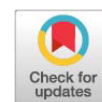


Research Article



Practices and Self-Assessed Competencies of Local Government Artificial Insemination Technicians for Large Ruminants in Bukidnon, Philippines

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Abstract | Local government unit (LGU) artificial insemination (AI) programs for large ruminants in the Philippines are implemented through the Unified National Artificial Insemination Program (UNAIP). However, the profile and field practices of AI technicians in Bukidnon had not been systematically documented. This study described the demographic profiles, training backgrounds, field practices, and self-assessed competencies of 48 LGU AI technicians from 20 LGUs and affiliated agencies across Bukidnon, and examined associations among selected variables. A descriptive survey was conducted from February to March 2026 using structured face-to-face interviews, with data analyzed using frequency analysis, descriptive statistics, Spearman's rank correlation, and chi-square tests. Respondents were predominantly male (87.5%), with a mean age of 41.55 years, and 72.9% held agricultural science degrees. Nearly all technicians (97.9%) received formal AI training, but 50.0% did not receive refresher training. Semen handling included government-sourced semen (100%), verification of semen identification before use (95.8%), and compliance with single-use straw requirements (97.9%). Deviations from recommended protocols were identified in pre-thaw air exposure exceeding 3 seconds (26.1%), non-standard thawing methods (19.5%), thawing duration below 15 seconds (36.2%), and post-thaw holding in iced containers for up to 2 hours (72.3%). Insemination within 6 hours of estrus onset (25.5%) was suboptimal, particularly for carabao. Hygiene gaps included AI gun warming omission (31.9%), vaginal glove omission (42.6%), and absent perineal cleaning (8.3%). Record completeness was 79.2% with low digital adoption (27.7%). Self-assessed competence was high across all six dimensions. Significant associations were found among years in practice, AI confidence, protocol adherence, service volume, and record completeness. The AI workforce demonstrated correctable practice gaps in semen handling, timing of insemination, hygiene, and record keeping.

Keywords | Carabao, Cattle, Estrus detection, Record keeping, Reproductive management

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INTRODUCTION

Artificial insemination (AI) is the primary reproductive biotechnology for genetic improvement of large

ruminants in the Philippines. The technique enables access to superior germplasm, reduces disease transmission, and accelerates breed upgrading without the costs of maintaining breeding bulls (Fernando and Duran, 2017;

Yitayih *et al.*, 2017). In developing countries, AI is the most widely applied biotechnology for large ruminant improvement, and its adoption expands as governments invest in livestock-based food security programs (Garcia *et al.*, 2001; Mekonnen and Gebremariam, 2024). In the Philippines, AI delivery is governed by the Unified National Artificial Insemination Program (UNAIP), established under DA-Bureau of Animal Industry Administrative Order No. 01, Series of 2010. Under this framework, LGUs deploy, supervise, and compensate AI technicians, while the national government provides training, frozen semen, liquid nitrogen, and AI equipment. The program targets 30% coverage of breedable cattle and carabaos and first-service conception rates of 65% for cattle and 45% for carabaos. Bukidnon, a livestock province in Northern Mindanao (Region X), hosts the Philippine Carabao Center Semen Processing Laboratory at Central Mindanao University and maintains active UNAIP implementation across its municipalities.

Technician-level factors are primary determinants of AI program success. Barth (1993) identified knowledge, technical expertise, and attention to semen handling, timing of insemination, and semen placement as core AI competencies. Garcia *et al.* (2001) found that half of all inseminations across 14 developing countries were associated with management deficiency or human error. Semen handling practices, thawing method and temperature, and estrus detection accuracy are recognized technician-related determinants of AI outcomes (Ybañez *et al.*, 2017; Kusuma *et al.*, 2019). Insemination timing relative to ovulation, AI technique, hygiene, record keeping, and pregnancy diagnosis are similarly consequential (Mekonnen and Gebremariam, 2024; Ybañez *et al.*, 2017). Training quality and refresher frequency are further linked to technician competence and field performance (Palacpac *et al.*, 2013; Vartia *et al.*, 2017).

Ybañez *et al.* (2017) in Eastern Visayas and Palacpac *et al.* (2013) in Nueva Ecija documented associations among technician background, field practices, and AI success rates for water buffaloes. Pacana and Koerkamp (2025) assessed AI technician challenges and institutional support in the UNAIP cattle program in Negros Oriental. Comparable documentation for LGU AI technicians in Bukidnon remains absent. Bukidnon is a distinctive case study because its technicians operate under dual mandates covering both cattle and carabao, creating timing and technique challenges not present in single species programs and because its established UNAIP forum infrastructure enables provincial-level coordination and data aggregation (DA-RFO10 nd; Rallos, 2026). Despite this institutional investment, training and equipment decisions have been made without an empirical baseline of deployed technicians' practices, strengths, and deviations from recommended

protocols.

This study aimed to describe the demographic and professional background of LGU AI technicians for large ruminants in Bukidnon, document their semen handling, estrus detection, AI procedures, record keeping, and pregnancy diagnosis practices, assess their self-reported competence and training needs, and examine associations among selected background, practice, and self-assessment variables.

MATERIALS AND METHODS

PLACE AND DURATION OF THE STUDY

The study was conducted in municipalities and cities in Bukidnon where the LGU artificial insemination (AI) programs for large ruminants are implemented. Structured interviews with AI technicians were conducted from February to March 2026, covering 14 municipalities and 2 component cities, as well as the Provincial Local Government Unit (PLGU) and affiliated agencies, including the National Dairy Authority.

