*Original Research Article*

A Strategic Analysis of Artificial Insemination (AI) Adoption in Goat Farming in Kamrup, Assam

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ABSTRACT

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| Given the potential of artificial insemination (AI) to enhance goat productivity, this study conducted a strategic assessment of AI adoption among goat farmers in Kamrup district, Assam, covering both rural and urban subdivisions. A total of 120 goat farmers (60 each from Kamrup Rural and Kamrup Metro) were selected using stratified random sampling to ensure diverse representation. Data were collected through a structured, pre-tested interview schedule, with goat farmer perceptions captured under a SWOT framework. Analysis was performed using Mean Percent Score (MPS), Z-score, and percentile ranking to prioritize the top five factors under each SWOT category. Key strength identified included favourable agro-climatic conditions, presence of indigenous breeds, traditional knowledge, herd health benefits, and available institutional support. Major barriers to adoption were limited awareness of AI, cultural resistance, shortage of trained AI technicians, distant AI service centres, and low conception rates. Opportunities emerged in the form of increasing demand for goat meat and milk, prospects for genetic improvement, rising youth interest in livestock-based livelihoods, entrepreneurial potential, and the relevance of climate-resilient breeding programs. Notable threats included poor AI accessibility in remote areas, heightened disease risk, climate-related stress, and complications such as dystocia. Based on the SWOT outcomes, a TOWS matrix was formulated to develop actionable strategies such as mobile AI delivery units, farmer-led awareness campaigns, capacity building, and integration of veterinary and extension services. The study offers practical insights to guide sustainable AI adoption in goat farming across Kamrup, Assam. |

*Keywords: Artificial Insemination (AI), Adoption, Goat Farmers, Kamrup, SWOT Analysis, TOWS Analysis*

1. INTRODUCTION

The Assam Hill Goat (AHG), a native breed of Assam, is extensively raised across the state, primarily for meat and skin production. In addition to AHG, other breeds such as Sirohi, Black Bengal and Beetal are also raised. These breeds are frequently utilized in crossbreeding to improve the local genetic diversity (Borah and Sharma, 2014). These goats are valued for their remarkable adaptability, their resilience to diseases, reproductive efficiency and exceptional quality of meat, making them well-suited to Assam’s diverse tropical agro-climatic conditions. Moreover, Goat farming plays a crucial role in the rural income of Assam, especially in districts like Kamrup, where a large section of the population depends on small ruminants for livelihood.

According to the 20th Livestock Census report, the goat population in Assam was estimated at 4.315 million, representing about 24% one-quarter of the total number of livestock in the state. However, this marked a sizable decrease of 30% when compared to data from the previous census, as reported by the Department of Animal Husbandry and Dairying. While, Kamrup district, being the capital of the state, retained the sixth largest goat population, has also experienced a significant decline, apparently attributable to the factors including shortfalls in feed and fodder, disease outbreaks that swept through herds, insufficient adoption of scientific animal husbandry practices, reliance on outdated rearing traditions, and deleterious impacts of a changing climate (Sisay et al. 2017; Ingabire *et al*. 2018). Additionally, the deliberate adoption of scientific technologies such as artificial insemination (AI) may have inadvertently intensified the issue (Dhara *et al*. 2023).

Artificial insemination (AI) is the single most significant reproductive biotechnology, which has revolutionized animal breeding (Ingabire *et al.,* 2018). AI enables controlled goat breeding, which allows farmers to choose superior genetic characteristics like increased growth rates, disease resistance and better product quality, which are crucial for the viability and production of the herd (Nair *et al.,* 2021). AI can play a pivotal role in genetic improvement of the non- descriptive and native breeds which can change the future of goat farming. Nevertheless, despite initiatives by entities such as the Goat Research Station, Byrnihat, Assam Livestock Development Agency (ALDA) and Integrated Goat Development Association (IGDA) to advocate for artificial insemination, its adoption remains irregular and inconsistent. Furthermore, socio-economic constraints, lack of technical competence and insufficient institutional backing have impeded its extensive adoption in Kamrup (Doley *et al.,* 2018; ALDA, 2022).

The persistent decrease in Kamrup's goat population necessitates immediate intervention. Although AI possesses the capacity to mitigate some of these challenges, its erratic use may exacerbate persistent issues. Therefore, this study, titled “A Strategic Analysis of Artificial insemination (AI) Adoption in Goat Farming in Kamrup, Assam,” aims to identify the key major strengths, weaknesses, opportunities and threats (SWOT) that impact AI adoption in the region. The study also uses the TOWS matrix framework to formulate specific methods that facilitate sustained AI integration and tackle the overarching decline in goat husbandry in Kamrup.

