International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Assessment on Production, Feeding, and Marketing Practices of Philippine Carabao (Bubalus bubalis carabanensis) Raisers in Lanao del Sur, Philippines

Fayruzza G. Disomimba[1], Hasmina B. Sultan[2], Jesse Jay O. Villanueva[3]

Author Information:
[1-3]*Mindanao State University – Main Campus, Marawi City, Philippines*

Correspondence:
disomimba.fayruzza@s.msumain.edu.ph

Article History:

Date Received: November 5, 2026
Date Revised: November 11, 2026
Date Accepted: November 18, 2026
Date Published: November 23, 2026

DOI: https://doi.org/10.67903/ijroms0670

Document ID: *2026IJROMS0670*

Recommended Citation:
Disomimba, F. G., Sultan, H. B. & Villanueva, J. J. O. (2026). Assessment on Production, Feeding, and Marketing Practices of Philippine Carabao (Bubalus bubalis carabanensis) Raisers in Lanao del Sur, Philippines. International Journal of Research on Multidisciplinary Studies, 1(10), 735-747. https://doi.org/10.67903/ijroms0670

Abstract. Smallholder carabao (*Bubalus bubalis carabanensis*) farmers in Lanao del Sur, Philippines, face persistent productivity and marketing constraints despite the animal's socioeconomic and cultural value. Employing a descriptive-correlational design, this study assessed the socio-demographic profile, technical knowledge, and management practices of selected carabao raisers, analyzing survey data through descriptive statistics and Spearman's rank correlation (r_s). The workforce was predominantly male (88%) and single (76%), with 52% having attained basic education. Most respondents had one year of raising experience (62%), owned at least one carabao (64%) primarily for draft purposes (92%), relied on farming for income (64%), and used personal savings as capital (68%). Although raisers showed moderate knowledge across production (WM = 2.99, Agree), feeding (WM = 2.64, Agree), and marketing (WM = 2.67, Agree), management remained traditional: 100% practiced exclusive natural mating and daily pasture grazing, while 92% used advance buyer reservations to mitigate market volatility. All respondents (100%) also reported major bottlenecks in financing, feeding knowledge, veterinary access, quality forage, and grazing land. Municipality significantly influenced knowledge across all domains (p less than .05) as well as production ($p = 0.001$) and marketing practices ($p = 0.007$), whereas knowledge showed no significant correlation with adoption in production ($r_s = -0.164$, $p = 0.256$) or feeding ($r_s = -0.270$, $p = 0.058$). Overall, the study concludes that while smallholder carabao production in Lanao del Sur is substantially shaped by raiser demographics and knowledge, a persistent knowledge–practice gap—driven by systemic extension deficits and weak market infrastructure—hinders full profitability, underscoring the need for targeted local government support, practical training, and structured market linkages.

Keywords: Feeding Management; Livestock Marketing; Philippine Carabao; Production Practices; Smallholder Raisers

Introduction

Carabaos (*Bubalus bubalis carabanensis*) remain central to rural agriculture in the Philippines, supplying farming households with draft power, milk, meat, and organic fertilizer. In Lanao del Sur, raising carabaos is closely woven into daily crop production, rural livelihoods, and local cultural life (Food and Agriculture Organization [FAO], 2020; Ortega et al., 2021). Even with this long-standing importance, most smallholder raisers still struggle to achieve consistent yields and fair profits. Traditional husbandry practices, limited access to quality feeds, seasonal pasture shortages, weak breeding systems, and scarce extension support continue to hold back farm output (Philippine Carabao Center [PCC], 2020).

Environmental pressures and day-to-day farm realities make these challenges harder to overcome. During dry months and post-harvest periods, fresh forage becomes scarce, leaving many farmers with little choice but to feed untreated rice straw—a bulky, nutrient-poor byproduct that animals digest poorly (Aquino et al., 2020; Abo-Donia et al., 2022). High tropical heat combined with low-quality roughage also suppresses feed intake and slows animal performance (Galloso-Hernández et al., 2021). Proven technologies like forage ensiling, legume supplementation, and artificial insemination are available, yet uptake on smallholder farms remains low due to high input costs, limited land, gaps in practical know-how, and slow technology transfer across Mindanao (Galang & Vaughter, 2020; PCC, 2024; Reproto et al., 2024). Selling animals and farm products brings separate hurdles: inadequate market facilities, dependence on local traders, and weak

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

bargaining power keep smallholders from accessing more profitable value chains (Ballesteros & Ancheta, 2021; Nwafor, 2021).

While national studies have examined livestock production and barriers to technology adoption, far less is known about how these dynamics play out on the ground in the Bangsamoro region, especially in Lanao del Sur. Broad national findings rarely reflect the specific cultural norms, resource limits, and local market realities that shape how Maranao and neighboring smallholder farmers feed, breed, and sell their animals. To help fill this gap, this study primarily evaluates the production, feeding, and marketing practices of Philippine carabao raisers in selected municipalities of Lanao del Sur, generating empirical evidence to guide sustainable livestock development in the province.

On a practical level, these results give local government units (LGUs), the Department of Agriculture (DA), and agricultural extension officers a clearer baseline for designing relevant farmer training, veterinary outreach, and local support programs. For researchers and students in animal science, agriculture, and rural development, the study also adds a localized reference on smallholder carabao systems in Lanao del Sur.

Research Questions

This study aims to answer the following general research question:

1. What is the socio-demographic profile of Philippine carabao raisers in Lanao del Sur in terms of age, sex, educational attainment, farming experience, household size, farm size, and land ownership status?
2. What is the level of knowledge of Philippine carabao raisers regarding production, feeding, and marketing practices?
3. What are the actual management practices implemented by Philippine carabao raisers in terms of production, feeding, and marketing?
4. Is there a significant relationship between the socio-demographic profile of carabao raisers, their level of knowledge, and their actual management practices in production, feeding, and marketing?
5. What practical guidelines and extension strategies can be developed to enhance the production performance of Philippine carabao raisers in Lanao del Sur?