RESEARCH DESIGN

This study employed a descriptive survey design. A structured survey was used to document the demographic profiles, training backgrounds, professional experiences, field practices, and self-assessed competencies of LGU AI technicians for large ruminants in Bukidnon. This design is appropriate when the objective is to characterize the attributes and behaviors of a defined population at a point in time without experimental manipulation of variables (Barooah, 2025). In addition to descriptive analysis, inferential analyses using Spearman's rank correlation and Pearson's chi-square test of independence were conducted to examine associations among selected technician background, practice, and self-assessment variables.

RESPONDENTS OF THE STUDY

The respondents were LGU-deployed artificial insemination technicians for large ruminants in Bukidnon. Respondents were recruited from LGU offices, municipal agriculture offices, and associated agencies within the province. Participation was voluntary and conditioned upon signing an informed consent form.

The inclusion criteria were: (a) active AI technician providing AI services for cattle and/or carabao at the time of data collection; and (b) currently deployed or affiliated with an LGU, PLGU, or government or non-government agency implementing a large ruminant AI program in Bukidnon. The exclusion criteria were: (a) AI technicians handling only swine, goat, or other non-large ruminant species with no cattle or carabao AI practice;

(b) technicians who declined to provide written informed consent; and (c) duplicate entries identified during data encoding and cleaning.

A total of 52 technicians were initially identified and approached. Four were excluded from the analytical sample: one technician who reported handling only swine and goats with no large ruminant AI practice, and one duplicate entry identified during data cleaning. Ten respondents reported less than 1 year of AI experience, which falls below the criterion in the original study protocol. These respondents were retained because they were deployed at the time of the interview and reported current AI services, indicating that this category captured recently deployed technicians rather than non-practicing individuals. The final analytical sample comprised N= 48 large ruminant AI technicians from 19 LGUs and affiliated agencies across Bukidnon.

INSTRUMENT DEVELOPMENT AND VALIDATION

The data collection instrument was a researcher-developed structured questionnaire organized into eight thematic sections. These sections covered demographics, professional background, training and experience, semen-handling practices, estrus-detection practices, AI procedures, record-keeping, pregnancy diagnosis, and self-assessment of competence. Items were developed through a review of the literature on AI technician competencies, semen-handling protocols, and field performance standards for large ruminants in tropical settings (Barth, 1993; Ybañez

et al., 2017; Kusuma *et al.*, 2019).

Content validity was established through review by subject matter experts in animal reproduction and veterinary science, who evaluated each item for relevance, clarity, and appropriateness for Philippine LGUs. Feedback was used to refine item wording, adjust response option labels, and remove redundant items prior to pilot testing.

Pilot testing was conducted with ten AI technicians from the same sampling frame as the main study, representing diverse LGU affiliations across Bukidnon. The pilot assessed the clarity of the questionnaires, the appropriateness of response options, the adequacy of vernacular translations used during interview administration, and the average completion time. Minor revisions were made to item phrasing and interviewer prompts based on pilot feedback. No Cronbach's alpha computation was performed for internal consistency, as the survey sections measure distinct constructs across different practice domains rather than a single underlying scale. Face validity was confirmed by the pilot participants' ability to respond to all items without difficulty.

DATA GATHERED

Table 1 summarizes the data categories, variables, and collection methods used in the study. The corresponding score range, verbal interpretation, and descriptive meaning for the Likert scale are presented in Table 2.

Table 1: Data categories, variables, and collection methods

Data category	Specific variables	Collection method
Demographics	Sex, age, educational attainment	Structured interview with survey questionnaire
Professional background	LGU/agency affiliation, species handled, scale of AI services, organizational membership	Structured interview with survey questionnaire
Training background	Formal training status and type, training duration, year of first training, refresher training attendance	Structured interview with survey questionnaire
Professional experience	Years in AI practice, average monthly AI services, total AI services in last 12 months, perceived first-service conception rate	Structured interview with survey questionnaire
Semen handling practices	Semen source, ID verification, handling style, straw retrieval method, LN ₂ exposure time, thawing method and temperature, thawing duration, post-thaw holding time, straw reuse	Structured interview with survey questionnaire
Estrus detection practices	Who performs estrus detection, signs relied upon, AI timing relative to estrus observation, pre-insemination re-check frequency	Structured interview with survey questionnaire
AI procedure	Route of insemination, semen deposit site, pre-warming, glove use, perineal hygiene, perineal cleaning method, instrument disinfection, technique modifications	Structured interview with survey questionnaire
Record keeping	Record completeness, information recorded per AI service, record storage method, frequency of conception rate calculation	Structured interview with survey questionnaire
Pregnancy diagnosis	Who performs PD, PD method, timing of PD post-AI, recording of PD results	Structured interview with survey questionnaire
Self-assessment of competence	Perceived training preparedness, protocol adherence, protocol modification, estrus detection confidence, AI skill confidence, desire for additional training	Five-point Likert scale via structured interview

Table 2: Likert scale score ranges, verbal interpretations, and descriptive meanings for self-assessment of competence items.

