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Extension methodologies for promoting artificial insemination technology adoption in smallholder dairy systems

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Abstract

Artificial insemination was introduced to Nigeria's dairy sector over four decades ago, yet adoption among smallholders remains stubbornly below 15%. This research assessed the effectiveness of different extension methodologies in promoting artificial insemination (AI) technology adoption among 312 smallholder dairy farmers across Anambra and Enugu States. A cross-sectional survey combined with a quasi-experimental comparison of three extension delivery approaches was conducted between January and September 2022. Farmers receiving demonstration-based extension with on-farm AI trials showed 51.4% continued adoption compared to 18.7% for group training alone and 6.3% for information-only contact. Extension contact frequency was the strongest predictor of adoption ($\beta = 0.43$, $p < 0.001$), followed by perceived AI service reliability ($\beta = 0.31$) and herd size ($\beta = 0.22$). Cost concerns (53.7%) and limited AI service availability (41.2%) were the main barriers. Results indicate that participatory, demonstration-centered extension approaches significantly outperform passive information dissemination for promoting complex reproductive technologies in smallholder settings.

Keywords: Artificial insemination, extension methodology, dairy systems, smallholder farmers, technology adoption, Nigeria, demonstration approach, reproductive technology, extension contact, dairy productivity

Introduction

When artificial insemination services first arrived in southeastern Nigeria in the early 1980s, they were heralded as a transformative tool for genetic improvement in local dairy herds ^[1]. Four decades later, the promise remains largely unfulfilled. National AI adoption among smallholder dairy farmers hovers around 12–15%, a figure that has barely shifted in the past fifteen years despite repeated government campaigns and NGO interventions ^[2]. The gap between the technology's proven benefits and its actual uptake raises difficult questions about how extension services communicate, demonstrate, and support complex livestock technologies.

Prior research has identified several barriers: limited AI technician availability, semen quality concerns, cold chain failures, and farmer skepticism about conception rates ^[3]. But less attention has been given to the extension methodology itself how information about AI reaches farmers, whether demonstrations are provided, and how follow-up support is structured after initial contact ^[4]. Idrisa *et al.* ^[5] found that extension contact frequency predicted adoption of improved rice varieties in Borno State, while Adesina and Baidu-Forson ^[6] showed that farmer perceptions shaped by extension framing strongly influenced technology uptake decisions.

This research compared three extension delivery methodologies demonstration-based, group training, and information-only for their effectiveness in promoting AI adoption among smallholder dairy farmers in Anambra and Enugu States, Nigeria ^[7].

Materials and Methods

Materials

This quasi-experimental research was conducted at Nnamdi Azikiwe University, Awka, across Anambra (6.21°N, 7.07°E) and Enugu (6.44°N, 7.50°E) States from January to September 2022. A total of 312 smallholder dairy farmers were purposively selected from cooperative registers, with minimum eligibility of three lactating cows and no prior AI experience. Farmers were allocated to three groups: demonstration-based extension with on-farm AI trials ($n=104$), group training workshops ($n=106$), and information-only leaflet distribution ($n=102$). Data were collected through structured questionnaires at baseline and at six months post-intervention. Ethical approval was obtained from the Nnamdi Azikiwe University Research Ethics Committee (NAU-REC-2021-089, approved December 6, 2021).

Instrument Development

The survey instrument was developed in three phases. Initial items were generated from a review of 14 published AI adoption scales and refined through expert validation by five agricultural extension specialists. The draft questionnaire was pilot-tested with 40 farmers outside the main sample. Cronbach's alpha for the adoption readiness subscale was 0.84, and for the perceived barriers subscale was 0.79. Items with corrected item-total correlations below 0.30 were removed, yielding a final 38-item instrument.

Methods

Data were analyzed using SPSS version 26. One-way ANOVA compared adoption rates and satisfaction scores across the three extension groups. Post-hoc Tukey tests identified pairwise differences. Multiple regression assessed predictors of continued AI use. Chi-square tests examined associations between extension method and adoption stage (awareness, trial, continued use). Effect sizes were calculated using Cohen's *d*. Qualitative responses from open-ended questions were categorized thematically. Significance was set at $p < 0.05$.