The present article is a significant study focused on the critical needs in goat breeding programs in Kamrup, Assam. It highlights the pressing necessity for mobile artificial insemination (AI) units, community-based AI service centers, farmer-focused awareness campaigns, youth skill development programs and strengthened extension services etc. The publication will open further discussion and will bring new possibilities to improve goat production in Kamrup, Assam.

2. methodology

The study was conducted in the **Kamrup district of Assam**, specifically covering the **Kamrup Rural and Kamrup Metro subdivisions.** These areas were selected due to their diverse goat-rearing practices and varying levels of exposure to artificial insemination (AI) technologies.

**2.1 Sampling Technique and Respondents**

A stratified random sampling method was employed to ensure balanced representation from both subdivisions. From each subdivision, 60 goat farmers were randomly selected, resulting in a total sample size of 120 respondents. The strata were defined based on geographical location (rural and metro) to capture variations in socio-economic conditions and accessibility to AI services.

#### **2.2 Data Collection Instrument**

Data were collected using a **pre-tested, structured interview schedule** developed specifically for this study. The instrument was designed to capture farmer perceptions across four key strategic dimensions of AI adoption, namely, Strengths, Weaknesses, Opportunities and Threats. Each SWOT component initially included **10–12 potential statements**, derived from literature review, field observations, and expert consultations. After data collection, the **top five factors** under each category were shortlisted based on their **Mean Percent Score (MPS)**.

#### **2.3 Scoring Method**

#### Responses to each SWOT statement were recorded on a binary scale as per the format suggested by Choudhary et al., (2018), where ‘1’ indicated agreement or acknowledgment of the factor (‘Yes’) and ‘0’ indicated disagreement or absence of the factor (‘No’). To quantify the level of agreement for each statement, the Mean Percent Score (MPS) was calculated using the formula: MPS = (Observed Score / Maximum Possible Score) × 100. Here, the Observed Score represents the total number of 'Yes' responses for a given item, while the Maximum Possible Score corresponds to the total number of respondents, which was 120 in this study.

#### **2.4 Statistical Analysis**

Mean Score and Mean Percent Score (MPS) were calculated to quantify the level of agreement among respondents. Z-score analysis was conducted to evaluate the relative deviation of each factor from the mean, providing insight into its significance within the dataset. Percentile ranks were used to position each factor within its respective SWOT category. Final rankings were primarily based on MPS values, with Z-scores applied to resolve instances of closely tied scores. All data were processed and analyzed using Microsoft Excel and SPSS to derive both descriptive and inferential insights.

**2.5 Strategy Formulation through TOWS Matrix**

Based on the prioritized SWOT factors, a TOWS matrix was developed to generate strategic directions for enhancing the adoption of artificial insemination in goat farming (table.1). The TOWS framework enabled the integration of internal strengths and weaknesses with external opportunities and threats to formulate four types of strategies: Strength–Opportunity (SO), Strength–Threat (ST), Weakness–Opportunity (WO), and Weakness–Threat (WT). This matrix served as a planning tool to identify practical and context-specific interventions aimed at improving AI outreach and effectiveness in the study region.

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**Table 1: SWOT and TOWS Matrix**

|  |  |  |
| --- | --- | --- |
|  | **Strength (S)**  Determine first 6 internal strength | **Weakness (W)**  Determine first 6 internal weakness |
| **Opportunities (O)**  Determine first 6 external opportunities | **SO Strategy**  Exploiting opportunities through strength | **WO Strategy**  Exploiting opportunities to overcome weaknesses |
| **Threats (T)**  Determine first 6 external threats | **ST Strategy**  Using strength to mitigate threats | **WT Strategy**  Mitigate weakness to avert risks. |

S & W= Internal factor, O & T= External factors

3. results and discussion

**3.1 SWOT Analysis**

**3.1.1 Key strengths facilitating AI adoption in goat farming**

**Table 2: Key strengths facilitating ai adoption in goat farming (based on mean percent score)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **STRENGTH** | **Score Obtained** | **Mean Score (out of 1)** | **MPS (%)** | **Z-Score** | **Percentile Rank (%)** | **RANK** |
| **Favourable Agro-Climatic Conditions** | **119** | **0.99** | **99.17** | **+1.49** | **100** | **I** |
| **Availability of Indigenous Breeds (AHG)** | **118** | **0.98** | **98.33** | **+1.24** | **95** | **II** |
| **Traditional Goat Farming Knowledge & Practices** | **105** | **0.875** | **87.50** | **-0.06** | **75** | **III** |
| **Improved Herd Health and Disease Management** | **94** | **0.78** | **78.33** | **-1.20** | **50** | **IV** |
| **Institutional and Governmental Support** | **88** | **0.73** | **73.33** | **-1.48** | **25** | **V** |