Score range	Verbal interpretation	Descriptive meaning
4.50 – 5.00	Strongly agree	The technician strongly endorses the statement as consistently true of their practice or self-perception
3.50 – 4.49	Agree	The technician generally endorses the statement as true of their practice or self-perception
2.50 – 3.49	Neutral	The technician is uncertain or does not strongly endorse nor reject the statement
1.50 – 2.49	Disagree	The technician generally does not endorse the statement as true of their practice or self-perception
1.00 – 1.49	Strongly disagree	The technician strongly rejects the statement as inconsistent with their practice or self-perception

DATA COLLECTION PROCEDURE

Prior to conducting interviews, the researcher coordinated with municipal agriculture offices and LGU veterinarians in the target municipalities and cities to obtain permission for data collection and facilitate the identification and scheduling of eligible respondents. A letter of endorsement from the study institution was presented to each LGU office.

Structured interviews were conducted individually with each eligible technician at a mutually convenient time and location, either at the LGU agriculture office or at the technician's place of work. Before the interview commenced, the purpose, scope, and voluntary nature of the study were explained, and written informed consent was obtained. The researcher and trained enumerators administered the questionnaire through direct interviews to ensure clarity of items and completeness of responses. Items requiring clarification were explained using standardized prompts to maintain consistency across respondents. Each interview lasted approximately 30 to 45 minutes.

Completed questionnaires were reviewed for completeness before the interviewer left the site. Any blank item was clarified with the respondent as soon as possible. Encoded data were checked against the original questionnaires for accuracy prior to statistical analysis.

Confidentiality of information provided by respondents was maintained. No personal identifiers were disclosed in the reporting of results. Data were encoded using assigned respondent codes and stored in password-protected files accessible only to the researcher and authorized study personnel. The study involved no deception, no physical risk, and no procedures that could cause harm to participants. All data collected were used exclusively for this research.

STATISTICAL ANALYSIS

Frequency distribution and percentages were computed for categorical variables; descriptive statistics (mean, SD, minimum, maximum) were computed for continuous and Likert-scale variables. Variables comprising multiple-

response dichotomous sub-items were analyzed using the Multiple Response Frequencies procedure; percentages for these items represent the proportion of respondents endorsing each option (percent of cases) and may exceed 100%. Spearman rank correlation (ρ) was used to examine associations among ordinal variables (two-tailed, pairwise exclusion of missing, $\alpha = 0.05$). Pearson chi-square tests with Cramér's V effect size were used for categorical associations; Fisher's Exact Test was applied where expected cell frequencies fell below 5. Pairs where more than 20% of cells had expected counts below 5 were flagged as statistically unreliable.

RESULTS

DEMOGRAPHIC AND TRAINING PROFILE

The LGU AI technicians in Bukidnon were predominantly male (87.5%). The mean age was 41.55 years. The experience distribution showed two concentrations: 21.3% with less than 1 year of practice and 34.0% with more than 10 years of practice (Table 3). The educational profile showed that 72.9% held agricultural science degrees. Nearly all respondents (97.9%) received formal AI training through DA-BAI/PCC programs (78.7%), with training lasting more than 10 days (93.8%). However, 50.0% reported no refresher training since their initial program. Perceived first-service conception rates were below 50% for 52.1% of respondents. Organizational affiliation was high, with 97.9% affiliated with the Bukidnon Artificial Insemination Technician Association (BAITA), 66.7% with UNAIP, and 56.3% with JOCV-PASA. Technicians were deployed across multiple species: 97.9% handled cattle, 91.7% carabao, 50.0% goats, and 43.8% swine.

SEMEN HANDLING PRACTICES

All 48 respondents sourced semen from government centers (100%), reflecting the centralized UNAIP distribution system (Table 4). Semen ID verification before use was performed by 95.8% of respondents, and single-use straw compliance was reported by 97.9%. Pre-thaw air exposure exceeded 3 seconds for 26.1% of technicians, with 11 respondents (23.9%) exposing

straws for 10–30 seconds. Thawing method differed from evidence-based protocols for 19.5% of technicians, who used warm water by feel, room temperature, or body heat. Thawing duration of less than 15 seconds was reported by 36.2% of technicians. Post-thaw holding in iced containers for up to 2 hours before insemination was practiced by 72.3% of technicians.

Table 3: Demographic and training profile of LGU AI technicians for large ruminants in Bukidnon ($n=48$).

Variable	f	%
Highest educational attainment		
Non-college (elementary, HS, vocational)	4	8.30
College, non-AgriSci	9	18.8
BSA/Animal Science or DVM	35	72.9
Species handled		
Cattle	47	97.9
Carabao	44	91.7
Training received		
Formal training	47	97.9
Primary source: DA-BAI/PCC	37	78.7
Duration >10 days	45	93.8
No refresher training	24	50.0
Perceived first-service conception rate		
<50%	25	52.1
50–69%	17	35.4
≥70%	6	12.5

Age group based on $n=40$ valid responses. Training data $n=47$. Species handled = percent of cases (multiple response). Perceived CR categories collapsed from original five-category scale.

AI PROCEDURAL PRACTICES

The rectovaginal technique was used by 91.5% of technicians, and uterine body deposition was reported as the primary deposit site by all valid respondents (100%). Mid-cervical deposition was reported by 12.8% of respondents. Regarding AI gun pre-warming, 29.8% always pre-warmed, 31.9% never did, and the remainder was distributed across sometimes (23.4%), often (8.5%), and rarely (6.4%). Of respondents, 57.4% used both rectal and vaginal gloves, while 42.6% used only a rectal glove. Perineal cleaning was not performed by 8.3% of technicians. Instrument disinfection after every animal was practiced by 83.3% of respondents.

