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RESEARCH ARTICLE

# Extension Model Based on Farmers' Resources and Need to Improve Feed Technology Adoption

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**Abstract:** Feed technology is essential for improving beef cattle productivity, yet its adoption by farmers often remains partial and misaligned with their actual needs. This study aimed to develop a context-responsive agricultural extension model to enhance the adoption of feed-related innovations among beef cattle farmers. The research was conducted in Herlang and Bulukumpa Districts, Bulukumba Regency, South Sulawesi, Indonesia. Using a qualitative approach complemented by quantitative elements, data were collected through structured interviews (employing both closed and open-ended questions), three rounds of Focus Group Discussions (FGDs) with farmer groups and experts, and in-depth interviews with key informants selected through purposive sampling. Informants included farmers, local policymakers, academics, and government representatives who possessed relevant knowledge and experience. From a total population of 373 beef cattle farmers (168 in Herlang and 205 in Bulukumpa), a sample of 254 farmers was determined using the Slovin formula. The study successfully formulated an extension model termed the Pusaka Ternak model grounded in farmers' local resources, challenges, and institutional context. This model strengthens communication and collaboration between extension agents and farmers, offering a practical and scalable approach to improve the relevance, adoption, and impact of feed technology in smallholder beef cattle farming.

**Keywords:** Beef Cattle Farming, Feed Technology Adoption, Agricultural Extension Model, Pusaka Ternak Model, Participatory Rural Appraisal, Smallholder Farming, South Sulawesi

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## Introduction

Feed plays a critical role in beef cattle development, and its importance is underscored by the need for high levels of feed technology adoption to increase productivity. Furthermore, farmers play a central role in adopting feed technology, and the technologies introduced must be aligned with their actual needs. However, farmers often adopt only certain components of an introduced livestock technology rather than the technology as a whole. Agricultural extension workers, as agents of change, need to accompany farmers in adopting livestock innovations in order to improve farmers' welfare [1]. Technology adoption is influenced by numerous factors, including the socioeconomic characteristics of adopters, institutional aspects, technology characteristics, utilization of production facilities, technology cost, technical aspects of production technology, risk,

communication networks, extension agents, and technical efficiency [2, 3]. The influence of each factor may vary and can shape the direction of future decisions regarding technology adoption. Trach [4] reported that hay processing technology was not fully adopted due to farmers' insufficient understanding of the technology. Therefore, an appropriate extension model is needed to address this issue by delivering information that is easy to understand and contextually relevant through various extension media channels. The use of extension media as an information source has a significant impact on farmers' knowledge, attitudes, and skills in the agricultural sector; the more frequently farmers access such information, the greater the behavioral change they tend to experience. Rehman et al. [5] identified cost-effectiveness, personal knowledge and skills of farmers, and improved detection and conception rates as the main drivers of technology adoption.

Extension workers play an important role in technology adoption. Agricultural extension agents, as agents of change, are necessary to accompany farmers through the process of adopting innovations. Technology adoption significantly impacts farmers; therefore, an effective extension system is essential [6]. The more actively a technology is promoted, the faster farmers tend to adopt the innovation [7]. An intensive extension program delivered with appropriate methods, materials, and approaches results in higher innovation adoption rates. Therefore, more intensive extension programs are likely to increase the adoption of new technologies by farmers. Furthermore, enhanced understanding and experience among farmers improve their insight and strengthen their motivation to succeed, owing to increased confidence. Of the farmers surveyed, 41.43% rated extension agents as responsive, while 21.43% rated them as very responsive to the problems faced by farmers [8, 9]. This suggests that extension agents demonstrated appropriate empathy toward farmers and carried out their duties professionally to enhance farmers' welfare based on actual conditions. This also indicates a close relationship between extension workers and farmers. In terms of problem-solving, 65.71% of extension agents were found to respond to problems slowly, which may be attributed to their limited access to technology and market information.

Feed technology for beef cattle has long been introduced to farmers; however, studies have reported that its adoption has remained low. According to Le Hoang Nguyen et al. [10], technology adoption rates have remained low in most developing countries. Syamsu and Abdullah [11] reported that in Bulukumba, South Sulawesi, only 56.25% of farmers were aware of feed technologies such as ammoniation and fermentation techniques. Only 24.07% of farmers implemented these technologies [12], a low rate attributed to farmers' perception of them as ineffective and time-consuming. Additional obstacles included waste storage challenges, high waste management costs, and difficulties in transporting waste from origin to storage sites. For these reasons, many farmers chose not to implement the technology.

