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Analysis in making decision of farmer to select bull frozen semen in Indonesia

R. Agustine[1], S. Bintara[2], S. Andarwati[1], M. A. U. Muzayyanah[1], T. S. M. Widi[3] and A. R. S. Putra[1,*]

[1]Department of Livestock Social Economics, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281 - Indonesia
[2]Department of Animal Breeding and Genetics, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281 - Indonesia
[3]Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta 55281 - Indonesia
**Corresponding E-mail: ahmadromadhoni@ugm.ac.id*

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ABSTRAK

Penelitan ini bertujuan untuk menganalisis pengambilan keputusan yang dilakukan oleh peternak dalam memilih semen beku dari bangsa sapi pejantan unggul untuk Inseminasi Buatan (IB). Terdapat lima jenis pilihan semen beku yang berasal dari lima bangsa sapi pejantan unggul yang disimulasikan dalam penelitian ini, antara lain Simmental, Limousin, Peranakan Ongole, Brahman, dan pilihan lainnya. Pilihan lainnya digunakan apabila peternak tidak mengetahui jenis semen beku yang digunakan dalam IB. Peternak harus memilih salah satu dari kelima pilihan tersebut yang sesuai untuk sapi induk yang akan diinseminasi. Pengambilan data dilakukan dengan wawancara menggunakan kuesioner yang diperoleh dari 400 peternak rakyat yang berdomisili di Provinsi Jawa Tengah dan Daerah Istimewa Yogyakarta. Teknik *multistage random sampling* digunakan untuk menentukan responden tersebut. Analisis statistik deskriptif dan regresi multinomial logistik merupakan analisis yang digunakan dalam penelitian ini. Hasil penelitian menunjukkan bahwa semen beku dari sapi pejantan bangsa Simmental lebih disukai peternak (42%), begitu juga semen beku dari sapi pejantan bengsa Limousin (30.75%). Pengambilan keputusan yang dilakukan peternak dalam memilih semen beku sapi pejantan untuk IB dipengaruhi oleh enam faktor, antara lain jumlah anggota keluarga, biaya IB, kepemilikan lahan, *breed* sapi induk yang diinseminasi, lokasi penelitian, dan pengetahuan peternak tentang inseminator setempat.

Kata kunci: Inseminasi Buatan, Sapi potong, pengambilan keputusan, peternak rakyat

ABSTRACT

The research objectives was to analyze the farmer's decision in selecting breed of bull frozen semen for Artificial Insemination (AI) and determine the factors influencing the decision. There were five bull frozen semen options which simulated in this research, such as Simmental, Limousine, Ongole Grade (*Peranakan Ongole /* PO), Brahman, and other option. "Other" option was used if the farmer did not recognize what breed of frozen semen was inseminated to their cow. Farmers must choose only one option of bull frozen semen that suitable for their cow. This study was conducted by collecting data using questionaire from 400 beef cattle's farmers in Central Java Province and Yogyakarta Province. Respondents were selected by multistage random sampling technique. Descriptive statistical analysis and multinomial logistic regression analysis was used in this study The results revealed that 42% of

farmers were more interested in inseminating their cows with bull semen from Simmental, and 30.75% of farmers were more interested in Limousin. Other variables such as family member, AI's cost, land ownership, cow breed which lastly being inseminated, geographical factor, and farmer's knowledge about the inseminators were variables that determine farmer's decision process.

Keywords: Artificial Insemination, beef cattle, decision making, smallholder farmers

INTRODUCTION

Beef cattle have an important role in the national economy and the economy of smallholder farmers (Haq *et al*., 2019). Nowadays, demand of the animal protein increases rapidly as the increase of global population, population displacement, and livelihood enhancement (Haq *et al*., 2019; Thundathil *et al*., 2016). Improvement of beef productivity will support the requirements of animal protein for human needs (Lamb *et al*., 2016). One of the solution to answer the challenge of beef productivity is to improve the cattle reproduction with technology intervention such as Artificial Insemination (AI) (Thundathil *et al.*, 2016). AI as a reproduction technology have been applied not only to improve productivity but also to realize rapid genetic gains (Mwanga *et al.*, 2018). AI technology can also be accessed by smallholder farmers in relatively affordable cost expenses and may produce more healthy offspring (Rathod *et al*., 2017).

Frozen semen of Simmental, Limousin, Ongole Grade (PO), and Brahman are often chosen by farmers, especially farmers in Central Java and Yogyakarta Province. Therefore, farmers must decide to choose only one type of frozen semen that was suitable for their cow. Research on decision making in selecting frozen semen for AI has never been done before.