ESTRUS DETECTION PRACTICES

Estrus detection was performed by both the farmer and the technician in 87.2% of cases (Table 5). Standing heat (95.7%), mucus discharge (95.7%), and swollen or reddened vulva (89.4%) were the most frequently relied upon signs. Of technicians, 48.9% inseminated at 6–12 hours post-estrus observation, while 25.5% inseminated within 0–6

hours and 4.3% at the time of estrus observation. Pre-insemination re-check was performed always by 76.6% of technicians and often by 19.1%.

Table 4: Semen handling and AI procedural practices of LGU AI technicians in Bukidnon ($n=48$).

Variable	f	%
Semen handling		
Semen source: Government center only	48	100
Always check semen ID before use	46	95.8
Preferred handling: center/station thawing	42	89.4
Straw retrieval: canister to neck <10 sec	39	83.0
Pre-thaw air exposure <3 seconds	34	73.9
Pre-thaw air exposure 10–30 sec or more (deviation)	12	26.1
Thawing: 35–37°C water bath with timer	27	58.7
Thawing: 38–42°C water bath with timer	10	21.7
Non-standard thawing (no thermometer/room temp/body heat)	9	19.5
Thawing duration <15 seconds (deviation)	17	36.2
Post-thaw holding: iced container ≤2 hrs	34	72.3
Never reuse partially thawed straw	46	97.9
AI procedure		
Route: rectovaginal technique	43	91.5
Deposit site: body of uterus (primary)	47	100
Pre-warms AI gun: never (deviation)	15	31.9
Gloves: both rectal and vaginal	27	57.4
Gloves: rectal only (deviation)	20	42.6
Perineal cleaning: clean water with paper/cloth	43	89.6
Perineal cleaning: none performed (deviation)	4	8.3
Instrument disinfection after every animal	40	83.3

All percentages based on valid n per variable (range 46–48). Items labeled ‘deviation’ represent departures from recommended protocols. Deposit site and cleaning method = percent of cases (multiple response).

RECORD KEEPING AND PREGNANCY DIAGNOSIS

Record completeness was reported by 79.2% of respondents, and no respondent reported keeping no records (Table 5). Estrus timing was recorded by 66.7% and animal parity by 64.6%, compared to 100% for date of AI and farmer identification. Digital storage was used by 27.7% of respondents, while 80.9% used personal logbooks. Conception rate was calculated at least once per year by 68.8% of respondents. Of technicians, 95.7% personally conducted pregnancy diagnosis, all relying on rectal palpation (100%). Pregnancy diagnosis was performed beyond 60 days post-insemination by 48.9% of respondents. Recording of pregnancy diagnosis results linked to AI services was reported as always done by 89.6% of technicians.

Table 5: Estrus detection, record keeping, and pregnancy diagnosis practices of LGU AI technicians in Bukidnon ($n=48$).

Variable	f	%
Estrus detection		
Who detects: both farmer and technician	41	87.2
Signs: standing heat (multiple response)	45	95.7
Signs: mucus discharge (multiple response)	45	95.7
Signs: swollen/reddened vulva (multiple response)	42	89.4
AI timing: 6–12 hrs post-estrus sign (optimal range)	23	48.9
AI timing: 0–6 hrs post-estrus sign (early/suboptimal)	12	25.5
Pre-insemination re-check: always	36	76.6
Record keeping		
Keeps complete written records	38	79.2
Records estrus signs and time of AI	32	66.7
Records parity and age of animal	31	64.6
Record storage: personal logbook	38	80.9
Record storage: digital (spreadsheet/app)	13	27.7
Calculates conception rate $\geq$ once/year	33	68.8

All percentages based on valid n per variable (range 47–48). Multiple response items may exceed 100%. Early AI timing (0–6 hrs) is classified as suboptimal particularly for carabao given delayed ovulation.

SELF-ASSESSMENT OF COMPETENCE AND TRAINING NEEDS

All six self-assessment items yielded group means in

the Agree or Strongly Agree range (4.06–4.67; Table 6). Protocol adherence ($M=4.67$, $SD=0.69$) and training preparedness ($M=4.65$, $SD=0.86$) scored highest. Protocol modification based on field experience yielded the lowest mean ($M=4.06$, $SD=0.78$) and the greatest variation, with 14.6% selecting neutral and 4.2% selecting disagree. Estrus detection confidence was rated at $M=4.46$ ($SD=0.80$), and AI skill confidence at $M=4.48$ ($SD=0.82$). Desire for additional training was reported at $M=4.52$ ($SD=0.95$), with 89.6% selecting Agree or Strongly Agree.

Table 6: Self-assessment of competence and training needs of LGU AI technicians in Bukidnon ($n=48$).

Statement	n	Min	Max	M	SD
Formal training adequately prepared me	48	1	5	4.65	0.86
I strictly follow established AI protocols	48	2	5	4.67	0.69
I modify protocols based on field experience	48	2	5	4.06	0.78
I am confident in my estrus detection skill	48	1	5	4.46	0.80
I am confident in my insemination skill	48	1	5	4.48	0.82
I want to receive additional AI training	48	1	5	4.52	0.95

5-point Likert scale: 1=Strongly Disagree, 5=Strongly Agree. $n=48$, no missing values. M =mean; SD =standard deviation. All means fall within the Agree (3.50–4.49) or Strongly Agree (4.50–5.00) interpretive range.

Table 7: Spearman rank correlation coefficients for selected variable pairs ($n=39$ –48).