Scope and Delimitation of the Study

This study assessed the socio-demographic profile, level of knowledge, and actual production, feeding, and marketing practices of Philippine carabao (Bubalus bubalis carabanensis) raisers in selected municipalities of Lanao del Sur. Data were gathered through structured survey questionnaires and interviews administered to selected carabao raisers within the target areas. The scope was strictly limited to these designated municipalities and did not cover the entire province of Lanao del Sur. Consequently, all findings rely solely on the self-reported responses and perceptions of the participants during the data collection period. Factors and regions beyond these parameters remain outside the scope of this investigation.

Literature Review

Water buffaloes (*Bubalus bubalis*), broadly divided into dairy-oriented river types and draft- and meat-oriented swamp types, underpin smallholder agriculture across tropical Asia, with the native Philippine carabao (*Bubalus bubalis carabanensis*) remaining vital to rural farm power, meat, milk, and household income (Pineda et al., 2021; Tsuji, 2021). Genetically diverse and well suited to harsh tropical climates, swamp buffaloes possess specialized rumen microbiota that allow them to digest coarse, fibrous crop residues more efficiently than cattle (Ban-Tokuda et al., 2021; Zhang et al., 2020), though actual weight gain and farm profitability still depend heavily on balanced feeding, sound breeding management, and regular veterinary care (Azmi et al., 2021; Nascimento et al., 2021). In the Philippines, however, smallholder feeding systems rely largely on seasonal native pastures and untreated rice straw, and the adoption of improved forage practices, silage making, or modern reproductive technologies remains constrained by input costs, land scarcity, and behavioral hesitancy (Aquino et al., 2021; Duza et al., 2021; Reproto et al., 2024). Commercial returns are similarly restricted because weak cooperative membership, poor market infrastructure, and limited access to credit force smallholders to self-finance operations and sell through local intermediaries at low margins (Belay et al., 2021; Mina & Cuevas, 2022). Recent empirical studies across developing regions further show that farmer awareness does not automatically translate into on-farm practice, revealing persistent knowledge–practice gaps driven by financial strain, climate vulnerability, and uneven extension reach (Olagunju et al., 2021; Sharma et al., 2025; Wairimu et al., 2022; Yumkella et al., 2020). Despite this growing body of work, most Philippine carabao literature focuses on major dairy corridors in Luzon and Visayas, leaving scant empirical evidence on how socio-demographic traits, local resource bottlenecks, and spatial differences shape production, feeding, and marketing behaviors in the Bangsamoro Autonomous Region in Muslim Mindanao. The present study directly addresses this gap by evaluating raiser knowledge, actual farm practices, and

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

structural constraints across selected municipalities of Lanao del Sur, providing an empirical baseline for locally tailored extension and livestock development programs.

Methodology

Research Design

The study used a descriptive-correlational quantitative research design. The descriptive design allows the researcher to acquire factual data about prevailing circumstances, attitudes, and practices about carabao management, breeding, feeding, and health care. The use of descriptive design in this study is appropriate since it involves the description of the prevailing conditions without manipulating any variable, which guarantees that the findings are indeed true to the prevailing condition of the respondent's practice (Creswell & Creswell, 2023).

Research Locale

This study was conducted across selected municipalities—specifically Balindong, Maguing, Marantao, Mulondo, and Ramain—in the province of Lanao del Sur, Philippines, between March and May 2026 using a purposive sampling technique. The province encompasses a total land area of 13,375.24 square kilometers, which includes 387.32 square kilometers of inland water bodies comprising lakes and marshlands. Politically, Lanao del Sur is partitioned into two congressional districts comprising 39 municipalities, Marawi City, and a total of 1,159 barangays (Provincial Government of Lanao del Sur, 2020).

Research Participants

The study respondents comprised 50 Philippine carabao raisers from selected municipalities in Lanao del Sur, selected through purposive sampling to ensure the inclusion of active raisers with direct experience in carabao husbandry (Etikan et al., 2016). Official rosters of carabao raisers were obtained from key local agencies, including the Municipal Agriculture Office, respective barangay offices, the Ministry of Agriculture, Fisheries, and Agrarian Reform (MAFAR), and the Provincial Veterinary Office. These respondents supplied primary data regarding their socio-demographic profiles, knowledge levels, and actual operational practices in carabao production, feeding, and marketing.

Research Instruments

Data were gathered using a dual-instrument approach consisting of a 4-point Likert scale and dichotomous survey questions. The 4-point Likert scale (4 – Strongly Agree, 3 – Agree, 2 – Disagree, 1 – Strongly Disagree) measured the respondents' level of agreement regarding technical knowledge, management practices, and operational challenges in carabao production (Huh & Gim, 2025). Additionally, dichotomous (Yes/No) questions were utilized to capture definitive responses regarding actual management practices and specific behaviors implemented in daily animal care, housing, feeding, and marketing operations.

Data Gathering Procedure

Primary data were gathered through personal interviews using structured survey questionnaires, which were either self-administered or enumerator-assisted and translated into the local dialect to ensure accurate comprehension. The instrument collected data on the respondents' socio-demographic profiles (age, educational attainment, and years of carabao raising experience) as well as their technical knowledge and implementation of management practices across feeding, reproduction, health care, sanitation, breeding, and housing. Prior to administration, respondents were briefed on the study's purpose and the questionnaire's contents. Following collection, the raw data were consolidated, tabulated, and categorized according to target parameters to evaluate the relationships among socio-demographic characteristics, knowledge levels, and actual operational practices.

Results and Discussions

Research Question 1: What is the socio-demographic profile of Philippine carabao raisers in Lanao del Sur in terms of age, sex, educational attainment, farming experience, household size, farm size, and land ownership status?

Socio-Demographic Profile of Respondents

Table 1 outlines the socio-demographic profile of carabao raisers in Lanao del Sur, revealing a workforce predominantly composed of males (88.0%) compared to females (12.0%), single individuals (76.0%)

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

relative to widowed respondents (2.0%), and raisers with basic education (52.0%), whereas only 2.0% had no formal education. Furthermore, a majority of respondents (56.0%) belonged to the 20–29 and 40–49 age brackets, while only 6.0% fell within the 15–19 and 60–65 age groups. This age distribution represents an economically active cohort possessing the physical capacity required for labor-intensive livestock management—a demographic trend consistent with the findings of Cheelo and van der Merwe (2021) and Pabuayon et al. (2021).

