necessary to obtain a comprehensive picture of natural resources, human resources, and local social and economic conditions before designing an extension intervention. IPW provides extension workers with updated information that can serve as a basis for developing extension programs and annual work plans according to local opportunities and constraints. Consequently, an extension design for rorak construction should not be developed as a generic technological package, but should emerge from the actual conditions of coffee farming in Parbuluan, including productivity constraints, organic-residue management, farmer characteristics, and land-conservation conditions.

The selection of extension methods and media is another determinant of whether an innovation can be effectively understood and adopted. Extension methods need to correspond with the objectives of the activity, characteristics of the target farmers, subject matter, number of participants, sociocultural context, and available facilities. For a practical technology such as rorak construction, demonstration is particularly relevant because farmers can directly observe the sequence of operations, including site selection, measurement, excavation, and organic-material placement. Extension media should likewise be selected according to their ability to clarify messages and support learning experiences. Print, visual, audio-visual, physical-object, and digital media may be utilized according to the characteristics of the content and target audience (Rustandi & Warnaen, 2019). Appropriate alignment among subject matter, method, and media is therefore expected to strengthen farmers' understanding and facilitate subsequent adoption.

Previous studies have provided important empirical foundations for understanding both the technical benefits of rorak and the role of extension in land conservation. Asrizal et al. (2022) demonstrated the positive contribution of rorak to soil physical and chemical conditions in coffee plantations. Research by Faizin & Maghfiroh (2023) found that rorak application did not significantly affect pest attack levels in Robusta coffee, suggesting that the principal relevance of rorak lies more directly in soil and water management than in pest suppression. Meanwhile, an extension program on land conservation among coffee farmers in Mamasa demonstrated improved farmer understanding of erosion risks, slope conditions, and the importance of conservation techniques, although sustained implementation still required continued assistance (Mithen et al., 2024). Research examining the relationship between extension workers' roles and technology adoption has similarly indicated that effective extension can strengthen farmers' knowledge and willingness to implement agricultural technologies (Saridewi & Siregar, 2020).

Other studies indicate that adoption of conservation technology cannot be explained solely by the technical performance of an innovation. Research on the adoption and dis-adoption of soil and water conservation technologies reported that adoption levels may remain relatively low and are influenced by farmers' knowledge, attitudes, and socioeconomic conditions (Qanti et al., 2023). Research on extension methods and media further demonstrated that extension interventions designed according to farmers' characteristics can improve the understanding and skills required for technology adoption (Pello & Djunina, 2024). These findings suggest that technological and extension approaches need to be integrated so that conservation innovations do not remain at the level of information dissemination but can be accepted and implemented within farmers' everyday production practices.

The research gap addressed in this study concerns the limited integration of regional potential identification, farmer characteristics, SMART and ABCD-based objective formulation, and the systematic design of an extension program for rorak construction within a specific coffee-farming context in Parbuluan District, Dairi Regency. Previous studies have predominantly examined the technical effectiveness of rorak on soil and crop conditions, specific effects of rorak application, or the general effectiveness of land-conservation extension activities. There remains limited research connecting empirical evidence concerning the technical benefits of rorak with a location-specific extension design that considers the actual characteristics and needs of coffee farmers. This gap is particularly relevant because the preliminary regional assessment and interviews with the local agricultural extension coordinator indicated that rorak adoption remains limited among coffee farmers in Parbuluan, while organic residues generated by coffee cultivation are not yet optimally managed.

The novelty of this study lies in developing a context-specific extension design for rorak construction based on the actual conditions and characteristics of coffee farmers in Parbuluan District, while integrating SMART and ABCD principles into objective formulation and systematically considering subject matter, methods, media, activity volume, location, timing, and extension costs. The novelty is further strengthened by positioning rorak as a multifunctional innovation that simultaneously addresses soil and water conservation and the management of organic residues generated by coffee cultivation. This approach provides a more practical perspective because the innovation is assessed not only according to its ecological benefits but also according to its potential acceptance and application within farmers' routine farming activities. The theoretical foundation of the study combines the concept of agricultural extension as a learning process, SMART and ABCD principles for objective formulation, behavioral concepts emphasizing knowledge and attitudes, and soil and water conservation principles through rorak application.

