

Effect of Soybean-based Semen Extender on Goat Artificial Insemination (AI) Conception and Factors Determining Conception Rate

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Abstract

One of the programs implemented by Isabela State University (ISU) and the Cagayan Valley Agricultural and Resources Research and Development (CVARRD) was the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) funded regional project entitled “*Enhancement of Artificial Insemination and Meat Processing Technologies Towards Production of Quality Slaughter Goats in Cagayan Valley*”, completed in 2011. The project had two components, one was focused on the developing improved goat semen extender using soybean lecithin and artificial insemination delivery system in Region 2.

This paper is a portion of the assessment results of this component, focusing on the effect of using soybean-based extender on goats’ conception and the factors that determine conception rate. Through the project, a cheaper extender named SemEx was produced. Conception rates of goats under AI was found to be comparable regardless of the type of extender used, indicating that soybean lecithin can be a potential alternative to egg yolk in terms of formulation, so that either type of extender can be used for processing semen and using it for AI.

Factors that determine conception rate were analyzed using multiple regression. The explanatory variables considered were number of years of adoption of AI technology, type of extender, farmer’s knowledge on estrus, farmer’s adoption of estrus synchronization, attendance to seminars on AI, and farmer’s adoption of housing in goat raising. The *a priori* assumption of each explanatory variable’s relationship to conception rate was positive. Based on the results, the farmers’ knowledge of the signs of a doe in estrus plays an important role in determining the right time for insemination, and farmers who had more years exposed to the technology had higher conception rate on goat AI. Farmers’ knowledge of estrus is the most important factor to goats’ success in conception.

Keywords: Conception rate, artificial insemination (AI), AI extender, estrus

I. Introduction

Artificial insemination (AI) has been used in many developed countries as an effective breeding tool for goats to rapidly improve their genetic makeup by using extended or frozen semen from superior bucks. However, AI on goat in the region and elsewhere in the country was relatively new and not yet widely adopted. Hence, there was a need for a delivery system so AI services can be done among goats in order to facilitate goat upgrading. The Isabela State University (ISU) and the Cagayan Valley Agriculture and Resources Research and Development (CVARRD) spearheaded AI delivery in Region 2. One project that was implemented was entitled “Enhancement of Artificial Insemination and Meat Processing Technologies Towards Production of

Quality Slaughter Goats in Cagayan Valley” with funding from the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD).

The project was completed in 2011. One of the project’s component developed a cheaper extender named as SemEx, a soybean lecithin-based semen extender as a possible alternative to egg yolk-based extender and identified a delivery system for artificial insemination (AI). The project involved the Isabela State University (ISU) in partnership with the Department of Agriculture, Provincial Veterinary Office and the Local Government Units in Region 2.

After years of project completion, the extent of adoption of AI technology and the use of the different semen extenders were examined. In the process, effect of using soybean-based extender on goats’ conception and the factors that determine conception rate were the focus. The results of the study provide information of the success of AI as measured by goat’s conception rate and the factors that could be attributed to their conception rate.

II. Data and Methods

A. Data

There were 184 of 197 goat raisers and 24 of 40 service providers from various municipalities of Isabela, Cagayan, Batanes, and Quirino, based from the list provided by the project implementers. These were the goat raisers and service providers who attended the meetings/seminars conducted by ISU under the project. Those who were not interviewed have transferred to places other than their known addresses, went abroad, or due to inaccessibility.

Primary and secondary data were obtained from ISU which is the producer of semen extender. Focus group discussions (FGD) among project implementers, and personal interview of service providers and goat raisers were conducted. To get additional information regarding extenders and artificial insemination on goat, personal interview was also done with the Regional Artificial Insemination Coordinator (RAIC) of the Department of Agriculture Regional Field Office 2, staff of Nueva Ecija Stock Farm, and service provider from the Central Luzon State University (CLSU). Secondary data were also obtained from the terminal/accomplishment reports as provided by PCAARRD Socio-Economic Research Division (SERD), and documents from RAIC.