To increase technology adoption in beef cattle farming, a more participatory approach is required to ensure that introduced technologies are suited to farmers' needs [13]. Misra et al. [13] reported that the adoption of urea molasses blocks in cattle feed requires further analysis with respect to farmers' needs and the applied technology. Therefore, this study aimed to develop an extension model to improve technology adoption that is appropriate for beef cattle farmers and capable of addressing the challenges they face in developing their farming operations. The proposed extension model, named the Pusaka Ternak model, is intended to holistically improve farmers' technology adoption.

## Materials and Methods

### Study Design

The research employed a qualitative approach, which aims to reveal processes and interpretations of meaning, leading to a holistic understanding of the observed circumstances or behavior of individuals. This approach emphasizes the socially constructed nature of reality and seeks to understand how social experience is shaped and given meaning. Qualitative research procedures encompass developing assumptions, identifying thematic approaches, defining the role of researchers, reducing collected data, developing field data, analyzing and verifying data, and creating informational units from which research conclusions are drawn. This study was based on participatory research to formulate a rural extension model that would increase the adoption of feed technology for beef cattle farming based on farmers' needs and resources. A qualitative survey and Participatory Rural Appraisal (PRA) were conducted with key persons in the case study area to synthesize farmers' problems, continuing until data saturation was reached [14].

### Case Study Area

The research was conducted in Bulukumba Regency, South Sulawesi Province, Indonesia, which comprises approximately 10 subdistricts. Sampling was performed using a multi-stage technique. In the first stage, subdistricts were selected as research locations based on the criterion of cattle density relative to the land area available for farming. The primary sources of forage were plots of farming land, including rice fields and gardens. With regard to cattle density relative

to available farmland, it was assumed that the high-density category indicated areas where the ratio of cattle to forage was very high, while the medium category indicated areas where forage availability was relatively adequate. Herlang and Bulukumpa Districts were selected as sampling locations [11]. The subsequent sampling stage involved selecting villages within these districts.

### Participant Selection

Closed and open questions to guide researchers interviewing the respondents. Closed questions are a type of short question in which the answer is given, while open questions allow the respondents to share their answers. Respondents included members of the farmer group, while experts were involved in the Focus Group Discussion (FGD). The selection of informants in this research was purposive sampling with the assumption that informants had knowledge, experience and were local policy makers included academics, government, and other members of the community. FGDs were carried out 3 times (depending on the level of data saturation, meaning when the information starts to repeat itself and nothing new appears). Based on central statistics, the number of farmers from the two locations Herlang and Bulukumpa District was 373 cattle producers: 168 from Herlang and 205 from Bulukumpa. The determination of the cattle farmer sample as respondents of the population is determined by cattle producers in villages in each District the location was chosen. The sample is taken using the formula by Slovin methods [15]. The number of respondent farmers in the research in the Herlang district was at least 118 farmers, and in the Bulukumpa district was at least 136 farmers, with a grand total of 254 farmers.

### Data Collection

Both closed and open questions were used to guide researchers in interviewing respondents. Closed questions are structured questions with predetermined answers, while open questions allow respondents to provide their own responses freely. Respondents included members of farmer groups, while experts were involved in the Focus Group Discussions (FGDs). Informants were selected through purposive sampling, based on the assumption that they possessed relevant knowledge and experience; they included local policymakers, academics, government representatives, and other community members. Three rounds of FGDs were conducted, with the number determined by data saturation, defined as the point at which information began to repeat and no new data emerged. According to central statistics, the total population of farmers across the two districts was 373 cattle producers: 168 from Herlang and 205 from Bulukumpa. The sample of cattle farmers was drawn from cattle producers in the villages within each selected district. Sample size was determined using the Slovin formula [15], yielding a minimum of 118 farmers from Herlang District and 136 from Bulukumpa District, for a grand total of 254 farmers.

### Data Analysis

This study collected both primary and secondary data from key persons. Primary data were collected through interviews and questionnaires designed to elicit detailed responses. Open questions were used to elicit more detailed information beyond what closed questions could provide. Secondary data were obtained through a review of available literature to support and supplement the primary data. To obtain more in-depth information, focus group discussions and in-depth interviews were also conducted with farmers. Prior engagement with key informants and farmers before formal observations helped establish mutual trust and facilitated the researchers' acceptance as part of the community. A modified PRA approach combining PRA and FGD methods adapted to field conditions, available time, resources, and research objectives was used to identify farmers' needs in adopting feed technology [14].

