American Journal of Humanities and Social Sciences Research (AJHSSR)
e-ISSN : 2378-703X
Volume-10, Issue-01, pp-90-99
www.ajhssr.com
Research Paper Open Access

Optimizing Local Feed Resources Through a Smart Empowerment Approach: A Literature Review on Livestock Feed Nutrition and Food Security

Dian Agustina Abidinsyah[1], Iskandar Zainuddin Rela [2]
[1](*Department of Animal Science, Faculty of Animal Science, Universitas Halu Oleo, 93232 Kendari, Sulawesi Tenggara, Indonesia*
[2](*Department of Agricultural Extension, Faculty of Agriculture, Universitas Halu Oleo, 93232 Kendari, Sulawesi Tenggara, Indonesia)*

ABSTRACT : The utilization of local feed resources is a strategic approach to enhancing livestock productivity and strengthening food security, particularly in rural areas of Southeast Sulawesi where the high cost of commercial feed remains a major constraint. This review aims to integrate scientific findings related to the nutritional quality of local feed sources, community-based livestock empowerment, the role of digitalization, and their combined contribution to livestock-based food security. The study employed a *conceptual systematic literature review* approach by examining 15 research articles published between 2020 and 2025 from national and international databases. The findings reveal that local feed resourcesincluding rice bran, leguminous forages, crop residues, and agro-industrial by products possess competitive nutritional potential when processed through appropriate formulation, fermentation, and preservation techniques. Concurrently, various studies highlight that the effective adoption of local feed innovations is strongly influenced by farmers' capacity and the strength of livestock groups as community institutions, supported through training, mentoring, and collaborative learning.

The analysis further demonstrates that digital technologies such as online extension services, educational media, and feed information systems play a critical role in accelerating knowledge dissemination (*smart empowerment*) and improving decision-making among livestock farmers. The integration of technical, social, and digital dimensions forms a conceptual model illustrating that optimizing local feed resources through smart empowerment can enhance feed quality, livestock productivity, household income, and regional food security in a sustainable manner. This review provides both scientific and practical foundations for designing livestock empowerment policies and for future empirical studies on the implementation of this model in Southeast Sulawesi.

I. INTRODUCTION

Food security in rural areas of Southeast Sulawesi has gained increasing attention due to the rising demand for animal protein and growing pressure on livestock feed resources. Feed represents the largest cost component in livestock production accounting for 60–70% of total expenses—therefore its quality and availability strongly determine livestock productivity and farmers' income. Heavy reliance on expensive commercial feed exposes smallholder farmers to economic vulnerability. At the same time, numerous local feed resources such as rice bran, leguminous leaves, improved forages, and agricultural by-products remain underutilized. These conditions highlight the need for a more strategic and empowerment-based approach to optimizing local feed resources as a foundation for regional food security.

Previous studies consistently demonstrate that livestock feed innovations based on local resources can improve nutritional quality while reducing production costs. However, implementation at the farmer level is often hindered by limited access to knowledge, low levels of technological literacy, and weak institutional capacity among livestock groups. Research conducted in Sulawesi and the broader eastern Indonesia region also indicates that inadequate scientific information on feed processing, storage techniques, and nutrient formulation poses major barriers to improving livestock productivity. Although recent studies reveal the potential of digital media for accelerating knowledge transfer in feed and livestock management, adoption remains low due to insufficient integration of digital tools into community empowerment programs.

This article proposes the concept of *Smart Empowerment*, a community empowerment approach grounded in digital literacy, multisectoral collaboration, and the utilization of information technologies to

support local feed innovation. This approach goes beyond traditional training activities by promoting the use of digital platforms as learning media, channels for disseminating innovation, and mechanisms for strengthening community networks. Through smart empowerment, farmers are expected to overcome informational barriers and adopt feed-processing technologies more rapidly. The concept also positions local feed resources as strategic assets that can be processed, reformulated, and utilized sustainably to meet livestock nutritional requirements.

When applied systematically, smart empowerment is expected to generate multiple positive impacts for farmers and regional food security. Enhanced feed quality directly improves livestock productivity, stabilizes the supply of animal-source foods, and increases household income. Furthermore, optimizing local feed resources reduces dependence on imported or high-cost commercial feed, thereby strengthening community-level economic resilience. At the regional scale, improving farmers' digital capacity and sustaining local feed innovations can support long-term agricultural and livestock development agendas in Southeast Sulawesi, particularly in transitioning toward more resilient and self-reliant food systems.