B. Methods

The extent of adoption of the technology that was translated to impacts were assessed. Relevant to the focus of this paper, the following procedures were used:

- i. *Examination of Adoption Characteristics.* This entailed determination of level of adoption and mapping the timeline for adoption. Adoption was examined among the service providers and goat raisers.
- ii. *Analysis of factors to explain conception rate.* The effect of using soybean-based extender on goats’ conception and the factors that determine conception rate were analysed using Multiple Regression. The dependent variable, Y, was expressed in % computed by:

$$\text{Conception rate of AI} = \frac{\text{number of does which conceived}}{\text{number of does inseminated}} \times 100 \% \quad (1)$$

The explanatory variables considered were number of years of adoption of the AI technology (X_1), type of extender (X_2), farmer’s knowledge on estrus (X_3), farmer’s adoption

of estrus synchronization (X_4), attendance to seminars on AI (X_5) and farmer's adoption of housing in goat raising (X_6). The *a priori* assumption of each explanatory variable relationship to conception rate is positive. The regression model used for the goats' conception rate (Y) as reported by goat raisers is given below. In this model, β_0 , β_i 's and e_i denotes the intercept, the regression coefficients and the error respectively.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e \quad (2)$$

The coefficient of determination, RMSE and the significance of the model were used primarily as the criteria in determining the final model to define the data set. In addition, the number of significant explanatory variables and their signs were used.

III. Results and Discussion

A. Description of *SemEx*, the soybean-lecithin based semen extender

The soybean-lecithin semen extender, with brand name *SemEx*, was developed. *SemEx* was produced as an improved semen extender to replace the egg yolk-based extender for longer semen viability and post-thaw motility of frozen spermatozoa. The formulation of semen extender was conducted at the existing semen laboratory of ISU. The extender increased semen motility and was found cheaper than the egg yolk-based extender using fresh egg yolk. From 2009 to 2011, about 200 does were synchronized in project sites (Echague, Jones, Alicia, and Santiago in Isabela, and Bayombong in Nueva Vizcaya) to test the successful conception rate of AI using the formulated extenders. Results showed 70% (70/100) does were verified pregnant using the traditional egg yolk-based extender, and 75% for does inseminated with soybean lecithin-based extended semen (Balbin et.al, 2012). This positive result from the laboratory was the basis in developing further soybean lecithin as extender for processed semen. *SemEx* and the protocol have registered patents under the Philippine Intellectual Property Office (IPO).

B. Examination of Adoption Characteristics

Number of adopters. The number of adopters is an indicator of the success of the AI technology transfer of the project. This project considered the AI service providers who used *SemEx*-processed semen and raisers whose goats were inseminated with the same as technology adopters. Figure 1 shows the adoption per year from 2009 to 2018. Adoption showed increasing trend until 2012, reaching peaks for both goat raisers and service providers in the same year. After this period, there had been a decreasing trend especially for service providers. Meanwhile, the number of goat raisers who adopted increased again after a decrease in 2013.

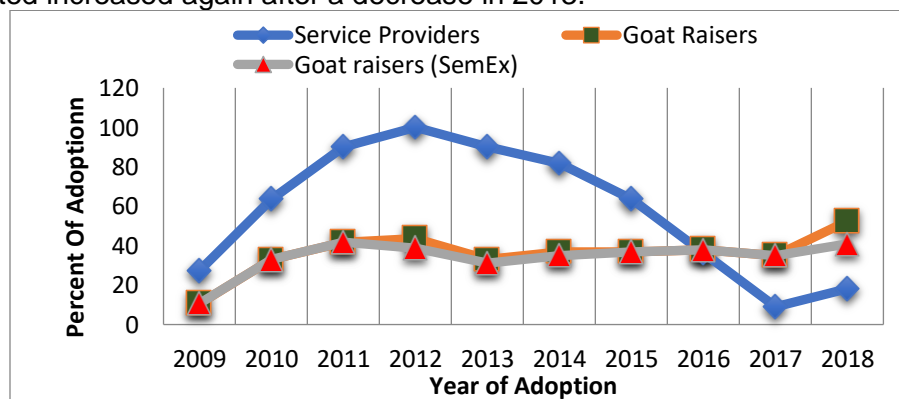


Figure 1. % adoption per year by service providers and goat raisers (*SemEx* and non-*SemEx* users)