Accordingly, this study focuses on designing and assessing an agricultural extension program for rorak construction as an approach to conserving coffee-growing land in Parbuluan District, Dairi Regency. The study aims to identify the regional potential that can serve as the basis for extension planning, analyze the formulation of extension objectives using SMART and ABCD principles, and determine the appropriate target farmers based on their demographic, social, and economic characteristics. It further examines farmers' acceptance of the proposed extension components, including subject matter, methods, media, activity volume, location, timing, and costs. Finally, the study seeks to determine the number of farmers who implement rorak construction following the extension activity as an initial indicator of innovation adoption. Through this approach, the study is expected to produce an extension design that is theoretically grounded, empirically informed, operationally feasible, and responsive to the needs of coffee farmers in Parbuluan District.

METHODS

This study employed a descriptive quantitative approach to assess an agricultural extension design for rorak construction as a soil and water conservation measure in coffee plantations in Parbuluan District, Dairi Regency, North Sumatra. The approach was used to describe farmers' acceptance of the extension design as well as changes in their knowledge, attitudes, and implementation of the recommended conservation practice. Data were collected using structured instruments and analyzed quantitatively with SPSS (Sugiyono, 2021).

The study was conducted over five months, from January to May 2026, while the extension activities were carried out during March–April 2026. The research procedure comprised coordination with the local Agricultural Extension Center, Regional Potential Identification (IPW), community engagement, respondent selection, extension implementation, data collection and processing, and report preparation. Parbuluan District was purposively selected because coffee farming is widely practiced in the area and many farmers had limited knowledge of rorak construction and its benefits.

The research design began with Regional Potential Identification using the Rural Rapid Appraisal (RRA) approach, which involved secondary-data review, direct observation, and interviews with key informants. The results were used to identify local problems and extension needs (Mardiana et al., 2020). Extension objectives were formulated using the SMART framework (Specific, Measurable, Actionary, Realistic, and Time Frame) and the ABCD framework (Audience, Behaviour, Condition, and Degree). The target population consisted of 40 farmers, with an intended increase in rorak implementation from 0% to 30%, corresponding to 12 farmers within one month.

The study assessed farmers' acceptance of seven extension-design components: subject matter, methods, media, activity volume, location, timing, and cost. Subject matter was assessed from technical, economic, and social dimensions; extension methods from suitability, effectiveness, participation, memorability, and error reduction; and media from attractiveness, information comprehension, retention, and memorability. Activity volume, location, timing, and cost were assessed using indicators related to frequency, accessibility, scheduling, efficiency, and affordability. Behavioral outcomes were assessed through knowledge and attitudes, with attitudes measured through cognitive, affective, and conative dimensions. The final outcome was the actual implementation of rorak construction in coffee fields.

The participants were 40 coffee farmers from the Unggul and Immanuel Farmer Groups in Bangun Village. Selection was based on group activity, coffee cultivation, absence of prior rorak implementation, and willingness to participate in the extension program. A saturated sampling technique was applied, meaning that all members of the two selected farmer groups were included as respondents. Primary data were collected through observation, interviews, questionnaires, and documentation, while secondary data were obtained from statistical publications, books, journals, scientific articles, and relevant institutions. The research questionnaire was tested using the Pearson Product Moment correlation. Of 122 tested statements, 93 were considered valid based on an r table value of 0.5140, while 29 items were excluded. Reliability was assessed using Cronbach's Alpha, with 0.600 as the minimum criterion, and all research variables met the reliability requirement.

The extension program consisted of two meetings using lectures, group discussions, demonstrations, and farm visits, supported by printed folders and video materials. Activities were conducted at the house and coffee field of one participating farmer to integrate theoretical explanation with direct field practice.