Variable Pair	ρ	n	p	Interpretation
Significant pairs				
Years in AI practice $\times$ AI Confidence	0.29*	47	0.046	Weak-moderate positive
Ave. AI per month $\times$ Calculate conception rate	-0.34*	48	0.015	Weak-moderate negative
Protocol adherence $\times$ AI Confidence	0.72**	48	<0.001	Strong positive
Years in AI practice $\times$ Calculate conception rate	-0.40**	47	0.005	Moderate negative
Age $\times$ Calculate conception rate	-0.51**	40	0.001	Moderate negative
Formal training $\times$ Protocol adherence	0.74**	48	<0.001	Strong positive
Average First-Service Conception Rate $\times$ Confident in Insemination Skill	0.49**	48	<0.001	Moderate positive
Years in AI practice $\times$ Age	0.561**	39	<.001	Significant, moderate positive
Years in AI practice $\times$ Protocol adherence	0.38**	40	<0.001	Significant, weak-moderate positive
Age $\times$ Average AI Services per Month	0.553**	40	<.001	Significant, moderate positive
Non-significant primary pairs				
Years in AI Practice $\times$ Confident in Estrus Detection	0.27	47	0.062	Borderline
Ave. AI per month $\times$ AI Confidence	0.275	48	0.059	Borderline
AI Refresher $\times$ Formal Training	0.14	48	0.337	Not significant
Years in AI Practice $\times$ Average First-Service Conception Rate	0.01	47	0.965	Not significant

Two-tailed test. * $p<.05$; ** $p<.01$. Calculate conception rate is reverse coded (higher code = less frequent calculation). Average First-Service Conception Rate is self-reported and ordinal; correlations should be interpreted cautiously. Non-significant primary pairs included for completeness.

Table 8: Chi-square tests of independence for selected categorical variable pairs.

Variable Pair	χ^2	df	p	V	Note
Years in AI Practice × Average First-Service Conception Rate	5.597	12	0.935	0.199	90% cells <5; unreliable
Highest Educational Attainment × Thawing Method	14.383	10	0.156	0.395	83% cells <5; unreliable
Years in AI Practice × Thawing Method	16.843	20	0.663	0.306	90% cells <5; unreliable
AI Refresher × Thawing Method	10.824	15	0.765	0.28	88% cells <5; unreliable
Years in AI Practice × AI Timing	17.244	12	0.141	0.353	85% cells <5; unreliable
Highest Educational Attainment × Keeps Written Records of Each AI Service	13.349	2	0.001**	0.527	50% cells <5; interpret cautiously
AI Refresher × Average First-Service Conception Rate	9.298	9	0.41	0.254	88% cells <5; unreliable
AI Services Scale × Regularly Calculates Conception	2.333	4	0.675	0.161	44% cells <5; not significant

χ^2 =Pearson Chi-Square; V=Cramér's V. Bolded row = only reportable significant result. Pairs with >20% cells with expected count <5 are flagged as unreliable and should not be formally interpreted. **p<.01.

ASSOCIATIONS AMONG VARIABLES

Most hypothesized Spearman pairs were significant (Table 7). Years in AI practice were positively correlated with AI confidence ($\rho=0.29$, $p=0.046$). Borderline non-significant associations were found for Years in AI Practice × Confident in Estrus Detection ($p=0.062$) and Average AI per month × AI Confidence ($p=0.059$). The inverse correlation between monthly AI service volume and the frequency of calculating conception rates was significant ($\rho=-0.34$, $p=0.015$). The same inverse relationship was observed for age ($\rho=-0.51$, $p=0.001$) and years in practice ($\rho=-0.40$, $p=0.005$). Strong positive correlations were found between formal training adequacy and protocol adherence ($\rho=0.74$, $p<0.001$), and between protocol adherence and AI confidence ($\rho=0.72$, $p<0.001$). A moderate positive correlation was found between perceived first-service conception rate and AI skill confidence ($\rho=0.49$, $p<0.001$).

Of the eight chi-square pairs examined, only Highest Educational Attainment × Keeps Written Records of Each AI Service was significant ($\chi^2=13.349$, $df=2$, $p=0.001$; $V=0.527$; Table 8). Agricultural Science or DVM graduates kept complete records at 91.4% compared to 25.0% among non-college technicians. The remaining chi-square pairs had 85–90% of cells below the expected count threshold, flagged as statistically unreliable.

DISCUSSION

DEMOGRAPHIC AND TRAINING PROFILE

The predominance of male AI technicians was consistent with Ybañez *et al.* (2017), who documented male dominance among AI technicians in Leyte, Samar, and Biliran, and with Kusuma *et al.* (2019), who found that all 76 inseminators in Bali were male. This pattern reflected the physical demands of the rectovaginal AI technique and the inequitable access to training and land ownership that Mbagaya and Anjichi (2008) attributed to male dominance in agricultural extension. Wezi *et al.* (2023)

noted that gender dynamics in livestock sub-sectors position men as primary decision-makers, necessitating policy interventions to improve women's participation in technical services.

The mean age of 41.55 years was comparable to that reported by Ybañez *et al.* (2017) and Asyraf *et al.* (2023), who found an average inseminator age of 39 years in Lembang, Indonesia. The bimodal experience distribution concentrating below 1 year and above 10 years reflected an expanding workforce alongside veterans, consistent with the reinvigoration of UNAIP following the 2021 increase in the AI cash calf incentive from ₱100 to ₱500 per live calf born (DA-RFO10 nd). Sibayan (2016) warned of succession challenges in Philippine agriculture if younger entrants are not recruited. However, technicians with less than 1 year of experience require intensive mentoring before field deployment.