Training of goat raisers and AI service providers. To enhance the delivery systems' effectiveness, trainings of potential AI service providers were conducted. It included a combination of lectures, demonstration of semen collection and processing, and actual insemination of goats. There were three (3) trainings conducted with a total of 63 technicians from DA stations, SUCs and LGUs from the Batanes, Isabela, Cagayan, Nueva Viscaya, and Quirino of Region 2 and Mt. Province in CAR and 127 goat raisers. The trained technicians organized the goat raisers within their areas, performed AI on goats and conducted field visits to monitor the does under trial. During the project life, the trained technicians organized the farmers in their areas of assignment, presented project details and collected baseline information among the goat raisers. To facilitate the initial activities of the project and AI estrus synchronization was also employed. Each of the trained AI technicians were given duckbill speculum and semen for free. The private inseminators hoped to be paid P350 by farmers as fee per insemination while technicians from LGUs and ISU provided the service for free as part of their job. In addition, an incentive of P100 per kidding was also hoped to be provided by the UNAIP.

To date (October 2018), there are only two (2) trained service providers (8.33%) out of 24 who are still providing AI services on goats. One service provider is a designated ISU technician from Cagayan while the other one is a technician in Batanes Provincial Veterinary Office. The latter only started providing AI service in 2018 despite being trained during the time of project's implementation. This is because it was only in 2018 that DA-Batanes had a program on AI for goat.

Characteristics of the AI Adopter Respondents

Table 1 presents distributions and statistics on some characteristics of goat raisers who adopted AI technology. The respondents as a whole are relatively middle aged (M = 50.1, SD = 12.04), however, it can be noted that there are five (4.85%) who are only at most 30 years of age. Majority (67 or 65.05%) of the respondents have been in goat farming for not more than 10 years, while 84 or 81.55% have adopted AI technology for at most 4 years to date. Based on the survey, around half (55 or 53.40%) have attended seminars related to AI technology, and 70 (67.96%) and 33 (32.04%) have adopted AI technology using SemEx and egg yolk-based semen extenders, respectively.

Table 1. Distribution and Descriptive Statistics on Characteristics of the AI Adopter Respondents

Characteristic	Frequency (n=103)	Percent	Descriptive Statistics
Age			
<= 30	5	4.85	Mean = 50.1 SD = 12.04 Range: 23 – 75
31-40	20	19.42	
41-50	25	24.27	
51-60	29	28.16	
> 60	24	23.30	
Years in Goat Farming			
< = 5	29	28.16	Mean = 11.7 SD = 9.24 Range: 1 – 56
6-10	38	36.89	
11-15	14	13.59	
16-20	10	9.71	
21-25	6	5.83	
>25	6	5.83	

Years Adopted AI			Mean = 2.9 SD = 2.50 Range: 1 – 10
1-2	62	60.19	
3-4	22	21.36	
5-6	5	4.85	
7-8	6	5.83	
9-10	8	7.77	
Attended Seminars on AI			
No	48	46.60	
Yes	55	53.40	
Type of Semen Extender adopted			
SemEx	70	67.96	
EggYolk based	33	32.04	

C. Goats' Conception Rates

As of 2018, there were 42 (22.8%) out of the total 184 goat raisers interviewed who are continually availing AI services (using SemEx-processed semen) for their goats. Others did not adopt AI (81 or 44.0%). For this IA study, the 103 (56.0%) goat raisers who have adopted AI, who had at least one goat subjected to AI, were interviewed to determine the performance of soybean lecithin-based extended semen on goat vis avis the egg yolk-based extender processed semen. Some of the goat raisers were not aware of what extenders was used, hence the data on type of extender used was based on who their service provider was. ISU technician used the soybean based-extended semen, while other technicians mostly used egg-yolk based extended semen from RAIC. This was corroborated with the validation made with AI service providers.

Thus, of the 103 adopters, 70 (68.0%) and 33 (32.0%) made use of SemEx and Egg yolk based processed semen extenders respectively. Sixty-two (60.2%) among them have experienced success in at least one doe subjected to AI, distributed as 43 (61.4% of 70 for SemEx) and 19 (57.6% of 33 for egg-yolk based). Table 2 below further gives information on the experience of adopters of AI categorized in terms of the variables which are deemed to have contributed on the conception rate of AI on goat regardless of the type of extender used.