Farmers' acceptance of the extension design was analyzed using percentage scores derived from a Likert-scale questionnaire and classified into five levels ranging from very low to very high acceptance. A response level below 68% served as the basis for revising the extension design. Knowledge improvement was assessed using pretest and posttest scores and analyzed through normalized gain (N-gain), categorized as high when $g > 0.7$, moderate when $0.3 < g < 0.7$, and low when $g < 0.3$ (Hake & Reece, 1999). Attitudes were measured using 14 statements with five response categories and interpreted using a continuum scale, while technology implementation was determined from the number of farmers who actually constructed rorak after the extension intervention.

RESULTS

The Regional Potential Identification (RPI) conducted in Bangun Village, Parbuluan District, Dairi Regency revealed substantial agricultural potential, with coffee serving as one of the main commodities supporting local livelihoods. The area is situated at an elevation of approximately 700–1.100 meters above sea level and is characterized by relatively cool temperatures, adequate rainfall, and environmental conditions that support coffee cultivation. Field observations and interviews indicated that coffee farming is widely practiced among the local population, including an area locally recognized as a coffee-producing community. However, coffee cultivation also generates organic residues, including leaves, pruning branches, litter, and coffee husks, which have not yet been optimally utilized. These residues are generally left within plantation areas and have not been systematically integrated into soil conservation and organic-matter management practices. This condition became the basis for selecting rorak construction as the main subject of the extension intervention.

Figure 1. Regional Potential Identification in Bangun Village

Figure 1. Regional Potential Identification in Bangun Village shows that the regional potential identification was conducted directly in coffee plantation areas to observe land conditions, farming activities, organic-residue availability, and local circumstances that formed the basis for determining the extension content. The field documentation demonstrates the availability of coffee organic residues as locally accessible resources that can potentially be integrated into rorak construction as part of soil and water conservation efforts.

Based on these findings, the extension design focused on rorak construction as a soil and water conservation practice for coffee plantations. The extension objectives were formulated according to the SMART and ABCD principles, targeting 40 farmers from the Unggul and Immanuel Farmer Groups. The initial target was to increase rorak implementation from 0% to 30%, equivalent to 12 farmers. The extension program was conducted through two meetings using lectures, discussions, demonstrations, and farm visits, supported by printed folders and video materials. Activities were conducted at the house and coffee field of one participating farmer, enabling the conceptual explanation to be followed by direct field practice.

Evaluation of the extension design showed consistently positive responses across all components. Overall acceptance reached 88.72%, placing the design in the very high acceptance category. The highest score was recorded for extension cost at 89.31%, followed by activity volume at 89.25%, media at 89.05%, methods at 88.92%, timing at 88.78%, and location at 88.75%. Subject matter obtained the lowest score at 85.75%, although it also remained within the very high acceptance category. The detailed results are presented in Table 1.

Table 1. Farmers' Acceptance of the Extension Design

Extension-design component	Obtained Score	Maximum Score	Percentage (%)	Category
Extension subject matter	1.029	1.200	85,75	Very highly accepted
Extension methods	4.624	5.200	88,92	Very highly accepted
Extension media	1.603	1.800	89,05	Very highly accepted
Extension volume	1.428	1.600	89,25	Very highly accepted
Extension location	1.420	1.600	88,75	Very highly accepted
Extension timing	1.243	1.400	88,78	Very highly accepted
Extension cost	1.429	1.600	89,31	Very highly accepted
Total	12.776	14.400	88,72	Very highly accepted

Source: Compiled by the researcher (2026)

Table 1. Farmers' Acceptance of the Extension Design shows that all components of the extension design received high acceptance from the participating farmers. The findings indicate that the subject matter, instructional methods, media, activity volume, location,

timing, and costs were generally considered appropriate for the farmers' conditions and needs. Cost received the highest acceptance, whereas subject matter received the lowest, although both remained within the very high acceptance category.

Knowledge evaluation demonstrated a clear improvement following the extension activity. The total *pre-test* score obtained by the 40 participants was 190 out of a maximum of 360, producing a mean score of 4.75. Following the intervention, the total *post-test* score increased to 330, with a mean score of 8.25. The mean knowledge score therefore increased by 3.50 points, corresponding to a reported knowledge improvement of 73.83%. This result indicates that farmers' understanding of rorak definition, benefits, construction procedures, and application improved following the extension intervention.