Given these urgencies, the primary aim of this review is to integrate scientific evidence on local feed resources, community empowerment, digital literacy, and food security into a comprehensive conceptual model. The study seeks to explain how smart empowerment can function as a catalyst in optimizing local feed utilization while enhancing livestock feed nutrition. Additionally, the article maps the pathways linking local feed, livestock nutrition, and food security, thereby providing both theoretical and practical foundations for future research and for formulating empowerment policies and programs for livestock farmers in Southeast Sulawesi.

II. LITERATURE REVIEW

2.1. Community Empowerment And Livestock Farmer Groups

The concept of community empowerment within livestock farmer groups not only emphasizes the ability of local communities to organize themselves, make decisions, and utilize local resources, but also reflects the social dynamics that shape collective action. In this context, Social Capital Theory, introduced by Coleman (1988**)** and further elaborated by Putnam (1993)**,** provides an important explanation of how social networks, trust, and shared norms function as assets that strengthen a group's capacity to access information and adopt innovation. Strong social capital enables livestock farmer groups to function as learning spaces where members exchange knowledge about local feed resources, formulation techniques, and simple technological innovations that improve production efficiency. This is especially relevant in rural settings where social cohesion and solidarity serve as foundational elements for effective empowerment.

In addition to social capital, learning processes within livestock groups can be understood through Social Learning Theory proposed by Bandura (1977)**.** This theory posits that learning occurs not only through direct instruction but also through observation, imitation, and social interaction. In practice, farmers often learn to produce silage, formulate fermented feed, or utilize agricultural waste by observing more experienced peers. When one member successfully adopts a local feed innovation and demonstrates improved livestock performance, others are more likely to replicate the practice. Such mechanisms accelerate innovation diffusion within the community without requiring extensive external intervention.

The integration of these theories becomes even stronger when linked to the concept of *smart empowerment*, which leverages digital literacy, technology-based information access, and digital media as learning tools. Through digital technologies, livestock farmers not only learn from their physical environment but also gain access to *online knowledge networks* that broaden sources of information and innovative practices. Educational videos, digital discussion forums, and online extension platforms enable faster, broader, and more inclusive social learning, aligning with recent literature on digital transformation in agriculture.

Thus, community empowerment within livestock farmer groups is a multidimensional process supported by social capital (Coleman, 1988; Putnam, 1993), social learning mechanisms (Bandura, 1977), and digital technology through smart empowerment. The combination of these three elements explains why farmer groups with strong social networks and sufficient digital literacy tend to adopt local feed innovations more rapidly and improve their livelihood outcomes in a sustainable manner.

2.2. Optimization of Local Feed Resources and Livestock-Based Food Security

The optimization of local feed resources has strong theoretical foundations in the Local Resource-Based Development Theory introduced by Chambers (1983)**,** which argues that sustainable rural development must be rooted in the use of locally available, affordable, and accessible resources. In the livestock sector, feed ingredients such as rice bran, crop residues, leguminous forages, and agricultural by-products represent abundant local resources in many regions, including Southeast Sulawesi. Utilizing these materials as feed not only reduces production costs but also strengthens farmers' independence from expensive commercial feeds. When processed appropriately through fermentation, reformulation, or preservation techniques such as silage the nutritional quality of local feed can be enhanced to effectively meet livestock requirements.

The linkage between local feed optimization and livestock-based food security can also be explained through the Food Security Framework of FAO (1996)**,** which identifies four key pillars: *availability*, *access*, *utilization*, and *stability*. Abundant and accessible local feed increases availability, while reduced feed costs improve farmers' access to essential production inputs. Proper processing improves feed utilization by enhancing nutritional quality, thereby supporting animal health and productivity. Moreover, relying on locally available feed resources enhances the stability of livestock production throughout the year. Therefore, optimizing local feed resources contributes not only to production efficiency but also to broader livestock-based food security at both household and regional levels.

The integration of these theories clarifies that optimizing local feed resources is not merely a technical strategy but a holistic rural development approach oriented toward independence, sustainability, and food system resilience. The alignment between Chambers' (1983) resource-based development principles and the FAO (1996) food security pillars provides a comprehensive framework positioning local feed as a foundational element of a resilient and competitive livestock system.

