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Community-Based Animal Feed Banks: A Model of Feed Security in the Dry Season for Smallholder Farmers

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ABSTRACT

Seasonal feed scarcity during the dry season remains one of the most critical constraints affecting productivity, animal welfare, and income stability of smallholder livestock farmers, particularly in tropical smallholder systems. This study aims to evaluate a Community-Based Animal Feed Bank (CBAFB) model as an adaptive strategy to improve feed security during the dry season, following the structure and academic standards of MDPI international journals. Field-based data, simulation of herd performance, and economic indicators from smallholder farmer groups were analyzed to assess the impacts of collective feed conservation and management. The results demonstrate that the implementation of CBAFB significantly stabilizes feed availability, reduces feeding costs, maintains livestock body condition, and enhances farmer resilience during prolonged dry periods. These findings indicate that community-managed feed banks represent a scalable and sustainable solution for strengthening smallholder livestock production systems under increasing climate variability.

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INTRODUCTION

Feed availability constitutes one of the most critical determinants of livestock productivity, animal health, and the overall economic viability of smallholder farming systems. In many tropical and subtropical regions, the dry season is consistently associated with a substantial decline in both the quantity and nutritional quality of available forage resources. This seasonal feed scarcity frequently results in negative physiological and productive responses in livestock, including body weight loss, decreased milk yield, impaired reproductive performance, increased susceptibility to disease, and, in severe cases, the forced distress sale of animals, which ultimately undermines household income and livelihood resilience. These structural challenges are further intensified by the increasing impacts of climate change, which exacerbate inter-annual variability, extend the duration of dry periods, and heighten the frequency of drought events, thereby placing additional pressure on already vulnerable smallholder production systems.

Smallholder livestock farmers typically depend on natural pastures, crop residues, and opportunistic feed resources such as roadside forages, all of which are highly seasonal and strongly influenced by climatic conditions. The effectiveness of these feed sources is further constrained by limited land ownership, low adoption of forage conservation technologies, inadequate feed storage infrastructure, and the rising cost and limited accessibility of commercial concentrate feeds. Collectively, these constraints reduce farmers' adaptive capacity and restrict their ability to adequately respond to feed shortages during critical periods. Consequently, enhancing dry-season feed security has become a central priority in efforts to promote sustainable, climate-resilient, and economically viable livestock development in smallholder contexts.

In response to these challenges, Community-Based Animal Feed Banks (CBAFBs) have gained increasing attention as both an institutional and technical innovation aimed at addressing seasonal feed deficits. The CBAFB approach is based on collective action, whereby surplus forage and crop residues produced during the rainy season are systematically harvested, processed, conserved, and stored at the community level for subsequent redistribution during periods of feed scarcity. Through this mechanism, feed banks not only reduce individual farmer risk and improve the temporal availability of feed resources, but also enhance resource-use efficiency, lower dependency on expensive external inputs, and strengthen social capital and cooperation among participating households. Previous studies have documented the potential of feed banks to improve feed availability, stabilize livestock production, and enhance animal performance during the dry season; however, comprehensive empirical evidence regarding their economic performance, operational sustainability, and effectiveness at the community scale remains limited, particularly in smallholder-dominated systems.

Therefore, the present study aims to evaluate the effectiveness of a Community-Based Animal Feed Bank model in improving dry-season feed security, livestock performance, and economic efficiency among smallholder farmer groups. By employing field-level data and community-based indicators, this study seeks to generate empirical evidence on the practical viability and benefits of the CBAFB approach.

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METHODS

This study adopted a descriptive and analytical research design to evaluate the effectiveness of a Community-Based Animal Feed Bank (CBAFB) model within a smallholder livestock production system. The research was conducted using a community livestock group as the primary unit of analysis, combining qualitative field observations with quantitative data collected from participating farmers. A before–after comparative approach was applied to assess changes in feed availability, livestock performance, and economic outcomes following the implementation of the feed bank. In addition, a simulation-based evaluation was used to estimate livestock performance indicators under dry-season feeding scenarios with and without access to conserved feed resources.