A positive response was also observed in farmers' attitudes. The overall attitude score reached 86%, classified as very positive. At the dimensional level, the cognitive component obtained 87.3%, the affective component 87.37%, and the conative component 86.1%. These findings indicate that farmers developed not only greater understanding and positive beliefs regarding rorak, but also favorable emotional responses and behavioral tendencies toward implementation.

Table 2. Farmers' Attitude toward Rorak Construction

Attitude Dimension	Percentage (%)	Category
Cognitive	87.30	Very Positive
Affective	87.37	Very Positive
Conative	86.10	Very Positive
Total	86.00	Very Positive

Source: Compiled by the researcher (2026)

Table 2. Farmers' Attitude toward Rorak Construction shows that all three attitude dimensions were classified as very positive. The affective dimension recorded the highest score, whereas the conative dimension recorded the lowest, although both remained strongly positive. The results indicate that the extension intervention generated favorable responses toward rorak technology across cognitive, emotional, and behavioral dimensions.

The final evaluation showed that 20 farmers, or 50% of the 40 participants, implemented rorak construction after the extension activity, while the remaining 20 farmers, or 50%, had not yet implemented it. The actual implementation rate therefore reached 50%, exceeding the initial target of 30%, equivalent to 12 farmers. This finding indicates that the extension program not only generated high acceptance and improvements in knowledge and attitudes but also encouraged a substantial proportion of participants to translate the recommended technology into actual practice.

DISCUSSION

The findings demonstrate that a locally grounded extension design can generate strong farmer acceptance while contributing to improvements in knowledge, attitudes, and actual implementation of a soil and water conservation technology. The significance of this finding lies in the fact that the conservation problem identified in Bangun Village was not exclusively biophysical. It was also associated with limited farmer knowledge and low adoption of rorak technology. Consequently, the effectiveness of the extension intervention depended not only on the technical characteristics of rorak but also on the alignment between the innovation, the characteristics of the target farmers, and the learning approach employed.

The RPI findings revealed a strong ecological and agricultural foundation for coffee production, but also exposed a gap between available local resources and their utilization. Organic residues generated by coffee cultivation were not yet systematically reintegrated into the farming system. Rather than being viewed as resources, they were largely treated as waste. This finding demonstrates the importance of extension planning that begins with actual field conditions rather than externally predetermined technological packages. The use of RRA enabled the identification process to capture both local potential and specific constraints relevant to farmers' production activities (Mardiana et al., 2020).

Participant characteristics also provide an important context for interpreting innovation acceptance. Most respondents were within the productive-age range, creating relatively favorable conditions for participation in learning activities and technology implementation. Farmer age has been identified as one of the characteristics associated with agricultural innovation adoption (Indrayanti et al., 2024). In addition, the relatively long farming experience of respondents suggests that they possessed substantial practical knowledge of coffee production. Such experience may facilitate the integration of new information with established farming practices. This interpretation is consistent with Fangohoi et al. (2023), who emphasized the relevance of farming experience to farmers' capacity to manage agricultural activities.

The overall acceptance score of 88.72% indicates that the seven components of the extension design were perceived as highly appropriate by the farmers. This result suggests that acceptance was multidimensional and could not be attributed to the relevance of subject matter alone. An effective extension design must simultaneously consider instructional content, methods, supporting media, activity intensity, location, timing, and economic feasibility. Such a holistic approach corresponds with the broader function of agricultural extension in promoting changes in farmers' knowledge, attitudes, and skills while supporting improved farming practices and livelihoods (Budi, 2018).

The highest acceptance was observed for the cost component at 89.31%. This result suggests that farmers perceived rorak as a relatively affordable technology because the principal organic materials were locally available and the required tools were generally accessible within the farming environment. Low economic barriers may facilitate willingness to adopt. This interpretation indicates that the low-cost nature of rorak represents an important practical advantage for smallholder coffee farmers.