2.3. Adoption of Innovation and Appropriate Feed Technologies

The adoption of alternative feed innovations among small-scale farmers can be comprehensively explained through Rogers' Diffusion of Innovation Theory (2003)**.** Rogers posits that adoption occurs through stages of knowledge, persuasion, decision, implementation, and confirmation. In the context of alternative feed technologies such as feed fermentation, silage production, or the utilization of agricultural waste the initial stage of knowledge transfer is essential. When an innovation demonstrates clear *relative advantage* (e.g., lower costs, improved livestock performance) and compatibility with local conditions, the likelihood of farmer adoption increases significantly.

Farmer willingness to adopt feed technologies is also shaped by their perceptions of usefulness and ease of use, aligning with the Technology Acceptance Model (TAM) developed by Davis (1989)**.** According to TAM, innovations are more readily accepted when farmers perceive them as beneficial such as reducing feed expenses or enhancing productivity and when these innovations can be applied without excessive technical complexity. Practical training and field demonstrations thus become critical in reinforcing perceived usefulness and ease of use.

In addition to diffusion and acceptance theories, the successful implementation of feed technologies is strongly influenced by participatory approaches such as the Participatory Technology Development (PTD) model proposed by Chambers & Jiggins (1987**)**. PTD emphasizes that appropriate technologies should be developed collaboratively with farmers rather than imposed externally. When farmers are actively involved in experimenting with, evaluating, and refining local feed innovations, they develop a sense of ownership that greatly enhances technology sustainability.

Together, these theories illustrate that the adoption of local feed innovations depends not only on the technology itself but also on supportive social environments, clear perceived benefits, ease of implementation, and collaborative engagement between farmers and agricultural institutions. The combined perspectives of Rogers (1962/2003), Davis (1989), and Chambers & Jiggins (1987) reinforce the conceptual foundation that *knowledge, access, and institution* are critical drivers in improving feed efficiency, reducing dependence on imported feed, and strengthening local food security systems.

2.4. Empirical Evidence: Studies on Local Feed, Alternatives, and Farmer Empowerment

The development of research on local feed optimization and farmer empowerment reveals a progressively integrated pattern over recent years. The study by Rahmawati, Lisnanti, & Muladno (2020**)** provided an important early foundation, demonstrating that local feed materials possess adequate and competitive nutritional value when properly formulated. Through *in vitro* testing, the study confirmed that local feed ingredients can increase livestock carrying capacity, establishing that optimizing local feed is a nutritionally justifiable strategy rather than a temporary solution.

By 2021, scholarly interest expanded from technical aspects to the social dimensions of empowerment. Husain & Abdullah (2021) showed that participatory livestock empowerment significantly enhances farmers' abilities to process and utilize local feed resources. Participatory approaches through training, group discussions, and hands-on practice bridge the gap between scientific knowledge (as evidenced in 2020) and farm-level adoption. These findings emphasize that nutritional quality alone is insufficient unless accompanied by effective knowledge transfer mechanisms. In 2022, research attention shifted toward simple technological innovations and their links to household food security. Sofyan, Sani, & Nurhayati (2022) demonstrated that local feed ingredients can be processed into Urea Molasses Blocks (UMB), improving digestibility and growth in ruminants. Meanwhile, Munir & Kurniasih (2022**)** found that incorporating local feed resources within mixed-farming systems enhances household income and food stability. Together, these studies highlight that local feed innovations benefit not only livestock productivity but also household food security outcomes.

Significant developments emerged in 2023 with the introduction of basic biotechnological techniques and digital extension approaches. Lestari & Nugroho (2023) showed that fermenting cassava peel increases protein content and reduces harmful cyanogenic compounds, offering a safe and economical feed option. Concurrently, Sujatmiko & Prasetyo (2023) demonstrated that digital-based extension through YouTube and social media can accelerate the adoption of local feed innovations by up to 35% within six months. These findings indicate that while earlier empowerment relied largely on conventional approaches, digital empowerment has begun to play a strategic role in scaling innovations.

In 2024, literature increasingly emphasized institutional strengthening and information systems. Kasim & Ardiansyah (2024) confirmed that agricultural waste based feed significantly improves beef cattle growth, reinforcing the substantial potential of local feed resources. Rahadian & Firmansyah (2024) introduced digital livestock information systems that enhance farmers' ability to formulate balanced rations and monitor nutritional requirements. Additionally, Saputra et al. (2024) found that livestock groups and knowledge of alternative feed have significant effects on farmers' welfare. Collectively, these studies demonstrate that the success of local feed innovations requires an enabling ecosystem that includes technical, social, and digital support.