The study identified and ranked five key strengths that significantly facilitated the adoption of artificial insemination (AI) in goat farming in Kamrup, Assam (Table 2). The prime strengths was the region’s ‘favourable agro-climatic conditions’ (99.17 %), characterized by moderate temperatures and high humidity, which reduced heat stress in goats, thereby enhancing reproductive efficiency and improving AI success rates (Nair *et al.,* 2021). The second strength was ‘the availability of indigenous breeds’ (98.33 %), particularly the Assam Hill Goat (AHG), recognized for its adaptability and reproductive potential, which provided a robust genetic foundation for crossbreeding programs utilizing AI. Doley *et al.,* (2018) reported notable improvements in growth and reproductive traits when AHG was crossbred with Beetal goats through AI. The third strength was ‘the prevalence of traditional goat farming knowledge and practices’ among local farmers (87.50 %), which facilitated the integration of AI without disrupting established husbandry systems (Choudhary *et al.,* 2018). ‘Improved herd health and disease control’ (78.33 %) was the fourth strength, as AI reduced the risk of transmitting reproductive diseases compared to natural mating, thereby promoting herd health and lowering mortality (Wetengere 2009). Finally, ‘institutional and governmental support’ (73.33 %), notably from the Assam Livestock Development Agency (ALDA) and Krishi Vigyan Kendras (KVKs), provided essential training, infrastructure and technical inputs to promote AI adoption (ALDA, 2022; DuttaBaruah *et al.,* 2023). These findings are consistent with earlier studies by Gupta *et al.,* (2016) and Choudhary *et al.,* (2018), which emphasized the value of native breeds, low-input production systems and indigenous knowledge in strengthening livestock development.

**3.1.2 Key weaknesses impeding AI adoption in goat farming**

**Table 3: Key weaknesses impeding ai adoption in goat farming (based on mean percent score)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **WEAKNESS** | **Score Obtained** | **Mean Score** | **MPS (%)** | **Z-Score** | **Percentile Rank (%)** | **RANK** |
| **Lack of Awareness and Knowledge** | **117** | **0.975** | **97.50** | **+1.58** | **100** | **I** |
| **Cultural and Behavioural Resistance** | **112** | **0.933** | **93.33** | **+1.02** | **95** | **II** |
| **Shortage of Skilled AI Technicians** | **95** | **0.792** | **79.17** | **-0.66** | **60** | **III** |
| **Distance to AI Centre** | **94** | **0.783** | **78.33** | **-0.78** | **50** | **IV** |
| **Inconsistent Success Rates in Field Conditions** | **90** | **0.75** | **75.00** | **-1.16** | **25** | **V** |

The study identified and ranked five critical weaknesses that impeded the adoption of artificial insemination (AI) in goat farming in Kamrup, Assam (Table 3). The leading constraint was ‘lack of awareness and knowledge’ (97.50 %) among farmers regarding AI techniques, benefits and potential outcomes’, which significantly limited their readiness to adopt the technology (*Mazumder* *et al.,* 2024). The second major weakness was ‘cultural and behavioural resistance’ (93.33 %), where strong adherence to traditional practices and a preference for natural mating fostered scepticism towards AI adoption (Witjaksono *et al.,* 2021). The ‘shortage of skilled AI technicians’ (79.17 %) emerged as the third barrier, as the limited availability of trained personnel in rural and remote areas resulted in service delays and suboptimal outcomes (Joshi and Khanal 2021). The ‘long distance to AI centers’ (78.33 %) constituted the fourth weakness, often impeding timely insemination during the ideal breeding window (Ibrahim and Seid, 2022). Finally, the ‘inconsistent success rate of AI under field conditions’ (75.00 %), influenced by factors such as poor animal health, insufficient technician expertise and mistimed procedures, eroded farmer confidence and discouraged adoption (Sisay *et al.,* 2017).

These findings resonated with those of Lidga *et al.,* (2013), who underscored inadequate strategic planning and technical training as major limitations and Kumar *et al.,* (2014), who identified unfamiliarity with modern technologies and socio-cultural resistance as significant challenges to AI adoption in small ruminant farming systems.