The educational profile, with 72.9% holding agricultural science degrees, distinguished Bukidnon from Bali, where most inseminators held only high school qualifications (Kusuma *et al.*, 2019). Chi-square analysis revealed a significant association between educational attainment and record completeness (Table 8), with Agriculture Sciences or DVM graduates keeping complete records at 91.4% compared to only 25.0% among non-college technicians. Kurniasari and Herlina (2022) found that educational level accounted for 57.7% of the variance in agricultural extension worker performance, and Ifenkwe (2012) documented a positive correlation between formal education and extension agent field performance, affirming that agricultural education predicts documentation behavior.

Nearly all respondents received formal AI training through DA-BAI/PCC programs lasting more than 10 days, consistent with UNAIP accreditation requirements (DA-BAI 2010). However, 50.0% reported no refresher training,

which is a concern documented by [Ybañez *et al.* \(2017\)](#), who attributed declining AI success rates in Eastern Visayas to the absence of continued training, and by [Mekonnen and Gebremariam \(2024\)](#), who identified capacity building as a determinant of improved calving rates. Multiple-species deployment across cattle, carabao, goats, and swine poses a risk of competence fragmentation. [Cruz *et al.* \(2013\)](#) reported 38.1% VBAIT inactivity attributable partly to insufficient service volumes, a pattern not observed here, likely reflecting the stronger accountability of the LGU employment structure. Refresher curricula should prioritize reproductive physiology content tailored to each species handled, with particular emphasis on carabao given the reproductive differences between carabao and cattle that affect insemination timing.

SEMEN HANDLING PRACTICES

All respondents sourced semen from government centers, eliminating procurement variability as a confounding factor but placing semen quality at the point of field delivery at risk from cold chain integrity. [Llanto \(2018\)](#) documented this vulnerability, reporting reductions in post-thaw motility and live sperm proportions in semen straws collected from the Bicol region compared with quality values recorded at the semen processing laboratory at the point of production. Semen ID verification and single-use straw compliance were positive baseline findings.

Pre-thaw air exposure exceeded 3 seconds for 26.1% of technicians. [DeJarnette *et al.* \(2000\)](#) demonstrated that exposing frozen semen straws to 22°C for as little as 2 minutes before thawing reduces acrosomal integrity. In Bukidnon's tropical field conditions, where ambient temperatures regularly exceed 25°C, a 10–30-second pre-thaw exposure is clinically significant. Non-standard thawing was used by 19.5% of technicians. [Barth and Bowman \(1988\)](#) found that water bath thawing at 35°C outperformed lower temperature alternatives for sperm motility, progressive motility, and acrosome integrity, and [DeJarnette and Marshall \(2005\)](#) confirmed that air-thaw procedures produced lower sperm motility and conception rates. The 36.2% of straws thawed for less than 15 seconds risked residual ice crystal damage ([Smith and Merilan 1991](#); [Zenteno *et al.* 2022](#)). Post-thaw holding in iced containers for up to 2 hours, practiced by 72.3%, was associated with a decline in sperm quality ([Diskin 2018](#)). Providing technicians with thermometers, timers, and standardized thawing cards would address most of the identified deviations.

AI PROCEDURAL PRACTICES

The rectovaginal technique and uterine body deposition were consistent with standard training curricula ([TESDA nd; DA-BAI, 2010](#)). [Jemal and Lemma \(2015\)](#) reported

higher non-return rates (the proportion of inseminated females that do not return to estrus, used as a proxy measure of conception success) for uterine body deposition than for cervical deposition, and [Saacke \(2008\)](#) emphasized that uterine body placement maximizes sperm transport to the oviductal isthmus. The 12.8% reporting mid-cervical deposition warranted correction through refresher training.

AI gun pre-warming showed the widest variation among procedural steps, with technicians concentrated at opposing extremes of always and never, reflecting an absence of standardization across the workforce. Contact with unwarmed equipment at ambient temperature compromises acrosomal integrity ([DeJarnette *et al.*, 2000](#)). In Bukidnon's upland areas, where morning temperatures can fall below 20°C, an unwarmed AI gun represents a cold-shock risk that is eliminated by placing it under the arm for 30–60 seconds before loading. The 42.6% using only a rectal glove without a vaginal sleeve was a source of cross-contamination in multiple-animal services ([Garcia *et al.*, 2001](#)), partially offset by per animal instrument disinfection in 83.3% of technicians. [Janett *et al.* \(2008\)](#) found that non-return rates varied across inseminators, implicating hygiene and instrument management as direct pathways from technician practice to AI outcome.

ESTRUS DETECTION PRACTICES

Estrus detection was collaborative between the farmer and technician, reflecting the LGU service model in which technicians travel across multiple farms ([Ybañez *et al.*, 2017](#)). [Ducrot *et al.* \(1999\)](#) found that 44% of cycling cows were undetected by farmers 2 months after calving, and [Alejandrino *et al.* \(1999\)](#) identified inaccurate estrus detection as one of three reproductive problems contributing to long calving intervals in Philippine smallholder dairy cooperatives. The reliance on multiple estrus signs such as standing heat, mucus discharge, and vulvar swelling was a sound practice. [Roelofs *et al.* \(2005\)](#) found that mounting onset was the most reliable predictor of ovulation, and [Layek *et al.* \(2011\)](#) confirmed that mucus and vulvar signs broaden detection coverage when used together.