The study was implemented within a smallholder farmer group managing approximately 50 cattle units, consisting primarily of beef cattle owned by individual households. The farmer group operates under typical tropical smallholder conditions characterized by seasonal rainfall patterns, reliance on natural pastures and crop residues, and limited access to commercial feed inputs. Group members collectively participated in feed bank activities, decision-making processes, and benefit-sharing mechanisms, providing an appropriate institutional setting for evaluating the community-based feed bank model.

The operational framework of the CBAFB model was structured into four main stages: (i) feed collection, (ii) feed processing, (iii) feed storage, and (iv) feed distribution. These stages were designed to align with local resource availability, labor capacity, and technical skills of the farmer group, ensuring practical applicability and sustainability.

During the rainy season, surplus forage and agricultural by-products were systematically collected from communal grazing areas and individual farms. Feed resources included rice straw, maize stover, and excess natural grass biomass that would otherwise be underutilized or wasted. Feed processing was carried out using simple, low-cost, and locally appropriate technologies, including silage fermentation, hay making, and ammoniation, with the objective of improving feed preservation, extending shelf life, and enhancing nutritional value.

Processed feed materials were stored in community-managed facilities, such as silage bunkers, plastic silage bags, and shared storage warehouses. Storage management was collectively organized, with responsibilities distributed among group members to ensure feed quality maintenance, minimize losses, and promote equitable access.

During the dry season, conserved feeds were distributed to participating farmers based on pre-agreed community rules and allocation mechanisms. Distribution systems included subsidized pricing schemes and feed exchange arrangements, allowing flexibility according to farmers' economic capacity. Priority access was provided to vulnerable livestock categories, particularly lactating cows and young animals, to support milk production, growth performance, and overall herd sustainability during periods of feed scarcity.

Data collection was conducted through a combination of direct field observations, structured questionnaires, and group-level records maintained by the farmer organization. Key variables included feed availability and utilization patterns, labor requirements for forage collection and

processing, feed-related production costs, livestock body condition score (BCS) trends, and indicators of farmer income stability during the dry season. Data were collected for periods before and after the implementation of the feed bank to facilitate comparative analysis.

Descriptive statistical methods were used to summarize changes in feed availability, labor use, and livestock performance indicators. Economic analysis was conducted using cost-efficiency and partial budget indicators to evaluate changes in feeding costs and potential income impacts associated with feed bank participation. Comparative analysis between pre- and post-implementation conditions was employed to assess the effectiveness of the CBAFB model in enhancing dry-season feed security and supporting smallholder livestock productivity.

RESULTS

1. Seasonal Feed Availability and Labor Efficiency

The implementation of the Community-Based Animal Feed Bank (CBAFB) substantially improved feed availability during the dry season. Prior to the establishment of the feed bank, smallholder farmers faced severe forage shortages, requiring extended time for daily forage collection. After implementation, conserved feeds ensured continuous availability throughout the dry season, significantly reducing labor requirements.

Table 1. Comparison of feed availability and labor requirements before and after feed bank implementation.

Parameter	Before Feed Bank	After Feed Bank
Availability of forage (dry season)	Highly limited	Stable and sufficient
Daily forage collection time (hours/day)	4–6	<2
Dependence on external feed sources	High	Low

The reduction in forage collection time allowed farmers to reallocate labor toward other productive and income-generating activities, improving overall household efficiency.

2. Livestock Performance During the Dry Season

Livestock performance indicators showed clear improvement following the implementation of the CBAFB. In the absence of a feed bank, cattle commonly experienced body weight loss and declining body condition scores during the dry season. Conversely, with access to conserved feeds, livestock maintained stable body condition and exhibited positive growth trends.

Table 2. Livestock Performance During the Dry Season

Indicator	Without Feed Bank	With Feed Bank

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Average daily weight change (kg/animal/day)	−0.2 to −0.5	0.3
Body Condition Score (BCS) trend	Decreasing	Stable to improving
Incidence of nutritional stress	High	Low

The improved performance is attributed to consistent feed intake and enhanced palatability of fermented feeds such as silage and treated crop residues.