**3.1.3 Key opportunities facilitating AI adoption in goat farming**

**Table 4: Key opportunities facilitating AI adoption in goat farming (based on mean percent score)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **OPPORTUNITY** | **Score Obtained** | **Mean Score** | **MPS (%)** | **Z-Score** | **Percentile Rank (%)** | **RANK** |
| **Expanding Demand for Meat and Milk** | **120** | **1.000** | **100.00** | **+1.57** | **100** | **I** |
| **Local Goat Breed Improvement** | **114** | **0.950** | **95.00** | **+0.83** | **90** | **II** |
| **Youth Participation in Livestock Sector** | **100** | **0.833** | **83.33** | **-0.39** | **70** | **III** |
| **Entrepreneurship Development** | **98** | **0.817** | **81.70** | **-0.65** | **60** | **IV** |
| **Climate-Resilient Breeding** | **88** | **0.733** | **73.33** | **-1.37** | **25** | **V** |

The study identified five key opportunities that could significantly facilitate the adoption of artificial insemination (AI) in goat farming in Kamrup, Assam (Table 4). The most prominent opportunity was ‘expanding demand for goat meat and milk’ (100.00 %), spurred by evolving dietary preferences and a growing health-conscious consumer base. Goat meat, unlike several other meats, enjoys broad cultural acceptance across all communities, enhancing its market potential (Anonymous, 2019). The second opportunity pertained to ‘genetic improvement of local goat breeds’ (95.00 %), whereby AI serves as a viable tool to enhance productivity traits and overcome limitations such as low growth and reproductive performance in indigenous breeds (Borah and Sharma, 2014). The third opportunity was ‘rising interest of rural youth in livestock-based livelihoods’ (83.33 %), which, if channelled through targeted training and awareness programs, could lead to increased adoption of modern goat farming practices (Mazumder *et al.,* 2024). Ranked fourth was the potential for ‘entrepreneurship development in AI-linked services’ (81.70 %) such as semen supply chains, mobile breeding units and private AI technician networks, thereby contributing to rural income generation (Hossain *et al.,* 2017). Lastly, ‘climate-resilient breeding through AI’ (73.33 %) was recognized as a strategic opportunity, enabling the selection and propagation of goats with improved heat tolerance, disease resistance and adaptability under changing environmental conditions (Nair *et al.,* 2021). These opportunities are consistent with prior studies by Choudhary *et al.,* (2018), who emphasized the potential of small ruminant farming in reducing rural poverty and promoting self-employment and by Legese and Fadiga (2014), who highlighted the significance of favourable agro-ecology and rising meat demand in supporting goat farming systems.

**3.1.4 Key threats to AI adoption in goat farming**

**Table 5: Key threats to AI adoption in goat farming (based on mean percent score)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| THREAT | Score Obtained | Mean Score | MPS (%) | Z-Score | Percentile Rank (%) | RANK |
| Inadequate AI Services in Remote Areas | 119 | 0.992 | 99.20 | +1.31 | 100 | I |
| Disease Transmission Risks | 118 | 0.983 | 98.33 | +1.14 | 95 | II |
| Climate-Related Stress and Natural Calamities | 117 | 0.975 | 97.50 | +0.97 | 90 | III |
| Low Success Rate in Remote Areas | 87 | 0.725 | 72.50 | -0.66 | 50 | IV |
| Dystocia in Initial Service | 62 | 0.517 | 51.70 | -2.76 | 10 | V |

The study identified five critical threats that constrained the adoption of artificial insemination (AI) in goat farming in Kamrup, Assam (Table 5). The foremost threat was ‘inadequate availability of AI services in remote areas’ (99.20 %), where limited infrastructure, scarcity of trained personnel and lack of equipment hindered timely and effective service delivery (Sisay *et al.,* 2017). The second threat was ‘risk of disease transmission due to improper sanitary practices’ (98.33 %) during AI procedures, which could compromise herd health and reproductive outcomes (Witjaksono *et al.,* 2021). The third was ‘climate-related stress and natural calamities’ (97.50 %), including floods, heat stress and prolonged humidity, negatively affecting animal health and fertility (Ingabire *et al.,* 2018). The fourth threat was ‘low success rate of AI in rural areas’ (72.50 %), often caused by poor logistics, lack of follow-up care and limited farmer knowledge (Mazumder *et al.,* 2024). Finally, ‘incidence of dystocia during initial AI attempts’ (51.70 %), especially in crossbreeding with exotic or larger breeds, posed a significant challenge requiring careful sire selection and pre-insemination health assessments (Mathewos *et al.,* 2023). These threats are consistent with observations made by Lidga *et al.,* (2013), Choudhary *et al.,* (2018) and Sisay *et al.,* (2017), who reported similar infrastructural, environmental and reproductive constraints in the context of AI adoption in small ruminants.