## Results and Discussion

In developing an extension model to increase feed technology adoption based on farmers' resources and needs, it is first necessary to identify the various problems underlying the low adoption of feed technology. Based on interviews and FGDs, the results presented in Table 1 were obtained as a basis for formulating the extension model. Through the FGD process, objective conditions, problems, and proposed solutions were identified and incorporated into the model. Furthermore, improving extension agent performance and farmers' perceptions of feed technology innovation became a clear necessity, alongside establishing the roles of stakeholders and strengthening communication and commitment in advancing feed technology innovations in beef cattle farming. Stakeholder participation, identified problems, proposed solutions, and future programs have been formulated and are presented in Table 1.

**Table 1: Formulation obtained from FGD in order to arrange the extension model for improving feed technology adoption based on farmers' resources and needs study**

| Objective Condition | Problem | Solution |
|---|---|---|
| Required technology for farmers is not identified. Thus, many extension programs are not suitable with current condition and expected results. | Identification is not conducted since the extension program is a top-down program and does not consider farmer's need. Extension program is fixed and applied to all regions. | Identification of farmer's necessity before determining the extension program. Compatibility between extension program, governance policy at all levels, and farmer's need. |
| | Extension program considers the condition of regions and lack of resource. No available reference about the region's resources. | Establishment of expansion program based on local or specific resources. |
| Extension activities are more dominated and oriented by project-based programs, which are time-dependent and not in line with the basic concept of extension. | Incompatibility between extension activity (government's program) and farmer's expectation. | The policy is allocated for the farmer's interest. An extension activity is addressed to the program, not project-based activity. |
| | Extension activities are project-based programs, such as Programs in Regional Government Budget (APBD). | |
| Extension agent performance gets worse as indicated by a decreasing frequency, formality-based program, less visitation by extension agent to farmers, fewer farmer (1-2 farmers) responses to visitations. | The relevant instance is re-organized due to changes in local governance policy. | The relevant instance or organization for the extension program is from echelon II officials. Improvement in extension training with up-to-date materials and technology in animal husbandry. |
| | The extension agent's competency in delivering materials is limited. The visitation by extension agents is more dominantly for administrative reasons. | There is a need to change the extension agent's perspectives in developing and empowering the farmers. |
| Farmer's participation in the extension program tends to decrease. Availability and access to feed technology information are very limited | Most extension material is provided based on the extension agent's competence, not based on the farmer's need. | The extension content is prepared based on what farmers need. |
| | Less information about current feed and animal technology. | Providing information related to the current feed and animal technology that is accessible to farmers. |

Based on Table 1, an extension model that considers farmers' needs and resources to increase feed technology adoption the Pusaka Ternak model was established. The Pusaka Ternak model is defined by the following principles:

1. The model is established by assessing farmers' resources and the feed technologies needed by farmers.
2. Extension agents must understand the resources available to farmers.
3. Innovations are developed in alignment with available resources, encompassing financial capacity, skills and competencies, and social and environmental values.
4. Extension methods and media are selected based on availability and farmers' preferences.
5. Extension agents may collaborate with local public figures.

To effectively address these aspects, a comprehensive matrix outlining the specific solutions, targeted programs, and the respective stakeholders responsible for enhancing feed technology adoption is detailed in Table 2.

In the Pusaka Ternak model, two critical factors drive the adoption of beef cattle feed technology: the roles and resources of both farmers and extension agents. The success of feed technology adoption is largely determined by both parties. A schematic of the Pusaka Ternak model is presented in Figure 1.