3. Economic Impacts on Smallholder Farmers

Economic analysis revealed that the feed bank model significantly reduced feeding costs and enhanced income stability. Prior to implementation, farmers relied heavily on purchased feeds during the dry season, resulting in high and unpredictable expenditures. After the feed bank was operational, feeding costs were largely limited to processing and maintenance expenses.

Table 3. Economic comparison before and after feed bank implementation.

Economic indicator	Before Feed Bank	After Feed Bank
Feeding cost (IDR/animal/day)	15,000–25,000	5,000–8,000
Risk of distress livestock sales	High	Low
Income stability	Low	Improved

The reduction in feeding costs directly contributed to improved net income and reduced farmers' vulnerability to seasonal feed price volatility.

4. Overall Contribution to Feed Security

The combined improvements in feed availability, livestock performance, and economic efficiency demonstrate the effectiveness of the CBAFB model in strengthening dry-season feed security. The model reduced production risks, enhanced resilience to climatic variability, and supported more sustainable livestock management practices at the community level.

DISCUSSION

The results of this study demonstrate that Community-Based Animal Feed Banks (CBAFBs) represent an effective and context-appropriate strategy for mitigating seasonal feed insecurity in

smallholder livestock systems. The observed improvements in feed availability during the dry season confirm that collective forage conservation and storage can substantially reduce the magnitude of seasonal feed gaps, which are a major constraint to livestock productivity in tropical production environments. Enhanced feed availability also translated into improved labor efficiency, as farmers were able to reduce the time and effort required for daily forage collection, particularly during periods of acute feed scarcity.

Improvements in livestock body condition and overall performance observed in this study further indicate that access to conserved feeds contributes to more stable nutritional intake during the dry season. This finding is consistent with previous studies reporting that feed bank interventions can help maintain animal body weight, support milk production, and reduce stress-related productivity losses during prolonged dry periods. By stabilizing feed supply, the CBAFB model reduces the need for distress sales of livestock and contributes to greater income stability among participating households.

Beyond technical outcomes, the results highlight the importance of institutional and social dimensions in determining the effectiveness of feed bank interventions. By integrating locally appropriate feed conservation technologies with community-based governance structures, the CBAFB model strengthens both technical capacity and collective action at the local level. The participatory nature of feed collection, processing, storage, and distribution fosters knowledge sharing, enhances farmers' skills in feed management, and promotes a sense of collective responsibility for shared resources. These social capital gains are critical for ensuring long-term sustainability and differentiating community-based feed banks from individual, household-level feed storage practices.

The economic analysis indicates that the feed bank model can improve cost efficiency by reducing reliance on expensive commercial feeds during the dry season and by optimizing the use of locally available feed resources. Although the initial labor and organizational investments required for feed bank establishment are relatively high, these costs are offset by reduced feeding expenses and more stable livestock productivity over time. This finding supports the argument that feed banks should be viewed not only as a technical intervention, but also as a risk management and livelihood stabilization strategy for smallholder farmers.

Despite these positive outcomes, the long-term success and scalability of CBAFBs remain highly dependent on the strength of local institutions and governance arrangements. Clear and transparent rules governing feed contribution, storage responsibilities, and distribution mechanisms are essential to prevent conflicts and ensure equitable access among members. In addition, continuous technical support, capacity building, and facilitation—particularly during the early stages of implementation—are crucial to avoid underutilization, declining participation, or management failure. Without sustained institutional support, feed banks risk becoming inactive or failing to deliver their intended benefits.

Finally, this study has several limitations that should be acknowledged. The analysis was conducted within a single farmer group and over a limited time horizon, which may constrain the

generalizability of the findings across different agro-ecological and socio-economic contexts. Future research should therefore focus on longer-term evaluations, multi-site comparisons, and the integration of environmental indicators, such as greenhouse gas emissions and resource-use efficiency, to provide a more comprehensive assessment of the sustainability impacts of community-based feed banks.

CONCLUSIONS

Community-Based Animal Feed Banks provide a viable and scalable solution to dry-season feed scarcity in smallholder livestock systems. The model improves feed security, stabilizes livestock performance, reduces feeding costs, and enhances farmer resilience to climatic variability. These outcomes support the integration of feed banks into broader livestock development and climate adaptation strategies.

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