**3.2 Strategy Formulation through TOWS Matrix**

**3.2.1 Strengths–Opportunities (S-O) strategies**

**Table 6: S–O Strategies**

|  |  |
| --- | --- |
| **Strategy Code** | **Strategy Description** |
| S1 + O1, O2 | Leverage Assam’s climate to increase AI adoption for improved meat/milk productivity and enhanced local breeds. |
| S2 + O2, O5 | Use adaptable local breeds in AI programs to improve genetic traits and breed resilience against climate challenges. |
| S3 + O3 | Integrate indigenous practices with modern AI training to attract and empower rural youth in goat farming. |
| S4 + O5 | Apply AI to develop disease-resistant and climate-adaptive goat populations. |
| S5 + O4 | Utilize support from ALDA and KVKs to promote AI-based rural enterprises like mobile AI services and training hubs. |

To strengthen the future adoption of artificial insemination (AI) in goat farming in Assam, the strategic integration of internal strengths with emerging opportunities should be prioritized. Table 6 revealed that, the region’s favourable agro-climatic conditions (S1) should be effectively leveraged to meet the expanding demand for goat meat and milk (O1), while simultaneously supporting local breed improvement initiatives (O2). This alignment can enhance AI adoption, improve productivity and promote genetic advancement (Ingabire *et al.,* 2018). The availability of indigenous breeds, particularly the Assam Hill Goat (S2), should be utilized in AI-led breeding programs to improve traits such as growth, adaptability and disease resistance, contributing to climate-resilient breeding goals (O5) (Nair *et al.,* 2021). Traditional goat farming knowledge and practices (S3) can be mobilized through targeted youth engagement (O3), fostering generational renewal and promoting the integration of indigenous knowledge with science-based livestock management (Hossain *et al.,* 2017). Improved herd health and disease management practices (S4) should be integrated with AI-driven selective breeding to develop disease-resistant and climate-adaptive goat populations (O5). Finally, institutional and governmental support (S5), such as that provided by ALDA and KVKs, should be harnessed to promote entrepreneurship development (O4), including mobile AI service enterprises and training hubs. Collectively, these S-O strategies present a robust framework for scaling AI in goat farming, enhancing accessibility, productivity and sustainability across the region (Lohani and Bhandari, 2021). Therefore, a coordinated and context specific approach to AI adoption grounded in regional strengths and supported by enabling institutions will be crucial for transforming goat farming in Kamrup Assam. Future research and policy must focus on scaling these interventions to ensure long term productivity, rural livelihood security and genetic advancement.

**3.2.2 Weaknesses–Opportunities (W-O) strategies**

**Table 7: W–O strategies**

|  |  |
| --- | --- |
| **Strategy Code** | **Strategy Description** |
| W1 + O1 | Leverage rising demand for goat meat and milk to promote AI through targeted awareness campaigns. |
| W2 + O2, O3 | Promote AI adoption through local breed improvement programs and youth-driven livestock entrepreneurship initiatives. |
| W3 + O4 | Encourage AI technician services as rural micro-enterprises by offering training and capacity-building for local youth |
| W4 + O5 | Deploy mobile AI units in climate-vulnerable areas to improve access and promote breeding for climate-resilient traits |
| W5 + O2 | Improve AI success by utilizing resilient local goat breeds better adapted to field conditions. |