Table 1. Frequency and percentage distribution of socio-demographic profile of the respondents

	Variable	Frequency (n=50)	Percentage
1.	Age:		
	15-19	3	6.0
	20-29	14	28.0
	30-39	6	12.0
	40-49	14	28.0
	50-59	10	20.0
	60-65	3	6.0
2.	Municipality:		
	Balindong	10	20.0
	Mulondo	15	30.0
	Maguing	10	20.0
	Ditsaan-Ramain	10	20.0
	Marantao	5	10.0
3.	Gender:		
	Female	6	12.0
	Male	44	88.0
4.	Civil Status:		
	Single	38	76.0
	Married	11	22.0
	Widow	1	2.0
5.	Educational Attainment:		
	Didn't get to Study	1	2.0
	Elementary Level	4	8.0
	Elementary Graduate	8	16.0
	High School Level	26	52.0
	High School Graduate	11	22.0
6.	Years of Experience:		
	1 Year	31	62.0
	6 Years	11	22.0
	11 Years	6	12.0
	16 Years	2	4.0
7.	Number of Carabaos Owned:		
	1	32	64.0
	2	14	28.0
	3	4	8.0
8.	Purpose of Raising Carabao:		
	Draft	46	92.0
	Meat	6	12.0
	Feeding	1	2.0
	Culture	3	6.0
9.	Sources of Income:		
	Carabao Sales	4	8.0
	Draft Services	22	44.0
	Farming Income	32	64.0
	Business Income	2	4.0
10.	Sources of Capital:		
	Personal Savings	34	68.0
	Cooperative Loan	8	16.0
	Family/Relatives	8	16.0

Geographically, the highest concentration of participants originated from Mulondo (30.0%), whereas Marantao recorded the lowest representation (10.0%). This spatial distribution reflects localized project accessibility and varying regional participation driven by agricultural assistance, aligning with reports by Mina and Cuevas (2022) and Sharma et al. (2025). Furthermore, most raisers were novice, small-scale operators, with 62.0% having only one year of experience compared to 4.0% with 16 years, and 64.0% owning a single carabao versus 8.0% who owned three—a pattern mirroring the observations of Yumkella et al. (2020). Carabaos were kept primarily for draft power (92.0%) and to a lesser extent for cultural purposes (6.0%),

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

highlighting a continued reliance on traditional, non-mechanized farming methods for land preparation, as noted by the Philippine Statistics Authority (PSA, 2022) and Tsuji (2021). Agriculture served as the primary livelihood for 64.0% of respondents compared to only 4.0% who depended on business income, reinforcing the vital role of carabao management in securing rural household income (Aquino et al., 2021; Chanco, 2022). However, farm expansion and technology adoption remain severely constrained, as 68.0% of raisers relied exclusively on personal savings rather than loans or financial support from family and relatives (16.0%) due to poor access to formal credit channels—a structural barrier previously identified by Belay et al. (2021) and Reyes and Dizon (2022).

Research Question 2: What is the level of knowledge of Philippine carabao raisers regarding production, feeding, and marketing practices?

Carabao Raisers Level of Knowledge

Production Practices

Table 2 illustrates the respondents' level of knowledge regarding production practices, yielding an overall weighted mean of 2.99 (Agree) which indicates a moderate baseline understanding of carabao management. The highest-rated indicators were selective breeding and proper mating management (WM = 3.46) alongside weaning, calving, and calf care (WM = 3.46), demonstrating stronger technical literacy in herd reproduction. Conversely, limited knowledge in illness detection and handling techniques poses a risk to disease management, animal welfare, and overall herd productivity. These findings align with PCC (2022) reports showing that smallholders often possess practical reproductive knowledge yet lack formal competencies in disease identification and handling. Furthermore, the results echo FAO (2021) observations that rural livestock keepers rely heavily on experience-based routines but require targeted extension programs and veterinary training to strengthen preventive healthcare.

Table 2. Level of knowledge on production practices

Knowledge on Production Practices	Frequency				Weighted Mean	Qualitative Interpretation
	4	3	2	1		
1. I am knowledgeable about selective breeding and proper mating management to improve productivity.	29	17	2	2	3.46	Strongly Agree
2. I understand the recommended breeding season and breeding practices for carabao production.	14	18	18	0	2.92	Agree
3. I am aware of the proper record-keeping practices for breeding, health, and production performance of carabaos.	27	18	5	0	3.44	Strongly Agree
4. I understand the recommended breeding season and breeding practices for carabao production.	24	24	1	1	3.42	Strongly Agree
5. I am knowledgeable about maintaining proper sanitation to prevent diseases.	20	18	10	2	3.12	Strongly Agree
6. I know the standard practices for carabao weaning, calving, and calf care.	30	15	32	2	3.46	Strongly Agree
7. I understand disease prevention practices such as vaccination and deworming schedules.	19	18	10	3	3.06	Strongly Agree
8. I am knowledgeable about monitoring the health of my carabaos regularly and seeking veterinary care when needed	13	25	10	2	2.98	Agree
9. I am knowledgeable about the signs that indicate when a carabao is ill.	3	14	14	19	2.02	Strongly Disagree
10. I am knowledgeable about the proper handling and restraint techniques for carabaos.	3	11	20	16	2.02	Disagree
OVERALL					**2.99**	**Agree**

Feeding Practices

Table 3 displays the respondents' level of knowledge regarding feeding practices, generating an overall weighted mean of 2.64 (Agree) that indicates a moderate foundational understanding of feed management. The highest-rated indicator was proper grazing management and rotational pasture practices (WM = 3.60, Strongly Agree), demonstrating high technical familiarity with traditional pasture-based systems. However, raisers exhibited noticeable gaps in advanced feeding management, particularly regarding feed rationing, nutritional requirements, and strategic supplementation, which could constrain animal growth and farm productivity. These results mirror the findings of Duza et al. (2021), who reported that Philippine smallholders

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

depend heavily on grazing routines but lack technical training in balanced feed formulation. Similarly, Tufail et al. (2025) observed that while rural livestock keepers master forage management, their nutritional feeding strategies remain limited without formal extension support and agricultural resources.