The subject matter received the lowest acceptance score, although it remained within the very high category at 85.75%. This comparatively lower score may indicate that technical conservation content requires more intensive explanation for some farmers. Differences in educational background, prior experience, and initial knowledge may result in varying levels of comprehension. This observation supports the importance of developing extension materials that are simple, practical, and adapted to the learning capacity of the target audience (Pramesti & Harahap, 2025).

The combination of lectures, discussions, demonstrations, and farm visits achieved an acceptance score of 88.92%. The contribution of this combination can be understood through the complementary functions of each method. Lectures established basic conceptual knowledge, discussions created opportunities for experience sharing, demonstrations translated concepts into visible procedures, and farm visits connected learning directly with farmers' fields. This finding is consistent with Gusmadevi & Hendrita (2024), who reported that combining extension methods can strengthen farmers' learning effectiveness. Irdiana et al. (2024) likewise emphasized that diverse communication methods adapted to target characteristics are important in producing more effective behavioral change.

The acceptance score for extension media reached 89.05%, indicating that the combination of printed folders and video was well suited to the target farmers. Video provided a visual representation of the rorak-construction process, whereas the folder offered a portable reference that could be revisited after the activity. This result supports

Nunihartini et al. (2024), who found that audiovisual media can strengthen learning by integrating visual and auditory information. Printed media may also reinforce independent and repeated learning because farmers can retain and revisit the material after the extension activity (Rihi et al., 2024). The combined use of these media therefore functioned not merely as a channel of information but also as a mechanism for reinforcing retention and implementation readiness.

The activity volume score of 89.25% indicates that two extension meetings were perceived as sufficient. This finding suggests that effectiveness is not necessarily dependent on a large number of meetings, but rather on how well the learning sequence is designed. In this study, the initial session provided conceptual explanation and technical demonstration, followed by farm visits to observe implementation. Such sequencing allowed farmers to move from receiving information toward applying and reviewing the recommended practice.

The location and timing components achieved acceptance scores of 88.75% and 88.78%, respectively. These values indicate that the selected location and schedule were compatible with farmers' practical circumstances. Conducting the activity at a farmer's house and coffee field brought the learning process closer to the actual farming environment and enabled direct observation. Field-based learning may strengthen comprehension because participants interact directly with the object being discussed, a pattern consistent with the importance of direct communication and experiential learning in agricultural extension (Irdiana et al., 2024). Supporting environmental and infrastructural conditions are likewise relevant to successful extension implementation (Permatati et al., 2026).

The increase in mean knowledge from 4.75 to 8.25 represents a substantial change following the intervention. This result indicates that the extension activity did more than generate positive perceptions; it also improved farmers' mastery of the material. The finding is consistent with Sudarmanto et al. (2022), who demonstrated that appropriate extension techniques can produce measurable improvements in farmers' knowledge. In the present study, the improvement can reasonably be interpreted as the combined result of relevant content, varied methods, supporting media, and hands-on demonstration, which exposed farmers to the same information through multiple learning experiences.

The positive attitude score of 86% provides additional evidence that the intervention influenced behavioral readiness beyond cognitive learning. The cognitive, affective, and conative scores of 87.3%, 87.37%, and 86.1%, respectively, indicate that farmers not only understood the innovation but also developed favorable evaluations and intentions to act. According to Azuz et al. (2024), these three dimensions are interconnected in shaping responses to agricultural innovations. The strong affective score suggests that farmers valued the innovation positively, whereas the conative score indicates an intention and readiness to implement it. This pattern is consistent with Sujono & Yahya (2017), who viewed positive attitudinal change as an important indicator of innovation acceptance within extension processes.

The most consequential finding was the actual implementation rate. Twenty farmers, or 50% of the participants, constructed rorak after the extension activity, exceeding the initial target of 30%. This result demonstrates movement from awareness and acceptance toward observable action. The finding is practically significant because it suggests that a locally tailored extension design can translate an initially underused conservation technology into an emerging farming practice. The role of extension workers as facilitators of behavioral change is particularly important in this process, consistent with Munifah et al. (2025).