By 2025, empirical evidence points toward full integration of technical, social, and digital components**.** Akhadiarto (2025) reported that community-based feed programs reduce dependence on commercial feed by up to 40% while increasing native chicken production, showing the practical effectiveness of community-driven innovation. In Southeast Sulawesi, Yasa, Zulkarnain, & Kurniawan (2025) found substantial variation in the nutritional quality of rice bran, underscoring the need for standardization and improved feed formulation technologies. This local evidence is crucial for designing region-specific strategies to optimize feed resources.

III. METODE PENELITIAN

This study employed a *conceptual systematic literature review* approach to develop a conceptual model that explains how local feed optimization, when integrated with a smart empowerment framework, influences livestock nutrition and food security. The scope of the review was guided by research questions addressing the potential of local feed resources, the forms of farmer empowerment, the role of digitalization, and their combined impact on food security, particularly in the context of Southeast Sulawesi.

The initial stage of the research involved identifying relevant theoretical foundations, including community empowerment theory, innovation adoption theory, livestock nutrition frameworks, and food security concepts. These theoretical elements served as the analytical basis and were iteratively refined as new insights emerged from the reviewed literature. A systematic search of national and international databases such as Scopus, Google Scholar, and SINTA was conducted using keywords related to local feed resources, empowerment, digitalization, and food security. Article selection was based on relevance, scientific rigor, and full-text availability.

The selected articles were analyzed through data extraction and thematic categorization. The coding process yielded several core themes, including the nutritional potential of local feed materials, community-based livestock empowerment, the role of digital media in extension services, and the interrelationships between local feed utilization and livestock-based food security. The final stage of the study involved synthesizing these findings to construct a comprehensive conceptual model. The synthesis process was carried out both chronologically and thematically, followed by the identification of research gaps that highlight the need for integrating local feed innovations, smart empowerment strategies, and food security frameworks within regional contexts such as Southeast Sulawesi.

IV. RESULTS AND DISCUSSION

The literature review of twelve Scopus-indexed articles and other reputable journals published between 2020 and 2025 produced several important insights related to the utilization of local feed resources, alternative feed innovations, farmer empowerment, and the role of digitalization in strengthening livestock-based food systems. These findings were organized in tabular form to facilitate the identification of overarching patterns, comparisons across studies, and logical relationships among technical nutritional aspects, socio-institutional factors, and digital technologies. Through coding and thematic categorization, each study contributes a unique perspective that collectively enriches the understanding of how local feed resources can be optimized within smallholder livestock systems in tropical regions, including Southeast Sulawesi.

The findings table illustrates not only the diversity of research contexts and methodologies but also a consistent scientific pattern showing that the successful optimization of local feed resources requires a combination of feed quality, farmer capacity and empowerment, and technological support through digital extension and information systems. This synthesis reveals converging empirical evidence across countries and years, indicating a unified understanding of the relationship between local feed resources, smart empowerment,

and food security. Accordingly, the table serves as an analytical foundation for developing deeper thematic discussions in the following sections.