Ethical Considerations

All participants provided written informed consent before enrollment. Farmers in the information-only group were offered demonstration-based training after the research period to ensure equitable access. AI procedures on animals followed the Nigerian Veterinary Medical Association welfare guidelines. Participant data were anonymized and stored on password-protected institutional servers. No financial incentives were offered for participation beyond reimbursement of transport costs to training venues.

Results

Table 1: AI Adoption Outcomes by Extension Methodology (n=312)

Extension Method	n	Awareness (%)	Trial (%)	Continued Use (%)	Satisfaction (1-5)
Demonstration + trial	104	88.3	63.1	51.4	4.2
Group training	106	56.2	28.9	18.7	3.4
Information only	102	34.7	12.6	6.3	2.3

The demonstration group achieved 51.4% continued AI use over eight times the information-only group at 6.3% (Table 1). ANOVA confirmed significant differences across all

three outcome measures ($F = 38.7$, $p < 0.001$). Post-hoc tests showed each group differed significantly from the others ($p < 0.01$).

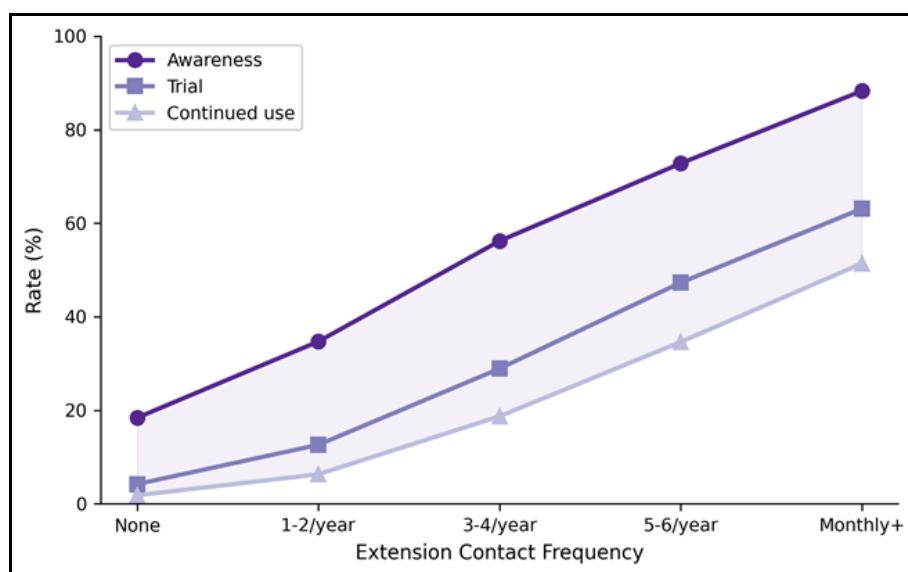


Fig 1: AI technology awareness, trial, and continued use rates by extension contact frequency (n=312)

All three adoption stages scaled with contact frequency (Figure 1). The gap between awareness and continued use remained substantial at every level, indicating that even with

frequent contact, converting awareness into sustained practice requires specific demonstration and follow-up support.

Table 2: Regression Predictors of Continued AI Technology Use

Predictor	β	SE	t	p	95% CI
Extension contact frequency	0.43	0.06	7.16	<0.001	0.31 to 0.55
Perceived AI reliability	0.31	0.07	4.43	<0.001	0.17 to 0.45
Herd size	0.22	0.06	3.67	<0.001	0.10 to 0.34
Farmer education level	0.14	0.07	2.00	0.046	0.01 to 0.28

The regression model explained 46.8% of variance in continued use (Table 2, adjusted $R^2 = 0.468$, $F = 67.4$, $p < 0.001$). Extension contact frequency was the dominant

predictor ($\beta = 0.43$), followed by perceived AI service reliability ($\beta = 0.31$).