The most critical concern was insemination timing. While 48.9% inseminated at 6–12 hours post-estrus, consistent with the AM-PM rule ([Pursley *et al.*, 1998](#); [Jemal and Lemma, 2015](#)), 25.5% inseminated within 0–6 hours and 4.3% at the time of estrus observation. [Dalton *et al.* \(2001\)](#) demonstrated that AI at 0 hours after estrus onset yielded only a 67% fertilization rate, versus 79% at 12 hours. Early insemination is more consequential for carabao. [Srivastava *et al.* \(1998\)](#) found zero conception in buffaloes inseminated within 10 hours of estrus, with maximum conception at 23–26 hours post-onset, and [Perera \(2011\)](#) documented

carabao ovulation occurring 24–48 hours (mean 34 hours) after estrus onset, substantially later than cattle. Given that 91.7% of Bukidnon technicians handle carabao alongside cattle, training on the differences in optimal insemination timing between the two species is an urgent priority.

The pre-insemination re-check, practiced always by 76.6% and often by 19.1% of technicians, reduced unnecessary inseminations. López-Gatius (2022) found rectal confirmation of estrus at insemination associated with a 150-day non-return rate of 43.9% in confirmed cows, compared to 26.7% in incorrectly timed cases. Kim *et al.* (2025) documented that experienced observers can differentiate true from false estrus through behavioral cues, affirming that consistent re-checking by the technician adds value beyond relying solely on estrus signs reported by the farmer prior to the technician's arrival.

RECORD KEEPING AND PREGNANCY DIAGNOSIS

Record completeness was achieved as a baseline through UNAIP's incentive-linked documentation requirement (DA-BAI, 2010). However, reproductive management fields, estrus timing and animal parity were recorded less frequently than logistical identifiers such as date of AI and farmer ID. Garcia *et al.* (2001) relied on estrus detection and insemination time records to identify services performed outside the recommended time range; incomplete recording of these fields limits the capacity for retrospective analysis. Digital storage remained low, consistent with age-related adoption barriers documented by Afzal *et al.* (2016). The negative correlations among age, years in practice, and service volume with frequency of calculating conception rates (Table 7) indicated that the most experienced and busiest technicians were the least engaged in formal performance monitoring, suggesting reliance on experience rather than computed feedback. The UNAIP E-Report System, which automates conception rate computation from submitted service records, directly addresses this monitoring gap without adding administrative burden.

SELF-ASSESSMENT OF COMPETENCE AND TRAINING NEEDS

All six self-assessment items yielded means in the Agree or Strongly Agree range. The strong positive correlations between formal training adequacy and protocol adherence and between protocol adherence and AI confidence confirmed that training, adherence, and self-efficacy are reinforcing dimensions of professional identity. Vartia *et al.* (2017) demonstrated that fertility consultants with advanced training achieved higher pregnancy rates (39.6%) than standard AI technicians (32.6%). Additionally, Kurniasari and Herlina (2022) found that Education, infrastructure, and capacity building accounted for 83.4%

of the variance in extension worker performance.

Protocol modification based on field experience yielded the lowest mean and greatest variation among the six items. Ybañez *et al.* (2017) found that protocol divergences among Eastern Visayas technicians were associated with lower AI success rates, while Vartia *et al.* (2017) found that higher training levels grounded modifications in reproductive physiology rather than leaving them without an evidence base. Estrus detection confidence contrasted with documented field challenges. For instance, Garcia *et al.* (2001) found that 17.3% of inseminations across 14 developing countries were performed on non-cycling cows. Banuvalli *et al.* (2015) noted that trained personnel frequently miss animals exhibiting subtle or abbreviated estrus, which is a gap that self-reported confidence cannot capture.

The coexistence of high self-assessment scores with documented practice gaps across semen handling, insemination timing, hygiene, and record keeping was consistent with the social desirability literature (Podsakoff *et al.*, 2003). This pattern suggests that self-assessment instruments are most valuable as motivational tools and indicators of training needs rather than as validators of competence. The strong desire for additional training expressed by a workforce in which half have received no refresher training should be treated as a motivational asset for program development.

ASSOCIATIONS AMONG VARIABLES

Years in AI practice were positively correlated with AI confidence, consistent with the principle that repeated performance builds technical self-efficacy. Asyraf *et al.* (2023) found no correlation between inseminator experience and objective AI success in Lembang, Indonesia, cautioning against assuming that self-reported confidence translates into improved performance. Palacpac *et al.* (2013) found that VBAIT performance in Nueva Ecija was associated with service volume and income rather than experience alone. The borderline non-significant associations for estrus detection confidence and monthly AI volume with AI confidence suggest modest but plausible relationships that a larger sample would likely confirm.

The inverse correlations among age, years in practice, and monthly service volume with frequency of calculating conception rates (Table 7) constituted the most important inferential finding of the study. The most experienced, oldest, and busiest technicians were the least engaged in formal performance self-monitoring, and Briones (2020) attributed this pattern of veteran reliance on experiential rather than computed performance feedback to workforce-

wide behavioral and organizational factors that require systemic rather than targeted solutions. A peer learning program pairing experienced veterans with structured performance accountability mechanisms could harness the competence of both cohorts while addressing the monitoring gap.

The Spearman associations formed a coherent professional development narrative. Experienced technicians were also older, had attended more refresher trainings, and reported stronger protocol adherence, suggested a reinforced cycle between field experience and professional practice. The Conception Rate $\times$ AI Confidence correlation warranted contextual interpretation, as perceived conception rate was a self-reported ordinal variable and the association may reflect mutually reinforcing perceptions rather than independently grounded assessments and Koerkamp (2025) found no correlation between institutional supports and AI success in Negros Oriental, confirming that biological, environmental, and farmer-driven factors beyond technician control also shape outcomes.