Table 1. Summary of Journals, Key Findings, and Coding

No	Authors & Year	Empirical Findings / Main Content:	Coding	Major Theme
1	Kilama et al., 2023.	Several agro-industrial by-products (fruits, vegetables, and food-processing residues) exhibit good nutritional quality, competitive *in vitro* digestibility, and relatively stable storability after processing. These materials have strong potential to serve as alternative ruminant feed ingredients and can reduce dependence on conventional commercial feeds.	by-product nutrition; high digestibility; storability; alternative feed	Agro-Industrial By-Product–Based Alternative Feed & Optimization of Local Resources
2	Balehegn, 2020.	The study explains that the adoption of feed technologies including alternative feed innovations in developing countries is strongly influenced by knowledge access, local relevance, and institutional support. Feed practices directly affect livestock productivity, farm profitability, and household food security.	technology adoption; social factors; productivity & food security	Adoption of Feed Innovations & Farmer Well-being
3	Mukasafari et al., 2025	The study analyzes the nutritional quality of 20 feed types used by smallholder dairy farmers and finds that roadside forages, cultivated grasses, and crop residues dominate the feed resources, with considerable variation in protein and fiber content. The findings highlight the need for improved feed management practices and better access to nutritional information among smallholder farmers.	feed resources; smallholder dairy; nutritional quality	Feed Profile & Nutritional Quality in Smallholder Dairy Systems
4	Getahun et al., 2025	The study identifies and evaluates local alternative feed sources for poultry such as enset, avocado seeds, and fruit waste used by smallholder farmers. Several of these materials demonstrate good nutritional potential, although certain antinutritional factors must be processed or mitigated before use.	alternative poultry feed; antinutritional factors; smallholder	Alternative Poultry Feed & Sustainability
5	Suryanti et al., 2025	The study examines the adoption of silage technology among dairy farmers and shows that, despite the abundance of local forage resources, utilization remains low due to limited knowledge and inadequate processing facilities. Silage adoption is significantly associated with increased milk productivity, highlighting the crucial role of extension agents and the strengthening of farmer institutions.	silage; innovation adoption; extension role Local Feed Optimization & Institutional Strengthening	Local Feed Optimization & Institutional Strengthening
6	Syaiful et al., 2025	The study reports on a farmer empowerment program through training in the production	UMB training; empowerment;	Farmer Empowerment

		of Urea Molasses Blocks (UMB) using locally available ingredients. The program resulted in improved farmer knowledge, skills, and autonomy in utilizing nutritious, low-cost local feed, as well as a reduced dependence on commercial feed.	local feed	& Local Feed Utilization
7	Chisoro et al., 2023.	The review examines novel local feed resources including by-products and agro-industrial waste in African livestock systems. The findings indicate that integrating local feed ingredients can reduce production costs, improve livestock performance, and support the circular economy and food security. However, further research is needed to address safety concerns and determine appropriate inclusion levels.	novel local feed; circular economy; food security	Alternative Feed & Circular Economy
8	Vastolo et al., 2024	The study emphasizes that alternative and novel feed sources—such as insects, algae, microbes, and agricultural by-products—can reduce environmental impacts, decrease reliance on conventional feed ingredients, and support sustainable livestock systems with a lower carbon footprint.	alternative feed; low carbon footprint; sustainability; feed innovation	Alternative Feed Strategies & Sustainable Innovations for Environmentally Friendly Livestock Systems
9	Vlaicu et al., 2024	The study reviews sustainable poultry feeding strategies such as recycling by-products, food waste, and local plant materials to support SDG2 (Zero Hunger). The findings show that integrating fruit and vegetable waste, as well as grain by-products, can maintain production performance while simultaneously reducing food waste.	sustainable poultry feeding; SDG2; by-products	Poultry Feed Strategies & Global Food Security
10	Choruma et al., 2024	This scoping review analyzes the digitalisation of agriculture in Sub-Saharan Africa, highlighting the use of various digital technologies including mobile applications, SMS-based advisory systems, and online platforms to support extension services in areas such as feed management and livestock production. The review underscores that digital literacy, device accessibility, and an enabling policy environment are essential conditions for the effective implementation of digital extension systems	digitalisation; smallholder; digital extension	Smart/Digital Empowerment of Farmers and Livestock Producers
11	Katiyatiya et al., 2025	The study reviews silvopastoral systems that integrate trees with grazing lands, demonstrating that such systems provide alternative feed sources during dry seasons, improve livestock welfare, and offer valuable ecosystem services, including carbon sequestration and soil conservation**:**	silvopastoral; alternative feed; ecosystem	Land-Use Systems & Resilient Feed Resources
12	Anim-Jnr et al., 2025	The study describes the valorisation of mango, cashew apple, and papaya waste as ruminant feed, highlighting their nutritional value, the presence of antinutritional factors,	fruit by-products; ruminant feed; valorisation	Valorisation of Agro-Waste & Sustainable Local Feed

		and their potential contribution to sustainable food systems. The findings emphasize the importance of appropriate processing technologies and quality standards to ensure safe and effective utilization.		Resources

I. Theme 1. Potential and Nutritional Quality of Local Feed Resources

Findings from multiple studies demonstrate the substantial potential of local feed resources to serve as competitive nutritional sources compared to commercial feeds. The early work of Rahmawati et al. (2020) established that local feed ingredients such as rice bran, straw, agro-industrial by-products, and local forages retain adequate digestibility and nutritional value, and can even increase livestock carrying capacity when properly formulated. This aligns with the findings of Mukasafari et al. (2025), who reported variation in forage and crop residue quality among smallholder dairy farmers, yet confirmed that many locally available materials, when managed and formulated effectively, can meet the protein and energy requirements of ruminants. These observations are consistent with trends in tropical countries rich in forage and agro-industrial by-products.