Nevertheless, adoption was not universal. Half of the participants had not yet implemented rorak despite receiving the same extension intervention. This result illustrates that technology adoption is a gradual and heterogeneous process. Differences in perceived benefits, time and labor availability, field conditions, and individual readiness may affect implementation decisions. This interpretation is consistent with Romadi et al. (2025), who identified farmer characteristics, perceived benefits, technological compatibility, and extension effectiveness as important determinants of agricultural innovation adoption.

Theoretically, this study contributes by demonstrating how regional potential identification, SMART and ABCD objective formulation, target characterization, and multidimensional evaluation can be integrated into a context-specific extension framework for conservation technology. Practically, the study provides agricultural extension workers with a model for developing conservation-oriented interventions that are locally relevant, economically accessible, and operationally feasible. The distinctive contribution of the study lies in integrating rorak construction with the utilization of coffee organic residues within a single extension framework. Rorak is therefore positioned not only as a soil and water conservation structure but also as part of a circular approach to utilizing locally available agricultural resources.

Several limitations should nevertheless be acknowledged. First, the sample comprised only 40 farmers from two farmer groups, which limits the direct generalization of the findings beyond Bangun Village and the wider Parbuluan context. Second, implementation was assessed relatively soon after the extension intervention and therefore does not establish the long-term sustainability of rorak adoption. Third, acceptance and attitude measurements relied primarily on questionnaire responses, meaning that some behavioral information was dependent on participant reporting. Future research should therefore employ longer observation periods and broader participant coverage to examine sustained adoption and to evaluate whether continued rorak use produces measurable improvements in soil conditions and coffee productivity.

CONCLUSION

This study concludes that an agricultural extension design for rorak construction can provide a relevant and practical approach to promoting soil and water conservation in coffee plantations in Parbuluan District, Dairi Regency. The Regional Potential Identification revealed substantial potential for coffee-based agricultural development, supported by favorable local conditions, while also identifying two major challenges: the limited utilization of organic residues generated from coffee cultivation and the relatively low knowledge and adoption of rorak technology among farmers. These local conditions provided the foundation for developing an extension intervention aimed at strengthening farmers' knowledge, attitudes, and willingness to implement rorak as a conservation practice.

The extension objectives formulated according to the SMART and ABCD principles were successfully achieved and exceeded the initial target. The original target was to encourage adoption among 12 farmers, equivalent to 30% of the participants, whereas implementation was ultimately achieved by 20 farmers, representing 50% of the target group. This result indicates that the extension design was capable of generating behavioral change beyond the level initially anticipated. The 40 participants were selected from farmer groups meeting the predefined criteria, enabling the intervention to be directed toward a specific and relevant target population. Overall acceptance of the extension design reached 88.72%, placing it in the very high acceptance category. Strong acceptance was recorded for the subject matter, extension methods, media, activity volume, timing, and cost, while the location component was categorized as accepted.

The principal contribution of this study lies in its integration of regional potential identification, SMART and ABCD-based objective formulation, target-group characteristics, and the systematic selection of extension content, methods, media, activity volume, location, timing, and costs within a single context-specific extension design. Practically, the study provides a usable framework for agricultural extension workers seeking to introduce land-conservation practices that are adapted to local coffee-farming conditions. The findings also demonstrate the practical value of introducing a relatively simple conservation technology through a structured extension process that emphasizes not only knowledge transfer but also behavioral implementation.

The findings imply that initial adoption should be followed by sustained extension support and field-level assistance so that rorak application can continue beyond the intervention period. Farmers are encouraged to maintain rorak construction and incorporate coffee organic residues into ongoing land-management practices. Agricultural extension workers should strengthen follow-up activities and continue using instructional methods and media that are accessible, practical, and engaging for farmers. Future studies should examine the long-term sustainability of rorak adoption and investigate its subsequent effects on soil conditions, coffee productivity, and the sustainability of coffee farming systems.

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