Table 2. Number of AI Adopters and Mean % Conception Rate by Adopter Characteristic

Characteristics of Adopters of AI		Number of Adopters		Conception Rate (%)		Point Biserial Correlation			
						All Adopters (n=103)		SemEx Adopters only (n=70)	
						Freq.	Percent	Mean	SD
Adopted semen extender	SemEx	70	68.0	52.58	45.65	0.037	0.712		
	Egg yolk based	33	32.0	48.99	46.43				
knowledge of estrus	YES	77	74.8	56.68	45.06	0.198*	0.044	0.335**	0.005
	NO	26	25.2	35.90	44.89				
Adopts estrus synchro	YES	49	47.6	57.14	45.80	0.120	0.229	0.106	0.383
	NO	54	52.4	46.25	45.42				
Adopts housing on goat raising	YES	57	55.3	56.68	45.05	0.128	0.196	0.259*	0.030
	NO	46	44.7	44.93	46.16				
Attended seminar	YES	55	53.4	54.27	45.07	0.067	0.502	0.185	0.126
	NO	48	46.6	48.18	46.68				

* - significant at 0.05

** - significant at 0.01

D. Factors Affecting Goat's Conception Rate

Also in Table 2, mean conception rate experienced by adopters of AI when classified into groups according to the different categorical characteristics were compared. These variables or groupings are namely: type of semen extender adopted, knowledge of estrus, adoption of estrus synchronization, adoption of housing on goat raising, and having attended AI seminar. Those who have adopted SemEx and those who were classified under 'Yes' in the different categorical characteristics were observed to have higher mean conception rates. This however have to be verified if there really are relationships between these characteristics and conception rate. Using Point Biserial correlation, t-test at 0.05 level of significance, conception rate and knowledge of estrus were found to have a significant positive correlation ($r_b = 0.198$, $p=0.044$, $n=103$). Further, among SemEx adopters only ($n=70$), significant positive correlations between conception rate and knowledge of estrus ($r_b = 0.335$, $p=0.005$) and in addition, as well as with the adoption of housing in goat raising ($r_b = 0.259$, $p=0.030$) were observed. In Table 3, number of years of adoption of the AI technology also may have a positive effect on conception rate, especially among the SemEx adopters ($r=0.344$, $p\text{-value} = 0.004$).

Table 3. Relationship between Conception Rate and Number of Years of Adoption of AI Technology

Characteristic	All Adopters (n=103)		SemEx Adopters only (n=70)	
	r	p-value	r	p-value
Number of years of Adoption of AI	0.187	0.058	0.344**	0.004

Variables that are likely to determine the conception rate of AI as experienced by goat raisers were included in the model, using the data on the 103 goat raisers. The explanatory variables considered were type of extender (X_1), knowledge of estrus (X_2), number of years of adoption of AI technology (X_3), attendance to AI seminars (X_4), farmer's adoption of estrus synchronization (X_5), and farmer's adoption of housing in goat raising (X_6). All these variables are dichotomous, except for the number of years of adoption of the AI technology. The *a priori* assumption of each explanatory variable relationship to conception rate was positive. In the preliminary investigations, only the knowledge on estrus was found to have a significant relationship with conception rate experienced by adopters.

Based on the analysis results on factors influencing conception rate in Table 4, knowledge of estrus significantly influenced conception rate ($p<0.05$). The positive sign of the coefficient means that for goat raisers who are aware in determining the goats' estrus or heat period, higher conception rate on AI is expected. Does exhibit estrus or heat period for 2-3 days every 18-21 days interval throughout the year. During this time, the doe is receptive to the buck and is manifested by "standing heat". In artificial insemination, conception rate is greatly affected by the timing of insemination. Thus, farmers' knowledge of the signs of a doe in estrus plays an important role in determining the right time for insemination. Farmers' years of adopting AI as a technology to breed goats was also found significant ($p<.05$) with a positive coefficient. This indicates that farmers who had more years exposed to the technology had experienced higher conception rate on AI. This could also be associated with correct timing of goats' in heat and call forth for AI service. The type of semen extender has no significant relationship with conception rate (Table 2). Either type of extender can be used for processing semen and using it for AI. Beta coefficients indicate knowledge of estrus as the most important factor to success in conception.