Marketing Practices

Table 4 presents the respondents' level of knowledge regarding marketing practices, yielding an overall weighted mean of 2.67 (Agree) that reflects a moderate understanding of livestock commercialization. The highest-rated indicator was price negotiation with traders and buyers (WM = 3.34, Strongly Agree), underscoring strong practical competence in direct bargaining and local market transactions. However, deficiencies in formal market documentation, financial record-keeping, and awareness of government support services constrain raisers from maximizing overall enterprise profitability. These findings align with Nwafor et al. (2020), who observed that smallholder livestock producers rely extensively on conventional negotiation tactics during transactions. Consequently, structured training programs and accessible extension services are vital to improving formal market participation, record-keeping skills, and long-term economic sustainability among carabao raisers.

Table 3. Level of knowledge on feeding practices

Knowledge on Feeding Practices	Frequency				Weighted Mean	Qualitative Interpretation
	4	3	2	1		
1. I understand the basic nutritional requirements of Philippine carabaos such as protein, energy, vitamins, and minerals.	1	17	20	12	2.14	Disagree
2. I understand the proper grazing, pasture management, and forage utilization for carabao production.	24	23	3	0	3.42	Strongly Agree
3. I know how to identify quality roughages and forages suitable for carabao feeding.	14	25	10	1	3.04	Agree
4. I understand the importance of providing clean and adequate drinking water for carabaos.	26	20	2	2	3.40	Strongly Agree
5. I am aware of the recommended amount or ration to feed carabaos based on age and body condition.	2	9	21	18	1.90	Disagree
6. I am knowledgeable about providing my carabaos with sufficient and nutritious feed daily.	6	12	15	17	2.14	Strongly Disagree
7. I understand the role of feed supplements and concentrates in improving carabao growth and productivity.	4	19	19	8	2.38	Disagree
8. I am knowledgeable about proper grazing management and rotational pasture practices.	30	20	0	0	3.60	Strongly Agree
9. I understand the importance of feeding pregnant and lactating carabaos with nutrient-rich rations.	5	26	19	0	2.72	Agree
10. I am aware that sudden changes in feed types or feeding schedule can cause stress and digestive problems in carabaos.	2	5	19	24	1.70	Strongly Disagree
OVERALL					**2.64**	**Agree**

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Table 4. Level of knowledge on marketing practices

Knowledge on Marketing Practices	Frequency				Weighted Mean	Qualitative Interpretation
	4	3	2	1		
1. I am knowledgeable about the best season or timing to sell carabaos for higher profit.	13	28	8	1	3.06	Agree
2. I am aware of the current market prices of live carabaos and carabao products (meat, milk, draft services).	19	24	7	0	3.24	Agree
3. I know how to properly negotiate prices with livestock traders or buyers.	26	15	9	0	3.34	Strongly Agree
4. I understand the importance of weighing or estimating the body weight of carabaos before selling.	15	29	6	0	3.18	Agree
5. I am aware of different carabao market outlets such as livestock auctions, traders, and direct buyers.	9	20	18	3	2.70	Agree
6. I know that healthy and well-managed carabaos can be sold at a higher price.	25	17	8	0	3.34	Strongly Agree
7. I understand the basic marketing costs involved (transportation, feeds, veterinary requirements, trading fees).	6	25	18	1	2.72	Agree
8. I am aware of government programs or agencies that support carabao marketing and production.	1	10	14	25	1.74	Strongly Disagree
9. I know the proper documents needed when transporting or selling carabaos (e.g., veterinary certificate, permit).	1	6	18	25	1.66	Strongly Disagree
10. I understand the importance of record-keeping in tracking sales, expenses, and profits from carabao raising.	2	9	12	27	1.72	Strongly Disagree
OVERALL					**2.67**	**Agree**

Research Question 3: What are the actual management practices implemented by Philippine carabao raisers in terms of production, feeding, and marketing?

Carabao Raisers Actual Management Practices

Actual Production Practices

Table 5 outlines the actual production practices of the respondents, demonstrating a predominant reliance on conventional livestock management methods. Notably, all respondents (100%) exclusively utilized natural mating for herd reproduction, reflecting established practical habits rather than modern breeding techniques. However, the low adoption of structured reproductive technologies and preventive healthcare protocols poses risks to genetic quality, herd growth, and disease control. These findings concur with PCC (2022) reports indicating that smallholders stick to traditional mating systems due to restricted access to artificial insemination and breeding services. Furthermore, the results echo Pabuayon et al. (2021), who observed that resource constraints and inadequate veterinary support drive rural raisers to rely almost entirely on experience-based breeding practices.

Table 5. Actual production practices of the respondents

Actual Production Practices	YES		NO	
	F	%	F	%
1. Do you regularly vaccinate your carabaos against common diseases?	11	22.0	39	78.0
2. Do you check your carabaos regularly for parasites such as ticks and lice?	23	46.0	27	54.0
3. Do you find veterinary services or medicines difficult to access?	37	74.0	13	26.0
4. Do you have a regular deworming schedule for your carabaos?	6	12.0	44	88.0
5. Do you consult a veterinarian when your carabaos show signs of illness?	5	10.0	45	90.0
6. Do you conduct pregnancy diagnosis (PD) for your carabaos?	4	8.0	46	92.0
7. Do you use artificial insemination (AI) as part of your breeding method?	0	0.0	50	100.0
8. Do you allow natural mating among your carabaos?	50	100.0	0	0.0
9. Do you select breeding carabaos based on specific traits such as size, strength, or productivity?	27	54.0	23	46.0
10. Do you monitor the signs of heat or estrus in your female carabaos?	43	86.0	7	14.0

Actual Feeding Practices

Table 6 details the respondents' actual feeding practices, revealing an exclusive reliance on basic, traditional management strategies. Most notably, all respondents (100%) allow their carabaos to graze daily,

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

utilizing immediately available natural pasture to meet baseline nutritional needs. However, the absence of strategic concentrate supplementation, formulated feed rationing, and leguminous forage integration threatens long-term animal growth, health, and reproductive efficiency. These results align directly with the findings of Duza et al. (2021), who reported that Philippine smallholders depend almost entirely on open grazing systems for livestock nutrition. Consequently, implementing localized forage development programs and hands-on extension training is essential to improve nutritional management and farm productivity.