Of the chi-square pairs examined, only Educational Attainment $\times$ Record Completeness was significant, making it the strongest predictor identified in this study. The CHED (2008) BSA curriculum's inclusion of data management and record keeping provides an academic pathway to this documentation advantage. The 25.0% record completeness among non-college technicians, though from a small subgroup, reflects the profile of newly recruited or remotely deployed practitioners and makes documentation training delivered within the workplace while technicians remain on active duty a priority for this subgroup. Future studies targeting a minimum of 150 respondents would provide adequate cell frequencies for multi-category crosstabulation inference across provinces.

LIMITATIONS OF THE STUDY

Several limitations should be considered when interpreting the findings of this study. First, the 48 respondents represented the entire accessible population of LGU AI technicians for large ruminants in Bukidnon at the time of data collection, constituting a provincial census rather than a drawn sample. However, the findings apply only to a single province and should be interpreted within that scope. The demographic, practice, and self-assessment patterns documented here reflect a workforce operating under a specific institutional arrangement and may not represent LGU AI technicians in other provinces or regions where training infrastructure, semen supply logistics, LGU support, and technician background differ. The small absolute number of respondents also constrained the statistical power of chi-square analyses, as evidenced by the high proportion of cells with expected counts

below five in most crosstabulation pairs (Table 8), leaving several hypothesized associations inconclusive. Future studies drawing respondents from multiple provinces across Mindanao or at the national level would provide the sample size necessary for multi-category inference and enable comparison of technician profiles across UNAIP implementation contexts with differing institutional capacities.

Second, all practice and competence data were self-reported through face-to-face structured interviews, introducing the risk of social desirability bias. Respondents may have overstated protocol adherence, understated deviations from standard procedures, and inflated competence ratings when responding directly to a researcher. This limitation is most consequential for the semen handling, hygiene, and self-assessment findings, where reported and actual field behavior are most difficult to verify. Direct field observation of AI procedures would provide a more objective measure of practice quality. Future research should complement survey data with structured field observation or objective semen quality assessment to reduce reliance on self-report.

Third, the cross-sectional design permitted identification of associations among selected variables but not establishment of causal relationships. The significant correlations among years in practice, AI confidence, protocol adherence, service volume, and record completeness describe co-occurring patterns at a single point in time. Whether longer experience causes higher confidence, or whether both reflect underlying institutional factors such as training access and LGU support, cannot be determined from these data. A longitudinal quasi-experimental design tracking AI conception rates and practice quality before and after targeted refresher training interventions would enable causal inference and strengthen program evaluation. The present survey data would serve as the baseline for such a design.

CONCLUSIONS

The LGU AI technicians in Bukidnon were predominantly educated in Animal Science and veterinary medicine and maintained high rates of organizational affiliation through BAITA, UNAIP, and JOCV-PASA. They were trained in formal AI procedures, including the rectovaginal technique, uterine body semen deposition, and compliance with single-use straw requirements. Practice gaps were identified in semen handling, timing of insemination, hygiene, and record keeping. The significant association between educational attainment and record completeness, and the negative correlation between service volume and frequency of conception rate calculation, had direct implications for the design and targeting of LGU and

DA-RFO 10 workforce development and performance monitoring interventions. The coexistence of high self-assessed competence with documented practice gaps indicated that self-reported quality indicators should be complemented by objective field observation or semen quality assessment in future studies.

Training priorities for DA-RFO 10 and municipal agriculture offices should address reproductive physiology content tailored to each species handled, with particular emphasis on the reproductive differences between carabao and cattle that affect insemination timing, standardized equipment provision, and support for digital documentation. The proportion of technicians without refresher training, combined with the strong desire for additional training expressed by the workforce, provided an institutional mandate for expanded capacity development within the existing UNAIP framework. The established organizational infrastructure through BAITA, UNAIP, and JOCV-PASA, together with the UNAIP E-Report System, provides the delivery platform for program-wide training and performance monitoring initiatives. Future research should adopt a multi-province design to improve generalizability and a longitudinal quasi-experimental approach to evaluate the impact of targeted refresher training interventions using the present survey data as a baseline.

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NOVELTY STATEMENT

This study provides the first multidomain characterization of LGU artificial insemination technicians for large ruminants in Bukidnon, Philippines. It documented the coexistence of high self-assessed competence with practice gaps in semen handling, timing of insemination, hygiene, and record keeping. It identified correctable deviations amenable to equipment standardization and species-specific refresher training within the UNAIP framework.

AUTHOR'S CONTRUBATION

GBS and IUH: Conceptualized, crafted the methodology and data curation, RMC and REC: Conducted data validation, visualization and editing. RDT and CGA: Analyze and wrote the original draft. All authors read and approved the final edition of the manuscript.

ETHICAL CONSIDERATIONS

Ethical standards were observed throughout the study. Before each interview, the purpose of the study, the nature of participation, and the voluntary character of involvement were explained to each prospective respondent. Written informed consent was obtained from all participants prior to questionnaire administration. Respondents were informed of their right to withdraw at any time without consequence.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGY STATEMENT

No artificial intelligence tools were used in the design, data collection, analysis, or interpretation of results in this study. All manuscript drafting and revisions were performed by the authors.

CONFLICT OF INTEREST

The authors have declared no conflict of interest

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