The final regression model (p-value = 0.016) using backward elimination procedure was chosen because it has the lowest RMSE (44.05) and highest adjusted R-square (0.098) and R-square (0.071), to wit:

$$\text{Conception rate} = 9.424 + 3.670 \text{ Number of years adopt} + 18.614 \text{ Type of extender} + 21.302 \text{ Knowledge of estrus}$$

Table 4. Regression results on factors influencing conception rate

Source of Variation	Sum of Squares	DF	Fc	P-value
Regression	20967.991	3	3.602	0.016
Error	192108.976	99		
Total	213076.968	102		

Variables	Coefficients	Std. Error	t-values	p-value
Constant	9.424	14.275	0.660	0.511
X ₁ Years of adoption of AI tech	3.670	1.751	2.095*	0.039
X ₂ Type of extender	18.614	11.478	1.622	0.108
X ₃ Knowledge of estrus	21.302	9.997	2.131*	0.036

R² = 0.098
Adj R² = 0.098
RMSE = 44.05

*Significant at 0.05 level

Increased income from adoption by farmers and inseminators.

Through AI, the goat raisers were ensured to upgrading their stocks in the absence of a quality buck. During the project's life span (2009-2011), goat raisers incurred an average incremental net income of Php1,250.33 in having their goats inseminated using soybean lecithin extended semen. Similar analysis was done after the project until this IA period (2012-2018). Result showed goat raisers' average incremental benefit for using a soybean-based semen extender was about Php927.42 (Table 5). This was based on the mean conception rates of 52.58% for goats inseminated using soybean lecithin-based extended semen and 48.99% for its counterpart. Their income was highly dependent of the success rate of the AI services and the number of animals they raised during the period. The higher these values, the higher is the net benefit, and the lower the values the lower is the net benefit.

Table 5. Comparison of income of farmer using soybean lecithin and egg-yolk based semen extender for goat (based on average conception rate from 2012-2018)

	Income of Goat Raiser	
	with soybean lecithin based semen extender	with egg-yolk based semen extender
Average no. of goats inseminated/raiser ¹	5	5
Does Conceived ²	2.63	2.45
Total kids born (hd) ³	3.94	3.67
Mortality (20%)	0.79	0.73
Total kids reared (hd)	3.15	2.94
Selling price ¹	4,305.56	4,305.56
Income of farmer	13,583.18	12,655.76
Additional Benefit/Loss per Raiser = Php 927.42		

¹ Based on the survey results

² Average no. of goats inseminated/raiser multiplied to the conception rate of each animal (soybean lecithin (52.58%) and egg-yolk based (48.99%))

³ No. of does conceived multiplied by kid size

The project's goal of promoting the technology by using the semen extender and delivering the AI technology to the farmers was also able to attain social benefits in the perspective of the raisers themselves (Figure 2). The most reported social benefit was solving the problem of having limited to no access to quality breeders. Instead of physically transporting the bucks from one place to another, the AI technology was able to make it more accessible. In addition, more does can be serviced compared to natural mating. Moreover, the general value of the goats in the community was also considered a notable improvement in the region. Other benefits that were mentioned was the perceived increased number of those who ventured into goat raising, readily available goat for slaughter during special occasions, and their areas being recognized as a good source of quality goats.