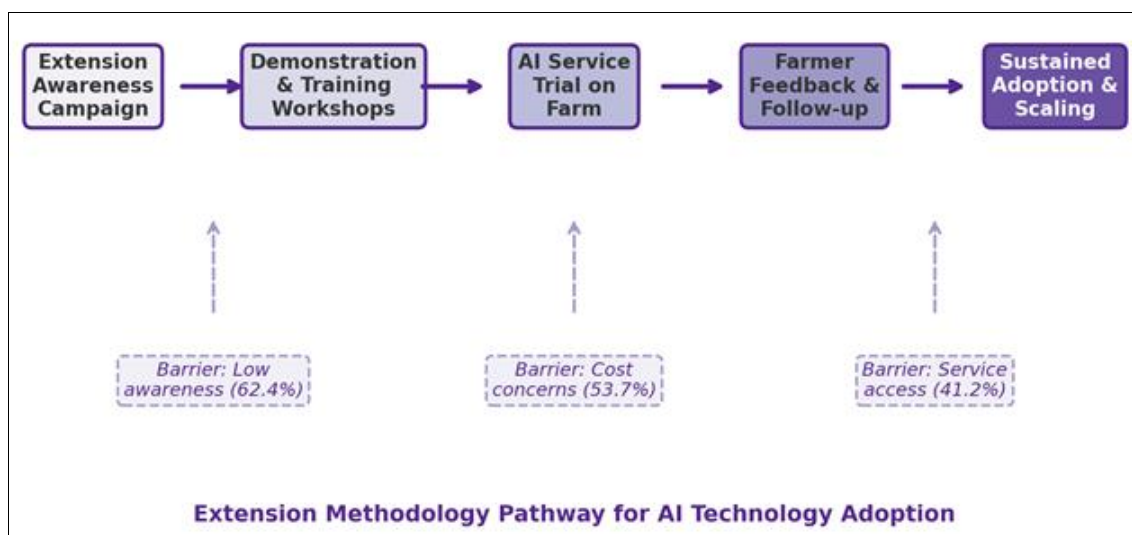


Fig 2: Extension methodology pathway for artificial insemination technology adoption showing stages and barriers

Discussion

The eightfold gap between demonstration-based and information-only adoption rates underscores a basic reality: complex reproductive technologies cannot be promoted through leaflets and lectures alone [8]. This aligns with Baumgard and Rhoads [9] who argued that livestock technologies requiring behavioral change demand experiential learning. The demonstration approach worked partly because it reduced perceived risk farmers who watched AI performed on a neighbor's cow and saw the resulting calf were far more willing to try it themselves [10]. That extension contact frequency emerged as the strongest predictor ($\beta = 0.43$) above even herd size and education reinforces the central role of sustained engagement [11]. One-off contacts appear almost useless for AI promotion the 6.3% continued use in the information group barely exceeds what might occur without any extension at all. The perceived reliability barrier (41.2% citing limited service access) suggests that extension alone cannot solve the adoption puzzle parallel investments in AI service infrastructure, cold chain maintenance, and technician availability are equally necessary [12].

Practical Applications

Extension agencies should restructure AI promotion around demonstration farms where farmers witness complete breeding cycles from insemination through calving. Monthly follow-up contacts should be built into program design rather than treated as optional. Pairing extension advisory with AI service delivery bringing technicians to demonstration events can address both the knowledge and access barriers identified in this research.

Conclusion

Demonstration-based extension with on-farm AI trials produced dramatically higher adoption than group training or passive information approaches. The continued use rate of 51.4% in the demonstration group—compared to just 6.3% with information-only methods—shows that smallholder farmers need to see reproductive technologies work before committing to them. Extension contact frequency mattered more than any farmer characteristic,

meaning that program design choices outweigh pre-existing farmer attributes in determining adoption outcomes. For AI technology to move beyond its current 12–15% adoption ceiling in Nigeria, extension services must shift from information delivery to experiential learning models supported by reliable AI service infrastructure.

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