In eastern Indonesia, the study by Yasa, Zulkarnain & Kurniawan (2025) provides important local evidence. Their analysis of rice bran quality in Bombana shows significant variability in crude protein and fiber content, underscoring the need for quality standardization and feed formulation training for farmers in Southeast Sulawesi. This variability also highlights the importance of feed nutrition laboratories to support ration planning. Collectively, the evidence across contexts and years reinforces that local feed resources are not merely low-cost alternatives but represent foundational assets for building autonomous livestock systems.

II. Theme 2. Alternative Feeds, Circular Economy, and Optimization of Local Resources

Since 2020, research on alternative feeds has expanded rapidly in response to the global push toward circular economy principles and waste reduction. Getahun et al. (2025) demonstrate that local feed ingredients such as enset, avocado seeds, and fruit waste can serve as nutrient-rich poultry feeds when appropriately processed to reduce antinutritional factors. This aligns with Anim-Jnr et al. (2025), who highlighted the valorization potential of fruit waste such as mango, cashew apple, and papaya as valuable ruminant feed ingredients, strengthening the integration of livestock systems with fruit-based agro-industries.

Global literature also emphasizes the increasing use of food waste and agricultural by-products as sustainable feed materials. Vlaicu et al. (2024) showed that incorporating fruit, vegetable, and grain by-products into poultry rations can maintain production performance while reducing food waste. Furthermore, Martin (2024) stressed the growing importance of environmentally friendly alternative feeds such as insects, algae, and agricultural residues. These alternatives not only reduce costs but also generate lower carbon footprints, contributing to SDG targets.

Taken together, the evidence demonstrates that waste valorization represents a strategic pathway toward affordable, sustainable, and locally grounded feed security an approach particularly relevant for Southeast Sulawesi, where feed resources are abundant but underutilized.

III. Theme 3. Farmer Empowerment, Training, and Community Institutions

The effective use of local feed resources is determined not only by feed quality but also by farmers' capacity to process and utilize these materials. Syaiful et al. (2025) provide clear evidence that Training On Urea Molasses Block (UMB) production enhances the skills and autonomy of smallholder ruminant farmers in preparing nutritious and low-cost feed. this training is effective because it employs hands-on methods and uses readily available materials.

Beyond Individual Skill Development, the role of farmer institutions is crucial for sustaining innovation. Saputra Et Al. (2024) Found That Livestock Groups Act As Social Learning Hubs Where Farmers Exchange Experiences, Adopt Innovations Collectively, And Improve Decision-Making. These Groups significantly increase the adoption rates of alternative feeds and positively influence income and welfare outcomes. These findings underscore that farmer empowerment involves more than technical knowledge it requires strengthening social networks and community structures. The *Smart Empowerment* Model proposed in this study seeks to integrate capacity building, community collaboration, and digital technology to accelerate the adoption of local feed innovations.

IV. Theme 4. The Role of Digitalization and Smart Empowerment in Feed Optimization

Digital transformation in agriculture and livestock systems has begun to significantly improve access to information and innovation. Sujatmiko & Prasetyo (2023**)** showed that educational videos on YouTube and social media increased adoption of local feed innovations by 35% within six months. Similarly, Choruma et al. (2024), in a scoping review of digitalisation in Sub-Saharan African agriculture, emphasized that digital

applications, online platforms, and SMS-based advisory services play a vital role in supporting smallholder farmers.

Furthermore, Rahadian & Firmansyah (2024) demonstrated that digital livestock information systems help farmers monitor nutritional needs, formulate balanced rations, and map the availability of local feed resources more accurately. These findings show that digital technologies are not merely communication tools but also serve as decision-support systems at the farm level. In the context of *smart empowerment*, digitalization acts as a catalyst—accelerating knowledge transfer, expanding access to information, and strengthening farmer institutions. Integrating digital tools into local feed development strategies is particularly strategic for regions like Southeast Sulawesi, where geographic challenges exist but feed resources are abundant.