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**Table 2: Matrix for enhancement of beef cattle feed technology adoption based on farmer's resource and need**

| Problem | Solution | Program | Executors |
|---|---|---|---|
| | ***Performance of Extension Agents*** | | |
| Lack of knowledge and competence on feed technology | Improving knowledge and competence through formal and informal education. | Training to improve skill and competence of extension agents about feed technology | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>University<br>Research Instance |
| Lack of creativity, initiative, motivation, and empathic | Fostering the capacity of extension agents; their roles are meaningful for farmers. | Training for extension agents and increasing their insight through comparative study to reference regions.<br>Providing technical counseling about feed technology to farmers. | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>Farmers |
| Farmer's response and roles of extension agent tend to be neglected by local government in developing the region | Fixing the instance and extension organization, requiring more echelon II officials. | Determining the permanent extension authorities or instance, with proper financial support. | Local government<br>Legislative council (DPRD) |
| Lack of extension agents, not suitable with covered area and geographical condition | One Village One Extension through recruiting leader/member of farming group as private/non-governance extension agents | Recruiting new extension agents from private extension agents. | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>Farmers |
| | ***Farmer's Perception to Feed Technology Innovation*** | | |
| Lack of knowledge and comprehension to feed technology | Enhancing knowledge about feed technology | Accompaniment program for improving farmer's capacity simultaneously.<br>Arranging technical guidance of feed technology application | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>Farmers<br>University<br>Research Instance<br>Non-Governance Organization |
| Farmers are not received proper information of feed technology, since the extension agents are less competent on this topic. | There is a necessity to identify potential resource and farmer's need while updating the extension content suitable with farmer's expectation. | Composing training module about feed technology based on farmer's need, as well as demonstrating feed technology in farmer group.<br>Provision of facilities and access to information and technology for farmers. | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>Farmers |
| Farmers are less involved in designing extension program, while extension method is less suitable with farmer's necessity | Empowering the farmer group as a medium for interaction with principles: from farmer, by farmer, and for farmer. | Arranging teamwork or taskforce in creating the extension program by all associated stakeholders. | Department of Animal Husbandry<br>Extension Instance<br>Extension Agents<br>Farmers<br>University<br>Research Instance<br>Non-Governance Organization |

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In the context of extension, farmers' resources refer to their capacity to manage their farming operations [16]. Counselling, learning by doing, and the replication of successful cases should be considered effective approaches for developing entrepreneurial skills among farmers [17]. Farmers who are able to solve problems and develop competitive, sustainable technologies will ultimately improve their welfare through profitable and sustainable farm management. The essential elements of the Pusaka Ternak model in Bulukumba Regency, along with its phases, are recorded in Figure 2.

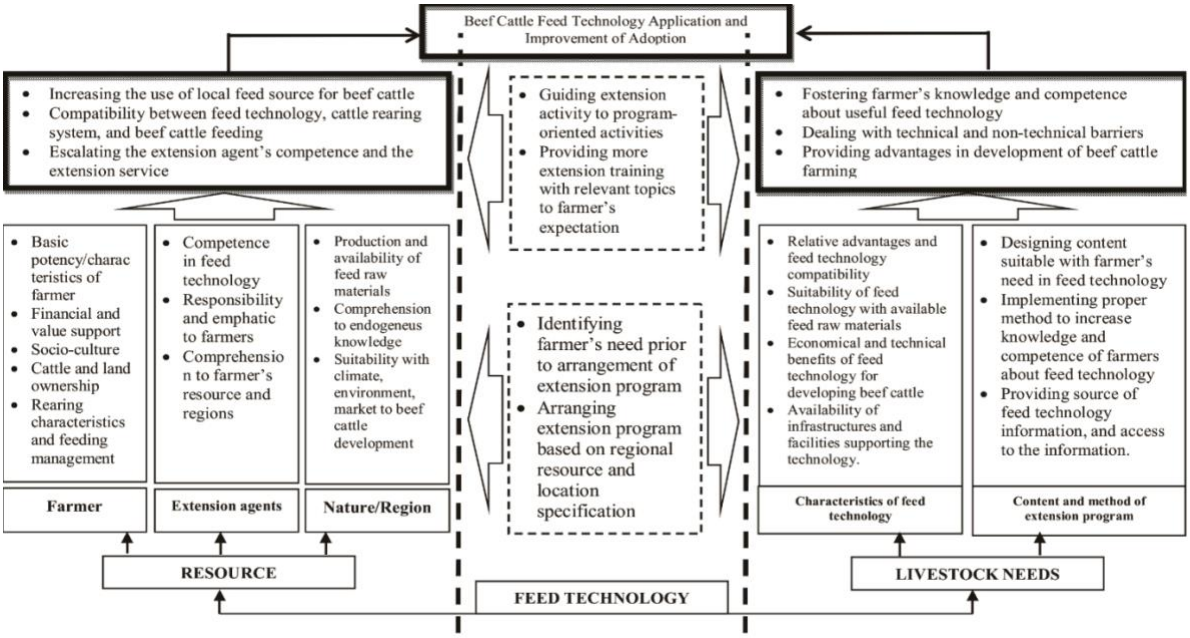


**Fig. 1: Extension model based on farmer's resource and need to increase adoption of feed technology (pusaka ternak model)**