Table 6. Actual feeding practices of the respondents

Actual Feeding Practices	YES		NO	
	F	%	F	%
1. Do you provide mineral blocks or salt to your carabaos?	38	76.0	12	24.0
2. Do you provide clean and sufficient drinking water every day?	47	94.0	3	6.0
3. Do you provide concentrate feeds or supplements?	6	12.0	44	88.0
4. Do you observe your carabaos during feeding to monitor their appetite and behavior?	48	96.0	2	4.0
5. Do you allow your carabaos to graze daily?	50	100.0	0	0.0
6. Do you rotate grazing areas to prevent overgrazing?	44	88.0	6	12.0
7. Do you supplement grazing with additional feeds when pasture grass is insufficient?	6	12.0	44	88.0
8. Do you regularly check the grazing area for harmful plants or objects?	30	60.0	20	40.0
9. Do you provide crop residues (e.g., corn stalks, rice straw) as part of the carabaos' diet?	42	84.0	8	16.0
10. Do you provide leguminous forages (e.g., ipil-ipil, madre de cacao) to increase protein intake?	8	16.0	42	84.0

Actual Marketing Practices

Table 7 details the respondents' actual marketing practices, revealing a strong reliance on practical, experience-based strategies. Notably, 92% of raisers engage in advance sales agreements or buyer reservations, establishing pre-arranged transactions to secure buyers and mitigate market volatility. While respondents demonstrate competence in direct price bargaining, market monitoring, and buyer communication, the complete absence of systematic farm record-keeping hinders effective financial planning and business expansion. Furthermore, the tendency to sell carabaos primarily to meet urgent household financial needs limits long-term enterprise growth. These observations concur with Nwafor et al. (2020) and Masephula and Olorunfemi (2023), who found that smallholder livestock raisers excel in informal negotiation and buyer relations but remain constrained by inadequate financial documentation and business management skills.

Problems Encountered by Carabao Raisers

Table 8 outlines the primary constraints facing carabao raisers in Lanao del Sur, with all respondents (100%) reporting major bottlenecks in financial support, feeding knowledge, veterinary access, quality forage supply, and available grazing land. These pervasive limitations severely impair farm operational efficiency, animal health, and overall profitability. Without adequate capital, smallholders cannot invest in superior feed, modern equipment, or productivity-enhancing technologies. These findings align with Reyes et al. (2022), who highlighted that limited extension training, outmoded production systems, and scarce veterinary access remain critical barriers for Philippine carabao raisers. Consequently, targeted government intervention—particularly regarding veterinary services, credit accessibility, and forage management programs—is essential to overcome these systemic challenges.

Table 7. Actual marketing practices of the respondents

Actual Marketing Practices	YES		NO	
	F	%	F	%
1. Do you sell your carabaos to meet household financial needs?	22	44.0	28	56.0
2. Do you consider production cost before setting a selling price?	40	80.0	10	20.0
3. Do you receive a fair price when selling your carabaos?	32	64.0	18	36.0
4. Do you know how to use mobile phones or social media to reach buyers?	44	88.0	6	12.0
5. Do you negotiate prices directly with buyers during marketing?	43	86.0	7	14.0
6. Do you sell your carabaos through middlemen or traders?	43	86.0	7	14.0
7. Do you check current market prices before selling your carabaos?	42	84.0	8	16.0
8. Do you sell carabaos only when you need income for household expenses?	36	72.0	14	28.0
9. Do you engage in advance agreements or reservations with buyers before selling?	46	92.0	4	8.0
10. Do you keep records of sales or transactions involving your carabaos?	6	12.0	44	88.0

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Table 8. Problems encountered of the respondents

Problems Encountered	F	%
1. Lack of capital/financial support	50	100
2. Limited knowledge/training of proper feeding practices	50	100
3. Lack of veterinary services in the community	50	100
4. Insufficient supply of quality forage or grasses	50	100
5. Lack of available grazing areas	50	100
6. Limited breeding technology	33	66

Research Question 4: Is there a significant relationship between the socio-demographic profile of carabao raisers, their level of knowledge, and their actual management practices in production, feeding, and marketing?

Socio-Demographic Profile and The Level of Knowledge of Philippine Carabao Raisers

Table 9 illustrates the Chi-square (χ2) test of independence results between socio-demographic attributes and managerial knowledge levels across production, feeding, and marketing domains. Geographical location ("Municipality") showed a statistically significant association across all three dimensions ($p < 0.05$), indicating that spatial proximity dictates access to agricultural extension services and local institutional support. Furthermore, production knowledge was significantly associated with gender ($p = 0.000$) and civil status ($p = 0.020$), while marketing knowledge correlated significantly with age ($p = 0.035$) and educational level ($p = 0.035$). Conversely, years of farming experience showed no significant relationship with knowledge across any domain, proving that length of engagement does not guarantee up-to-date technical competencies without formal training. These findings align with Sharma et al. (2025) and Reproto et al. (2024), underscoring the need for localized, demographically targeted extension programs rather than relying on informal, experience-based learning.