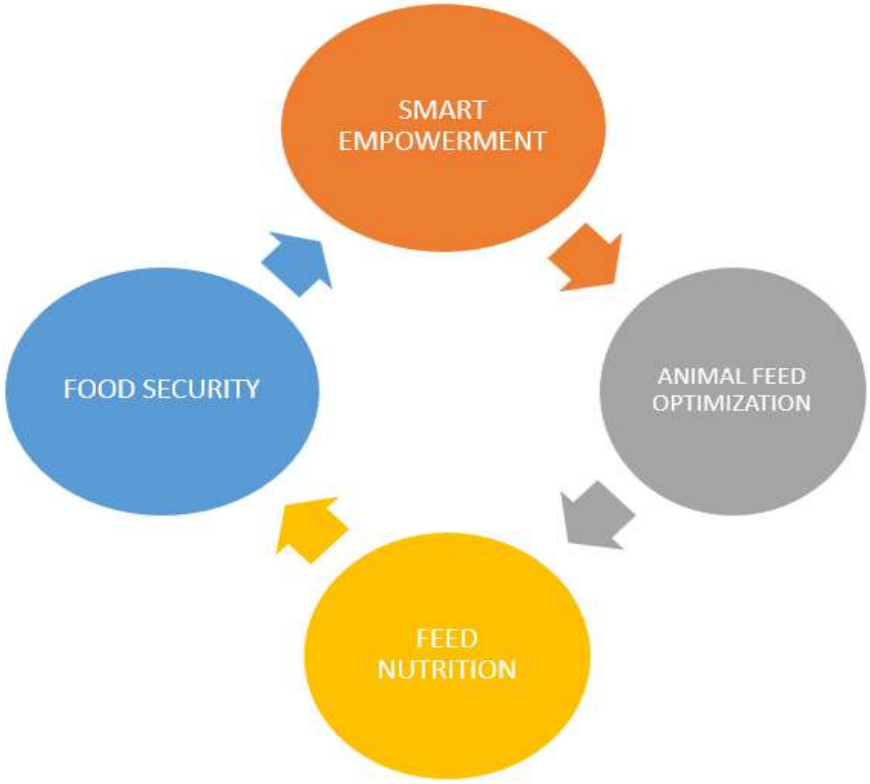

Figure 1. Conceptual Model of Livestock Feed Optimization and Feed Nutrition Enhancement through the Smart Empowerment Approach

V. CONCLUSION

1. The literature demonstrates that local feed resources hold significant potential to reduce farmers' dependence on expensive commercial feed. The nutritional quality of local feed can be enhanced through simple processing techniques such as fermentation, reformulation, and the utilization of agricultural residues. However, the effective use of local feed resources cannot be achieved without farmer empowerment through training, mentoring, and the strengthening of livestock farmer groups. Social and community capacity thus becomes a critical leverage factor in the successful adoption of alternative feed innovations.
2. Beyond technical and social aspects, the literature further highlights the pivotal role of digitalization in accelerating knowledge transfer and improving feed management efficiency. The smart empowerment approach which integrates digital literacy, multisectoral partnerships, and technology based information access has been shown to support behavioral change among farmers and enhance livestock productivity. The integration of these three dimensions technical, social, and digital forms a conceptual model capable of strengthening food security at both household and regional levels, particularly in Southeast Sulawesi, where abundant local feed resources coexist with limited integrated innovation systems.

RECOMMENDATIONS

1. Strengthening farmer capacity through training on local feed formulation, fermentation techniques, and the utilization of agricultural residues should become a priority program for local governments and extension agencies.
2. Developing accessible digital platforms such as ration formulation applications, educational videos, and feed information systems is essential to enhance innovation adoption and improve farmers' digital literacy.
3. Standardization of local feed quality, particularly rice bran and forages, needs to be established with support from regional feed nutrition laboratories.
4. Livestock farmer groups should be strengthened as learning hubs, centers for alternative feed production, and key partners for government agencies in disseminating appropriate technologies.
5. Further research is required to empirically test the proposed conceptual model through surveys or field studies in Southeast Sulawesi, enabling quantitative and qualitative verification of the identified influence pathways.
6. Cross-sectoral integration among government institutions, universities, the private sector, and local communities is needed to develop a sustainable smart empowerment ecosystem for local feed management.

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