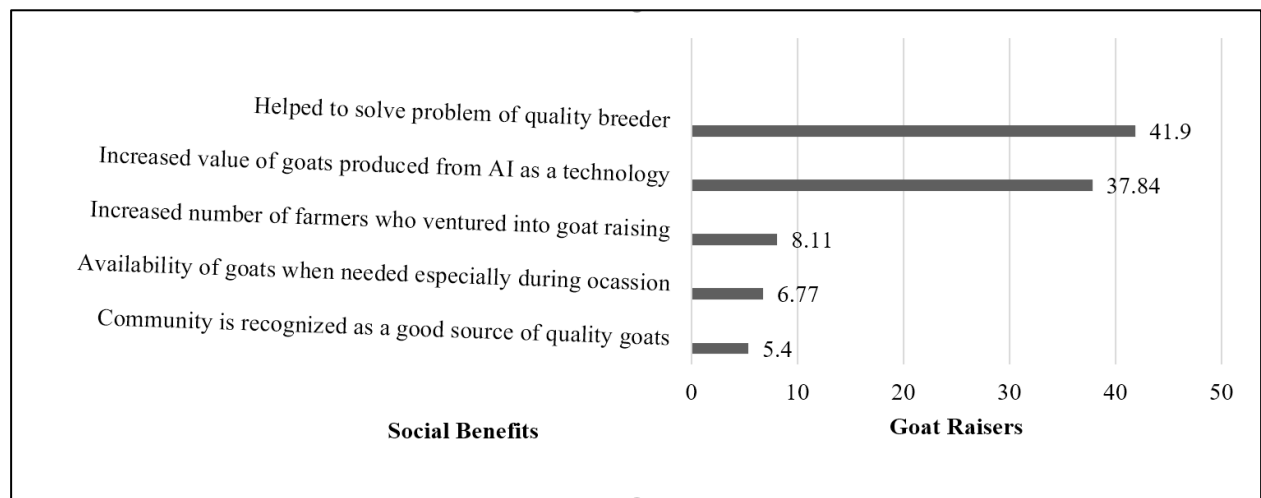


Figure 2. Perceived social benefits from the project

Summary and Conclusion

The PCAARRD funded project implemented by ISU developed technologies was in response to the problems associated with AI delivery in Region 2. Many farmers have limited knowledge on AI as a breeding technique in goat and there was a need to develop technologies on semen extender to improve the current egg yolk-based extender. The project was successful in generating the technology of improved semen extender, 'SemEx'. As part of its technology commercialization, the process and SemEx were applied and are now registered for patent under the Philippine Intellectual Property Office (IPO).

During the project life, trainings were conducted by ISU to capacitate the AI service providers in the target areas. Most of the participants were endorsed by their respective offices in consideration of their current involvement as livestock technicians. The purpose of the trainings was to get them involved in AI on goat hence facilitate the downloading the technology to goat raisers.

The number of client goat raisers had not increased significantly over time. As of 2018, out of 103 goat raisers interviewed, only 42 farmers were continually availing AI services (using SemEx-processed semen) representing 40.77%. Nonetheless, efforts to make the delivery of AI service is very challenging.

Among those whose goats were inseminated, numerically higher conception rate of 52.58% for SemEx and 48.99% for egg yolk, was derived. These values are comparable, indicating that the performance of goats under AI is comparable regardless of extender used. What explained the difference in conception at the farm level are the farmers' knowledge of estrus and the years AI had been adopted as a breeding technique. Nonetheless, the change in conception rate resulted in an added benefit of Php1,250.33 (computed in 2009-2011 during the project) and Php927.42 (2012-2018 after the project) per farmer. It is in this context that soybean lecithin can be a potential replacement to egg yolk in the formulation. True enough, the project was able to produce a technology that is cheaper whose performance is comparable to the prevailing one.

Recommendations

In essence, higher project worth could be attained if there will be higher adoption of the technologies. To attain this, the following are recommended in relation to component 1:

1. An incentive in doing AI service is recommended so private inseminators can make AI service as a source of income. The cost of AI service should be compensated by the remuneration of service.
2. To ensure higher success among goats under estrus synchronization, capability enhancement among inseminators and goat raisers could be an intervention.
3. Continued implementation of AI program at the regional, provincial and local levels especially in areas with difficult access to quality breeders;
4. For ISU to continue to produce SemEx and promote the same to DA as potential alternative to egg yolk-based extender;
5. Continue to capacitate LGU technicians who are and will be directly involved in AI services;

Bibliography

Balbin, A. J. M. et.al 2012. Development of Improved Goat Semen Extenders and Artificial Insemination Delivery System in Region 2. Unpublished Terminal Report.

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