Table 9. Relationship between the respondents' demographic profile and their level of knowledge on production, feeding and marketing practices

Socio-Demographic Profile	Production	Feeding	Marketing
1. Age	ρ = 0.240 ρ = 0.094 Not Significant	ρ = 0.217 ρ = 0.131 Not Significant	ρ = 0.299 ρ = 0.035* Significant
2. Municipality	χ^2 = 25.659 ρ = 0.001* Significant	χ^2 = 18.578 p = 0.017* Significant	χ^2 = 24.830 ρ = 0.002* Significant
3. Gender	χ^2 = 23.462 ρ = 0.000* Significant	χ^2 = 0.348 p = 0.849 Not Significant	χ^2 = 3.574 ρ = 0.167 Not Significant
4. Civil Status	χ^2 = 11.694 ρ = 0.020* Significant	χ^2 = 4.158 ρ = 0.385 Not Significant	χ^2 = 5.676 ρ = 0.225 Not Significant
5. Highest Level of Education	ρ = 0.177 p = 0.219 Not Significant	ρ = -0.187 ρ = 0.193 Not Significant	ρ = 0.300 ρ = 0.035* Significant
6. Years of Experience	ρ = 0.025 ρ = 0.864 Not Significant	ρ = -0.142 ρ = 0.326 Not Significant	ρ = -0.099 ρ = 0.4308 Not Significant

Socio-Demographic Profile and Their Actual Management Practices on Production, Feeding, and Marketing Practices

Table 10 details the Chi-square (χ^2) test of independence and correlation analyses evaluating socio-demographic influences on actual production, feeding, and marketing practices. Geographical location ("Municipality") significantly affected production ($p = 0.001$) and marketing practices ($p = 0.007$), indicating that spatial resource distribution, market access, and local extension support heavily govern management behaviors. Gender was significantly associated with production practices ($p = 0.000$), reflecting gender-differentiated labor roles in daily livestock handling. Conversely, age, civil status, education, and years of experience showed no significant relationship across practice domains—specifically with age showing negligible correlation to production (ρ = -0.037), feeding (ρ = -0.255), and marketing (ρ = 0.019). These results, supporting Salina et al. (2020) and Sazmand et al. (2020), demonstrate that actual management routines stem from shared community traditions, environmental realities, and service availability rather than individual demographic attributes alone.

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Table 10. Relationship between the respondents' demographic profile and their actual management practices on production, feeding and marketing practices

Socio-Demographic Profile	Production	Feeding	Marketing
1. Age	ρ = -0.037 ρ = 0.800 Not Significant	ρ = -0.255 ρ = 0.073 Not Significant	ρ = 0.019 ρ = 0.896 Not Significant
2. Municipality	χ^2 = 41.429 ρ = 0.003* Significant	χ^2 = 15.132 ρ = 0.769 Not Significant	χ^2 = 30.732 ρ = 0.162* Significant
3. Gender	χ^2 = -25.094 ρ = 0.000* Significant	χ^2 = 2.616 ρ = 0.759 Not Significant	χ^2 = 7.808 ρ = 0.253 Not Significant
4. Civil Status	χ^2 = 17.857 p = 0.003 Significant	χ^2 = 1.453 ρ = 0.918 Not Significant	χ^2 = 1.617 ρ = 0.951 Not Significant
5. Highest Level of Education	ρ = -0.147 ρ = 0.307 Not Significant	ρ = -0.008 ρ = 0.955 Not Significant	ρ = -0.215 ρ = 0.133 Not Significant
6. Years of Experience	ρ = -0.143 ρ = 0.323 Not Significant	ρ = -0.112 ρ = 0.323 Not Significant	ρ = -0.099 ρ = 0.438 Not Significant

Research Question 5: What practical guidelines and extension strategies can be developed to enhance the production performance of Philippine carabao raisers in Lanao del Sur?

Relationship Between Level of Knowledge and Actual Management Practices

Table 11 presents the Spearman's rank correlation (ρ) analysis evaluating the relationship between respondents' level of knowledge and their actual management practices across production, feeding, and marketing domains. The results revealed no statistically significant relationships, with production practices (ρ = -0.164, p = 0.256) and feeding practices (ρ = -0.270, p = 0.058) both exhibiting weak, non-significant inverse trends. These findings demonstrate a critical knowledge-practice gap, proving that technical awareness alone is insufficient to drive adoption when structural and socioeconomic barriers persist. Constraints such as capital scarcity, absent veterinary services, degraded grazing lands, and poor technology access prevent raisers from translating knowledge into actual farm operations. This aligns with Olagunju et al. (2021) and Wairimu et al. (2022), who observed that resource limitations and institutional deficiencies frequently decouple farmer knowledge from practical application, highlighting the need for hands-on extension, financial support, and infrastructure to bridge the implementation divide.

Table 11. Relationship between the level of knowledge of carabao raisers and their actual management practices on production, feeding, and marketing

Level Of Knowledge	Spearman's Rho Correlation Coefficient	Actual Practices
1. Production Practices	-0.164	Actual Production Practices
p-value	0.256	*p*-value
Interpretation	Not Significant	Interpretation
2. Feeding Practices	0.269	Actual Feeding Practices
p-value	0.059	*p*-value
Interpretation	Not Significant	Interpretation
3. Marketing Practices	-0.270	Actual Marketing Practices
p-value	0.058	*p*-value
Interpretation	Not Significant	Interpretation

Ethical Considerations

Ethical considerations were strictly maintained throughout the research process to protect the rights, welfare, and privacy of all participants. Prior to data collection, informed consent was secured from the respondents, explicitly emphasizing their right to voluntary participation and the freedom to withdraw from the study at any time without adverse consequences. All collected data were kept strictly confidential and anonymized to protect participant identities. Furthermore, institutional approval (Ethical Approval No. COA-ANSCI-REC-008) and administrative clearances were secured from the Provincial Office of Agriculture and relevant local government units in Lanao del Sur prior to field administration, ensuring that all survey procedures complied with established research protocols and ethical standards.

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Conclusion

Based on the survey findings, this study concludes that smallholder carabao production in Lanao del Sur remains anchored in traditional, experience-based management systems primarily geared toward farm draft power and subsistence livelihood rather than commercial enterprise. In addressing the farmers' technical capacities, the results show that while raisers possess foundational familiarity with basic feeding, husbandry, and marketing routines, substantial knowledge deficits persist in preventive healthcare, balanced nutrition, modern breeding, and systematic record-keeping. Furthermore, the documented universal reliance on natural mating, open grazing, and zero-input systems directly reflects underlying institutional constraints—specifically inadequate veterinary services, scarce credit facilities, and limited agricultural extension support. Consequently, transitioning these operations toward sustainable productivity requires targeted interventions grounded in these gaps: expanding localized veterinary outreach, establishing accessible micro-credit programs, and delivering hands-on training in feed formulation and farm record-keeping. Finally, to build upon these baseline findings, future investigations should examine the socio-economic, institutional, and environmental determinants shaping technology adoption and smallholder livestock resilience across Mindanao.