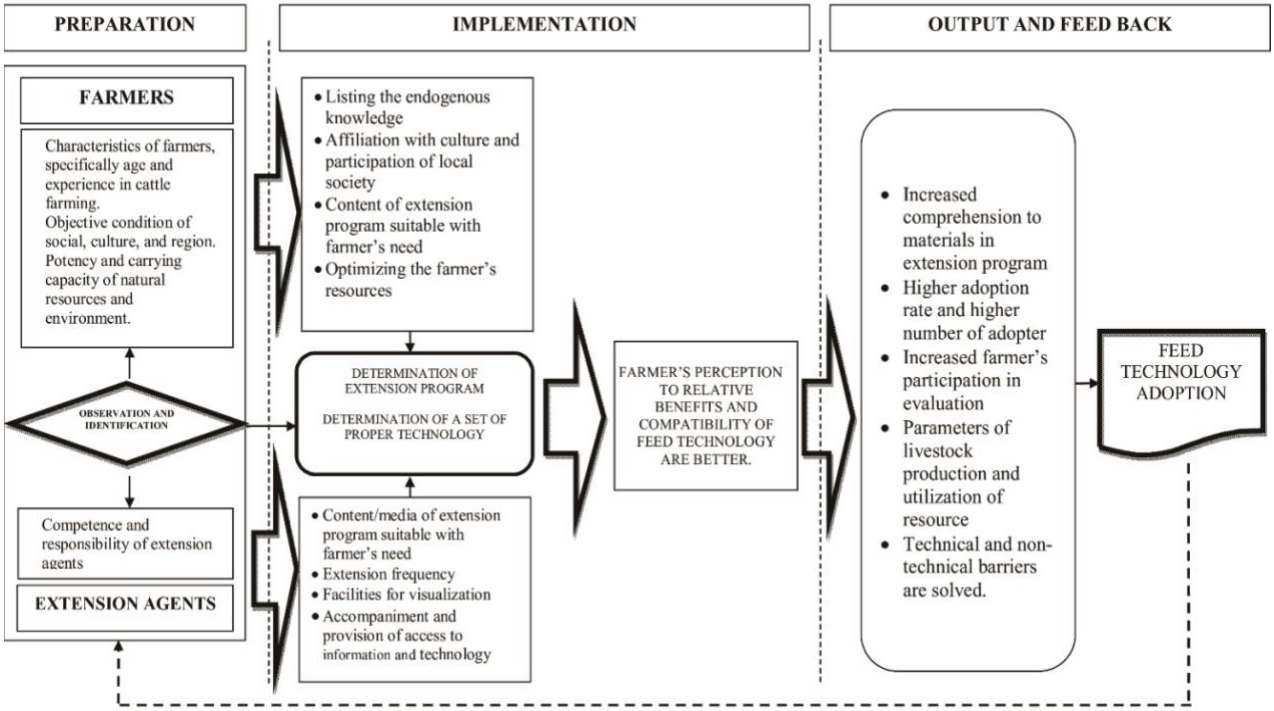


**Fig. 2: Steps of implementing pusaka ternak model**

Interview results revealed that farmers did not adopt feed technology largely because their specific needs for such technology had not been identified, resulting in many extension programs that were poorly matched to local conditions and not reaching the intended target groups. This was partly because most extension programs were still top-down in design and tended to be generic, applying the same content across all regions. In addition, the availability of information about feed technology was very limited, which reduced the capacity of extension agents to effectively introduce feed technology to farmers, further contributing to low adoption rates. This is consistent with Mardikanto [18], who stated that the more frequently extension agents deliver technological innovations using appropriate methods and materials tailored to farmers' needs, the faster the process of innovation adoption.