The strategies to address weaknesses and capitalize on opportunities for AI adoption in goat farming in Assam should be summarized as follows in the table 7. To overcome the lack of awareness and knowledge (W1), the expanding demand for goat meat and milk (O1) should be leveraged through targeted marketing and information campaigns, emphasizing the benefits of AI (DuttaBaruah *et al.,* 2023). To tackle cultural and behavioural resistance to AI (W2), AI adoption should be promoted by integrating it with local goat breed improvement programs (O2) and encouraging youth participation in livestock entrepreneurship (O3), thereby fostering acceptance and trust in the technology (Hossain *et al.,* 2017). Addressing the shortage of skilled AI technicians (W3), small business opportunities should be created by training local youth in AI technician services, supported by entrepreneurship development programs (O4) (Joshi and Khanal, 2021; Mazumder *et al.,* 2024). In areas facing distance to AI centers (W4), mobile AI units should be introduced, providing access to AI services and promoting climate-resilient breeding (O5), thereby addressing both logistical and environmental challenges. Lastly, to improve inconsistent success rates in field conditions (W5), the focus should be placed on enhancing AI success by improving and utilizing local goat breeds, which are better adapted to field conditions and more resilient (O2). These strategies should aim to integrate local resources with modern practices to strengthen AI adoption and its benefits in goat farming (Ingabire *et al.,* 2018). Hence, bridging knowledge gaps, enhancing accessibility, and promoting local capacity-building through context-specific opportunities will be essential to ensure the sustained and scalable adoption of AI in goat farming across Assam.

**3.2.3 Strengths–Threats (S-T) strategies**

**Table 8: S–T strategies**

|  |  |
| --- | --- |
| **Strategy Code** | **Strategy Description** |
| S1 + T3 | Leverage favourable agro-climatic conditions to develop climate-resilient breeding strategies and reduce climate-related stress. |
| S1 + T4 | Establish mobile AI units in favourable climates to boost success rates and accessibility in remote areas. |
| S2 + T5 | Educated farmers on preventing dystocia by using well-adapted indigenous breeds to enhance initial AI success. |
| S3 + T1 | Empower local farmers by integrating AI with traditional practices, using mobile units to deliver AI services in remote areas. |
| S3 + T2 | Promote AI adoption by combining traditional practices with modern disease control methods to reduce transmission risks. |
| S4 + T3 | Implement herd health management practices using AI to select climate-resilient goats and minimize environmental stress. |
| S4 + T5 | Utilize herd health management practices to reduce dystocia risks in initial AI services by ensuring proper care and selection of goats. |
| S5 + T2 | Partner with government agencies to implement disease-free AI protocols, reducing transmission risks in high-risk areas. |
| S5 + T1 | Leverage institutional and government support to create mobile AI units, improving service availability in underserved regions. |

To effectively mitigate key threats to artificial insemination (AI) adoption in goat farming, strategic integration of existing strengths should be essential. Table 8 highlighted that, the favourable agro-climatic conditions (S1) should be leveraged to expand mobile AI services in remote areas (T1) and to develop climate-resilient breeding programs addressing climate-related stress and natural calamities (T3) (Ingabire *et al.,* 2018). The availability of resilient indigenous breeds (S2) should support breeding initiatives aimed at overcoming low AI success rates in remote regions (T4) and reducing dystocia risks (T5). Traditional goat farming knowledge (S3) should be combined with modern practices to extend AI accessibility (T1) and minimize disease transmission risks (T2) through community-based education (Wetengere, 2009). Improved herd health and disease management (S4) should contribute to selecting and maintaining climate-resilient and reproductively efficient goats, tackling both environmental stress (T3) and dystocia (T5). Institutional and governmental support (S5) should be harnessed to establish disease-free AI protocols (T2) and expand veterinary and breeding services in underserved areas (T1). These integrated strategies should enhance AI success and sustainability across diverse farming systems (Dhara *et al.,* 2023; Ingabire *et al.,* 2018). Henceforth, aligning existing strengths with proactive measures to counter threats will be pivotal in ensuring resilient, accessible, and sustainable AI adoption in goat farming across Assam.

**3.2.4 Weaknesses–Threats (W-T) strategies**

**Table 9: W–T strategies**

|  |  |
| --- | --- |
| **Strategy Code** | **Strategy Description** |
| W1 + T1 | Develop community-based extension programs to raise awareness while linking farmers to mobile AI services. |
| W1 + T2 | Launch training modules on hygienic AI protocols to reduce risks of infection and enhance confidence in AI. |
| W2 + T5 | Promote culturally sensitive education that merges traditional knowledge with AI best practices to reduce fear of complications. |
| W3 + T1 | Establish local training hubs to build technician capacity and ensure consistent service delivery in underserved regions. |
| W3 + T4 | Upskill rural youth as AI technicians to enhance technical reach and improve conception outcomes in remote settings. |
| W4 + T3 | Deploy mobile AI units equipped for adverse climates to mitigate travel barriers and environmental disruptions. |
| W4 + T1 | Set up satellite AI points closer to remote clusters to minimize accessibility constraints. |
| W5 + T4 | Conduct adaptive trials using local breeds to improve AI reliability under field conditions. |
| W5 + T5 | Align AI practices with breed-specific reproductive profiles to lower complications and improve success rates. |
| W2 + T2 | Use peer educators to dispel myths and demonstrate biosecure AI practices within communities. |