Recommendations

Grounded in the study's empirical findings, actionable recommendations are structured into immediate policy interventions and future research priorities to strengthen the sustainability of smallholder carabao production in Lanao del Sur. In the near term, local government units (LGUs), the Philippine Carabao Center (PCC), and agricultural extension agencies should collaborate to deliver localized, hands-on training in preventive veterinary care, ration formulation using locally available feedstuffs, farm record-keeping, and modern breeding technologies such as artificial insemination (AI). Concurrently, public-private partnerships should expand access to low-interest rural credit facilities, mobile veterinary clinics, and managed forage production systems to overcome the structural bottlenecks identified in the survey. Building directly on the baseline gaps observed in this study, future research should pursue four targeted directions: (1) conducting on-farm feeding trials to evaluate carabao growth, milk yield, and reproductive efficiency when transitioning from exclusive open grazing to strategic supplementation and improved forage regimes; (2) assessing the socio-cultural, technical, and infrastructural barriers hindering AI adoption and genetic upgrading among traditional raisers; (3) quantifying household income dynamics and cost-benefit margins across draft, meat, and dairy value chains; and (4) investigating longitudinal market constraints alongside climate resilience strategies to safeguard smallholder ruminant enterprises in Lanao del Sur

References

Abo-Donia, F. M., El-Shora, M. A., Riad, W. A., Elgamal, N. B., & El-Hamady, W. A. (2022). Improve the nutritional value and utilization of rice straw via an ensiling process with different sources of energy and nitrogen enrichment. *Journal of Applied Animal Research, 50*(1), 333–341. https://doi.org/10.1080/09712119.2022.2076685

Aquino, D., Perez, J., & Ramos, P. (2020). Feeding systems and forage availability for buffalo production in the Philippines. *Journal of Animal Science and Technology, 62*(3), 211–219.

Aquino, R., Santos, M., & Dela Cruz, P. (2021). Livestock production and rural livelihood development in the Philippines. *Journal of Agricultural Studies, 15*(2), 45–56.

Arends, J., & Perrone, E. (2025). *Spearman's rho for bivariate zero-inflated data* [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2503.13148

Azmi, A. F. M., Hassim, H. A., Nor, N. M., Ahmad, H., Meng, G. Y., Abdullah, P., ... Zamri-Saad, M. (2021). Comparative growth and economic performances between indigenous swamp and Murrah crossbred buffaloes in Malaysia. *Animals, 11*(4), Article 957. https://doi.org/10.3390/ani11040957

Ballesteros, M. M., & Ancheta, J. (2021). *Linking agrarian reform beneficiary organizations in selected regions of the Philippines* (Research Paper Series No. 2021-09). Philippine Institute for Development Studies. https://doi.org/10.62986/rps2021.09

Ban-Tokuda, T., Abrar, A., Fujihara, T., & Matsui, H. (2021). Comparative analysis of rumen bacteria between water buffalo and cattle fed the same diet during their fattening period in the Philippines. *Japan Agricultural Research Quarterly, 55*(1), 69–75. https://doi.org/10.6090/jarq.55.69

This article is licensed under a Creative Commons Attribution 4.0 International License.

International Journal of Research on Multidisciplinary Studies
Online ISSN: 3116-4137 | Print ISSN: 3116-4145
Volume 1, Issue 10, pp. 735-747, November 2026
https://ijroms.com
Original Article

Belay, G. H., Mengstu, K. A., Kahsay, H. M., Hosseininia, G., & Özgüven, A. I. (2021). Determinants of smallholder commercialization of livestock: A case study from Tigray, Ethiopia. *Cogent Food & Agriculture, 7*(1), Article 1921950. https://doi.org/10.1080/23311932.2021.1921950

Chanco, B. (2022, September 5). How... how... the carabao! *The Philippine Star*. https://www.philstar.com/business/2022/09/05/2207371/how-how-carabao

Cheelo, T., & van der Merwe, M. (2021). What factors influence smallholder farmers' decision to select a milk marketing channel in Zambia? *Agrekon, 60*(3), 243–252. https://doi.org/10.1080/03031853.2021.1950017

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications. https://www.sagepub.com/shop/buy-a-book/research-design-6-270550

Duza, G. M., Trinidad, R. N., Baliuag, N. N. A., & Casauay, R. B. (2021). Pasture establishment and management practices of smallholder dairy farmers in Cagayan Province, Philippines. *International Journal of Biosciences, 18*(5), 207–213. https://doi.org/10.12692/ijb/18.5.207-213

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Food and Agriculture Organization. (2020). *Livestock marketing systems and infrastructure in developing countries*. https://www.fao.org

Food and Agriculture Organization of the United Nations. (2021). *Smallholder livestock production systems: Challenges and opportunities for sustainable rural livelihoods*. https://doi.org/10.4060/cb3171en

Galang, E. I. N. E., & Vaughter, P. (2020). Generational local ecological knowledge on the benefits of an agroforestry landscape in Mindanao, Philippines. *Asian Journal of Agriculture and Development, 17*(1), 89–108. https://doi.org/10.37801/ajad2020.17.1.6

Galloso-Hernandez, M. A., Soca-Perez, M., Dublin, D., Alvarez-Diaz, C. A., Iglesias-Gomez, J., Diaz-Gaona, C., & Rodriguez-Estevez, V. (2021). Thermoregulatory and feeding behavior under different management and heat stress conditions in heifer water buffalo (Bubalus bubalis) in the tropics. *Animals, 11*(4), Article 1162. https://doi.org/10.3390/ani11041162

Huh, I., & Gim, J. (2025). Exploration of Likert scale in terms of continuous variable with parametric statistical methods. *BMC Medical Research Methodology, 25*(1), Article 25. https://doi.org/10.1186/s12874-025-02668-1