## Formulation to Arrange Rural Extension Model

Access to and availability of extension services have been identified as key factors in technology adoption. Specifically, technology adoption is determined by extension agent performance and farmers' perceptions of feed technology innovation. In other words, better extension agent performance and more positive farmer perceptions are associated with higher rates of feed technology adoption, and vice versa [18]. Extension agent performance was measured using the indicator of frequency of extension activity. The frequency of farm visits was also found to be a determinant of feed technology adoption, whereby more frequent visits by extension agents were associated with higher adoption rates. Consequently, increased visitation by extension agents and greater farmer participation in extension programs were both associated with notably improved feed technology adoption [19]. A positive relationship between extension services and technology adoption has been well established in the literature [10, 20].

Another identified problem related to feed technology adoption was the infrequency of extension agent visits to farmers. Technology innovations that are promoted more regularly through appropriate methods and accessible materials tend to accelerate adoption [21]. The capacity of extension programs to promote innovation is therefore essential in determining adoption rates.

## Scheme of Rural Extension Model

In the Pusaka Ternak model, two factors are central to driving the adoption of necessary technologies for beef cattle feed: the role and capacity of cattle farmers, and the potential of extension workers. Labor availability has been recognized as a major factor influencing the adoption of livestock technologies. The success of the program and the achievement of feed technology adoption are largely determined by both of these groups. Cattle producers are a crucial element in the learning and implementation process. Farmers should be empowered with the same level of capacity as other stakeholders including researchers and academics so that local capacity, potential, problems, and needs are fully recognized and addressed [22].

Policies directed at beef cattle farming should respond to the actual demands of farmers' business management without imposing decisions that override their agency. Technologies developed on the basis of local resources are more likely to be competitive and adopted when there is compatibility between perceived benefits and manageable complexity [23].

## Implementation of Extension Model

Figure 2 illustrates that the successful implementation of the Pusaka Ternak model in Bulukumba Regency requires coordination among relevant stakeholders—including the Animal Husbandry Department under the Ministry of Agriculture and its affiliated staff, related local government departments, agricultural extension bodies, research institutes, higher education institutions, and the private sector—so that local resources and farmers' needs can be addressed through a positive and contextually relevant approach. Central to the model's success is the simplicity of the innovations, enabling farmers to adopt them readily and apply them to complex practical problems. A meaningful benchmark for the model is the sustained adoption of feed technology by beef cattle farmers, which in turn enhances cattle productivity and improves farmers' income and welfare [24].

To increase feed technology adoption in beef cattle farming based on farmers' needs and resources, the performance of extension workers and farmers' perceptions of feed technology innovation must be carefully considered. Extension worker performance can be enhanced by increasing their capacity in feed technology through training, improving their ability to engage relevant stakeholders, and adjusting their coverage area to ensure an adequate ratio of extension agents to farmers—ideally one agent per village. Extension planning activities should ensure that programs are carried out in accordance with farmers' actual needs in terms of both content and methods, thereby increasing the adoption of beef cattle feed technology. A new paradigm, characterized by more participatory and pluralistic approaches, has influenced the role of extension workers.

Extension workers are now recognized as fulfilling four important roles: empowerment, community organizing, resource development, and problem-solving. In these capacities, extension workers support farmers and rural communities in their growth and development through informed decision-making processes [25].

### Enhancement of Beef Cattle Feed Technology Adoption

Extension agent performance and farmers' perceptions of feed technology innovation were identified as two essential variables for improving beef cattle feed technology adoption. Accordingly, stakeholder engagement should be used as a strategic approach to improve these key variables.

The Pusaka Ternak model, which accommodates farmers' needs and resources, represents an alternative approach to increasing beef cattle feed technology adoption by taking into account farmers' needs and resources, the characteristics of farmers, their perceptions of novel technologies, and the performance of extension agents. This ensures that extension agents receive feedback informed by farmers' actual difficulties and needs, enabling them to make decisions that are genuinely aligned with farmers' expectations. Improving extension performance through meaningful interaction with farmers, expanding distance-learning approaches, and enhancing the quality of extension materials and methods are all likely to encourage greater adoption of modern technologies.

## Conclusion

This study demonstrated that extension programs promoting innovation are essential in determining feed technology adoption rates. The Pusaka Ternak model represents an alternative approach to increasing beef cattle feed technology adoption by taking into account farmers' needs and resources, the characteristics of farmers, their perceptions of novel technologies, and the performance of extension agents.

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## Author’s Contributions

Agustina Abdullah: Conceptualization, formal analysis, and writing original draft.
Indrawirawan Indrawirawan: Writing original draft, review, and editing.

## Ethics

This study did not involve any animal experimentation. All data were collected through surveys and interviews with farmers.

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