To effectively address the combined weaknesses and threats hindering the adoption of artificial insemination (AI) in goat farming in Assam, targeted mitigation strategies should be implemented. As shown in table 9, awareness and knowledge gaps (W1) should be bridged by community-based extension and training programs that simultaneously address inadequate AI services (T1) and the risk of disease transmission (T2) through hygienic AI practices (Nair *et al.,* 2021). Cultural resistance (W2) should be tackled by integrating AI education with traditional beliefs, especially to mitigate fears of dystocia (T5), while peer-led models should help normalize safe AI use. The shortage of skilled technicians (W3) should be addressed by establishing local vocational training centers, thereby enhancing AI access and success rates in remote areas (T1, T4). To overcome the challenge of distance to AI centers (W4), mobile AI units should be deployed with climate-resilient features to ensure consistent service during natural calamities (T3) (Ibrahim and Seid, 2022). Field-level inconsistencies in AI outcomes (W5) should be managed by using adaptive trials with indigenous breeds, aligning services with breed-specific traits to reduce reproductive complications (T5) and improve success rates (Sisay *et al.,* 2017). These strategies should collectively enhance AI adoption by addressing the systemic weaknesses while minimizing external threats in the region. Overall, a comprehensive mitigation approach targeting both systemic and contextual barriers will be key to strengthening AI adoption in goat farming across Assam.

4. Conclusion

To strengthen the future of artificial insemination (AI) in goat farming in Kamrup, Assam, a multi-pronged strategy integrating internal strengths, addressing systemic weaknesses, leveraging emerging opportunities, and mitigating contextual threats is essential. Harnessing the region’s favourable agro-climatic conditions and indigenous breeds alongside traditional knowledge, youth engagement, and institutional support can significantly enhance AI accessibility and genetic improvement. Simultaneously, targeted interventions such as awareness campaigns, mobile AI services, vocational training, and adaptive breeding trials are necessary to overcome knowledge gaps, cultural resistance, technical limitations, and environmental challenges. A coordinated and inclusive approach involving community stakeholders, veterinary institutions, and government agencies will be vital in transforming AI into a sustainable and widely accepted practice in goat farming across the region.

Consent

All authors declare that verbal informed consent was obtained from all the respondents prior to data collection. The purpose of the study was clearly explained to each participant, and confidentiality of responses was assured. No personally identifiable information has been published in this manuscript.

Ethical approval

All authors hereby declare that the research involved voluntary participation of farmers with informed consent. No animals or clinical patients were involved in this study. Ethical considerations such as anonymity and privacy of responses were maintained throughout the research process.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