Masephula, T. M., & Olorunfemi, O. D. (2023). Financial literacy and record keeping practices among smallholder livestock farmers. *Journal of Agriculture and Rural Development in the Tropics and Subtropics, 124*(1), 45–56. https://doi.org/10.17170/kobra-202305198141

Mina, C. S., & Cuevas, A. C. (2022). Impact of cooperative membership on technical efficiency and marketing efficiency: The case of dairy buffalo farmers in the Philippines. *DLSU Business & Economics Review, 31*(2). https://doi.org/10.59588/2243-786X.1193

Nascimento, A. V., Cardoso, D. F., Santos, D. J. A., et al. (2021). Inbreeding coefficients and runs of homozygosity islands in Brazilian water buffalo. *Journal of Dairy Science, 104*(2), 1917–1927. https://doi.org/10.3168/jds.2020-18397

Nwafor, C. U. (2021). Marketing channel preference among smallholder cocoyam farmers in South Africa. *Journal of Agribusiness and Rural Development, 62*(4), 415–428. https://doi.org/10.17306/J.JARD.2021.01507

Nwafor, C. U., et al. (2020). Market participation and marketing behavior among smallholder livestock farmers in developing countries. *Heliyon, 6*(10), Article e05263. https://doi.org/10.1016/j.heliyon.2020.e05263

Nwafor, C. U., Ogundeji, A. A., & van der Westhuizen, C. (2020). Adoption of ICT-based information sources and market participation among smallholder livestock farmers in South Africa. *Agriculture, 10*(2), Article 44. https://doi.org/10.3390/agriculture10020044

Olagunju, K. O., Ogunniyi, A. I., & Oyetunde-Usman, Z. (2021). Does agricultural training improve adoption of livestock management practices among smallholder farmers? Evidence from developing countries. *Heliyon, 7*(5), Article e06977. https://doi.org/10.1016/j.heliyon.2021.e06977

This article is licensed under a Creative Commons Attribution 4.0 International License.

Pabuayon, I. M., Catelo, M. A. O., & colleagues. (2021). Socioeconomic characteristics and production behavior among Philippine livestock farmers. *Philippine Journal of Agricultural Economics*. https://ovcre.uplb.edu.ph

Philippine Carabao Center. (2020). *Carabao development program*. Department of Agriculture. https://www.pcc.gov.ph

Philippine Carabao Center. (2022). *Annual report 2022*. Department of Agriculture. https://www.pcc.gov.ph

Philippine Carabao Center. (2024). *Genetic improvement*. https://www.pcc.gov.ph/geneetic-improvement

Philippine Statistics Authority. (2024). *Livestock and poultry statistics of the Philippines*. https://psa.gov.ph

Pineda, P. S., Flores, E. B., Herrera, J. R. V., & Low, W. Y. (2021). Opportunities and challenges for improving the productivity of swamp buffaloes in Southeastern Asia. *Frontiers in Genetics, 12*, Article 629861. https://doi.org/10.3389/fgene.2021.629861

Provincial Government of Lanao del Sur. (2020). *History of Lanao del Sur*. https://lanaodelsur.gov.ph/history/

Reproto, R. O., Barrio, A. N., Sevilla, C. C., Calalo, F. C., & Angeles, A. A. (2024). Behavioral insights into dairy farmers' adoption of feeding innovation. *Journal of Buffalo Science, 13*, 140–149. https://doi.org/10.6000/1927-520X.2024.13.16

Rost, J. K. (2024). Analyzing student success outcome variables in higher education utilizing the chi-square test of independence. *International Journal of Higher Education, 13*(2), 100–110. https://doi.org/10.5430/ijhe.v13n2p100

Salina, A. B., Hassan, L., Saharee, A. A., Jajere, S. M., Stevenson, M. A., & Ghazali, K. (2021). Assessment of knowledge, attitude, and practice on livestock traceability among cattle farmers and cattle traders in Peninsular Malaysia and its impact on disease control. *Tropical Animal Health and Production, 53*(1), Article 15. https://doi.org/10.1007/s11250-020-02458-5

Sazmand, A., Alipoor, G., Zafari, S., Zolhavarieh, S. M., Alanazi, A. D., & Sargison, N. D. (2020). Assessment of knowledge, attitudes and practices relating to parasitic diseases and anthelmintic resistance among livestock farmers in Hamedan, Iran. *Frontiers in Veterinary Science, 7*, Article 584323. https://doi.org/10.3389/fvets.2020.584323

Sharma, G., Sabu, A., Saxena, N., & Sharma, M. L. (2025). An analysis of knowledge, attitude and practice gaps in scientific buffalo husbandry. *PLOS ONE, 20*(7), Article e0327208. https://doi.org/10.1371/journal.pone.0327208

Tsuji, T. (2021). The conventional and modern uses of water buffalo milk in the Philippines. *Southeastern Philippines Journal of Research and Development, 26*(2). https://doi.org/10.53899/spjrd.v26i2.152

Tufail, M. S., Krebs, G. L., Quddus, M. S., Southwell, A., Piltz, J. W., Norton, M. R., & Wynn, P. C. (2025). Empowering smallholder farmers by integrating participatory research and establishing village-based forage seed enterprises to enhance on-farm productivity and local seed supply. *Seeds, 4*(3), Article 40. https://doi.org/10.3390/seeds4030040

Wairimu, E. W., Bett, H. K., & Mugivane, F. I. (2022). Determinants of adoption of improved livestock management practices among smallholder farmers in sub-Saharan Africa. *Veterinary World, 15*(6), 1452–1460. https://doi.org/10.14202/vetworld.2022.1452-1460

Yumkella, F., Ariyawardana, A., & Roberts, E. (2020). Livelihood's transformation and climate change adaptation: The case of smallholder water buffalo farmers in the Philippines. *Environmental Development, 33*, Article 100468. https://doi.org/10.1016/j.envdev.2019.100468

Zhang, Y., Colli, L., Barker, J. S. F., et al. (2020). Asian water buffalo: Domestication, history and genetics. *Animal Genetics, 51*(2), 177–191. https://doi.org/10.1111/age.12911

This article is licensed under a Creative Commons Attribution 4.0 International License.