References

1. Anonymous. (2019). Avoiding religious taboo, government scheme for goat meat. Times of India, February 4. Retrieved from <https://timesofindia.indiatimes.com/city/goa/avoiding-religious-taboo-government-scheme-for-goat-meat/articleshow/68056203.cms>.
2. Assam Livestock Development Agency (ALDA). (2022). District Wise Annual AI Progress Report, 2021–22. Animal Husbandry and Veterinary Department, Assam. Retrieved from <https://livestock.assam.gov.in/portlets/ai-progress-of-the-state>.
3. Borah, S. K., & Sharma, R. (2014). The Assam Hill Goat: Its adaptation and utilization in Assam's agro-climatic conditions. Journal of Animal Science and Veterinary Medicine, 2(3), 122–130.
4. Choudhary, F., Khandi, S. A., Bafanda, R. A., & Shehjar, F. (2018). SWOT analysis of sheep and goat rearing practices of Bakarwal tribe in Jammu district of Jammu and Kashmir. Journal of Experimental Biology and Agricultural Sciences, 6(5), 898–902. DOI: <http://dx.doi.org/10.18006/2018.6(5).898.902>
5. Department of Animal Husbandry & Dairying (DAHD). (2020). 20th Livestock Census of India: Assam report. Ministry of Fisheries, Animal Husbandry & Dairying.
6. Dhara, S., Thakur, S., Anwar, S. M. S., Gupta, M. D., & Sinha, S. (2023). Artificial insemination in goat: A new prospect for scientific goat breeding. Animal Reproduction Update, 3(2). <https://doi.org/10.48165/aru.2023.3.2.1>
7. Doley, M. K., Baruah, N., Deka, A. K., Maibangsa, S., Bhuyan, S., & Phookan, A. (2018). Performance of Assam Hill Goat and their crossbred Beetal through artificial insemination in hill district of Assam. International Journal of Agriculture Sciences, 10(10), 6168–6169.
8. Dutta Baruah, N., Borah, B., Ahmed, N., Borah, P., Dutta, M., Gogoi, D., *et al*. (2023). An assessment to measure knowledge level of goat farmers on artificial insemination (AI), Assam, India. International Journal of Statistics and Applied Mathematics, 8(6S), 901–905.
9. Gupta, P., Gupta, V., Ishar, A., Sharma, V., & Panotra, N. (2016). SWOT analysis of small ruminants rearing of Bakarwal tribe in district Rajouri of Jammu and Kashmir. Journal of Animal Research, 6, 1057–1060. https://doi.org/10.5958/2277-940X.2016.00154.6
10. Hossain, M. M., Alam, M. K., & Haque, M. (2017). Livelihood improvement of poor farmers through goat rearing in Mymensingh district of Bangladesh. Bangladesh Journal of Animal Science, 46(1), 29–36.
11. Ibrahim, M., & Seid, M. (2022). Assessment of constraints of artificial insemination service in smallholder dairy cattle keepers in Kacha Bira District of Southern Ethiopia. International Journal of Veterinary Science and Medicine, 10(2), 10081891. <https://doi.org/10.1155/2023/6512010>
12. Ingabire, M. C., Liu, Y., Pesha, J. C., & Alhassan Hardi, A. (2018). Factors affecting adoption of artificial insemination technology by small dairy farmers in Rwanda: A case of Rwamagana District. Journal of Economics and Sustainable Development, 9(12).
13. Joshi, P., & Khanal, S. (2021). Current status and future prospects of artificial insemination in goats in Nepal: A review. Big Data in Agriculture, 3(1), 31–34.
14. Kumar, V., Singh, B. P., Dutta, T., Kumar, R., & Maousami. (2014). Perceived constraints and suggestions in adoption of goat husbandry technologies: A study in semi-arid zone of Uttar Pradesh. Indian Journal of Animal Sciences, 84(8), 897–902. <https://doi.org/10.56093/ijans.v84i8.43283>
15. Ligda, C., Sossidou, E., & Tzouramani, I. (2013). Domestic project: Challenges and strategies for the sustainable development of the pastoral and rangeland sheep and goat production systems in Ipeiros region in Greece. Proceedings of the 10th International Symposium on Modern Trends in Livestock Production, October 2–4, 2013.
16. Mathewos, M., Endale, H., Tesfahun, M., Tiele, D., & Bukero, R. (2023). Assessment of constraints of artificial insemination service in smallholder dairy cattle keepers in Kacha Bira district of Southern Ethiopia. Veterinary Medicine International, 31, 6512010.
17. Mazumder, A., Hoque, M. J., Kundu, A. K., & Afrin, S. (2024). Farmer’s challenges in adopting artificial insemination of cattle in Bangladesh. Journal of Fisheries, Livestock and Veterinary Science, 1(1), 10–17. <https://doi.org/10.18801/jflvs.010120.02>
18. Nair, M. R. R., Sejian, V., Silpa, M. V., Fonsêca, V. F. C., de Melo Costa, C. C., Devaraj, C., Krishnan, G., Bagath, M., Nameer, P. O., & Bhatta, R. (2021). Goat as the ideal climate-resilient animal model in tropical environment: Revisiting advantages over other livestock species. International Journal of Biometeorology, 65(12), 2229–2240. https://doi.org/10.1007/s00484-021-02179-w
19. Sisay, W., Tamene, D., Worku, G., Kidanu, D., Getahun, B., & Nuraddis, I. (2017). Evaluation of artificial insemination efficiency in and around Ejere District, Western Shoa Zone, Ethiopia. Journal of Reproduction and Infertility, 8(3), 66–71. <http://doi.org/10.5829/idosi.jri.2017.66.71>
20. Wetengere, K. (2009). Socio-economic factors critical for adoption of fish farming technology: The case of selected villages in Eastern Tanzania. International Journal of Fisheries and Aquaculture, 1(3), 28–37.
21. Witjaksono, J., Dahya, T., Tando, E., & Rinaldi, J. (2021). Farmers’ attitude and factors influencing the adoption of artificial insemination in goat farming system. E3S Web of Conferences, 232, 01020.