Previous study used decision making analysis to determine farmer's decisions in adopting technology, such as AI. The distribution of AI adoption is possibly caused by variation in socio-economic status, information access and scientific orientation in the study area (Rathod *et al*., 2017). Previous study in Yogyakarta Province, Indonesia reported that smallholder farmer's decision to adopt AI is influenced by cattle ownership, membership of farmer's group, knowledge of the technology utilization, and activeness in seeking relevant information about technology (Putra *et al.*, 2017). The adoption of AI occurred when smallholder farmers perceive that the innovation will enhance the attainment of their personal goals, such as economic, social, and environmental goals (Pannell *et al.*, 2006). Furthermore, adoption among smallholder farmers is strongly associated with their socio-economic characteristics and access to accessibility of funding (Putra *et al.*, 2016).

Central Java and Yogyakarta Province have more than 60% of beef cattle farmers (Badan Pusat Statistik, 2013). Thus, the two provinces are suitably used as research locations. This study focused on farmer's preference for choosing bull semen for their cow. Farmer's decision to select bull semen usually considers the internal and external factors that can be qualitative or quantitative. Internal factors are inherent characteristics in decision making, while external factors are factors that originate from outside or from the environment. Internal factors are often associated with farmer characteristics in age, education level, and family member. External and environmental factors refer to cattle ownership, land ownership, AI's cost, cow breed which lastly being inseminated, farmer's participation in a farmers group, geographical factors, and farmers' knowledge about inseminators. If a decision has been made, it means that the choice is considered to be the most profitable among the others or it could be less risky than the other choices. Therefore, the purpose of this study was to estimate farmer's preference in selecting bull frozen semen in the time of AI. This study also determine the factors influencing the decision making.

MATERIALS AND METHODS

Data Collection Methods

This study was conducted as a cross-sectional survey. Data collection was performed using a questionnaire-based interview to beef cattle farmers from February 2018 to July 2018. The data were collected from 8 regions in Central Java (Grobogan, Sukoharjo, Karanganyar, Sragen, Klaten, Rembang, Blora, and Wonogiri) and 2 regions in Yogyakarta Province (Gunungkidul and Bantul). A total of 400 smallholder beef cattle farmers were interviewed as follows: Grobogan, 56; Sukoharjo, 9; Karanganyar, 23; Sragen, 32;

Klaten, 27; Rembang, 39; Blora, 68; Wonogiri, 63; Gunung Kidul, 61; and Bantul, 22. The respondents of this research were selected by multistage random sampling. Table 1 showed the variables that were grouped into dependent variable (y) and independent variables (x).

Statistical Analysis

A multinomial logistic regression was employed to identify factors influencing farmer's preference in selecting bull frozen semen. STATA 13 was used to analyze the data with multinomial logistic, also to calculate means and standard deviations. Cross tabulation between breed of bull semen and cow breed owned by farmers was applied to make data classification.

The multinomial logistic regression is a regression model that treat alike the logistic regression model by enabling for more than two discrete and nominal dependent variables (Lin *et al*., 2014). P is the probability of frozen semen from breed *b* to frozen semen from breed *e* in pixel *a*. Y is dependent variables and X is independent variable. The dependent variable (*y*) consist of 5 options (m=5), there were bull frozen semen from Simmental breed, Limousin breed, Ongole grade (PO) breed, Brahman breed, and other. The values of *Y* are unordered or nominal

Table 1. Definition of Variables and Type of Measurement

Variables	Definition	Type of Measurement
Dependent variable		
Frozen semen	Five codes of superior bull frozen semen.	Categorical (1=Simmental, 2=Limousin, 3=PO, 4=Brahman, and 5=others)
Independent variables		
Age	Age of the farmer in years	Continuous
Education	Farmer's level of education in years	Continuous
Member	Total family member in the household	Continuous
Cattle	Total number of cattle kept by farmer in Tropical Livestock Unit (TLU[a])	Continuous
AI's Cost	Farmers' expenses to inseminate their cow breed in IDR	Continuous
Land area	Total area land managed by farmer in m^2	Continuous
Cow breed	Cow breed which lastly inseminated	Categorical (1=PO, 2=Brahman, 3=Simmental Cross, 4=Limousin Cross, 5=Simmental-PO, 6=Limousin-PO, and 7=others)
Participation	Farmer's participation in a socio-economic group	Dummy (1=Yes, 0=No)
Geographical factors	Each region in surveyed location	Categorical (1=Grobogan, 2=Sukoharjo, 3=Karanganyar, 4=Sragen, 5=Klaten, 6=Rembang, 7=Blora, 8=Wonogiri, 9=Gunung Kidul, and 10=Bantul)
Inseminator	Farmer's knowledge about the inseminators	Dummy (1=know, 0=not know)

[a]TLU is Tropical Livestock Unit where a mature cow equals 1 AU and a calve equals 0,25 AU

data. The multinomial logit model was described based on Greene, 2012 (STATA, 2018). If there are categorical outcomes (*k*) and let the base outcome be 1. The probability that the response for the *b*th observation is equal to the *a*th outcome is:

$$P_{a,b,c,d,e} = \Pr(y_b = a) = \begin{cases} \frac{1}{1+\sum_{m=2}^{k} \exp(X_b\beta_m)}, \text{ if } a = 1 \\ \frac{\exp(X_b\beta_a)}{1+\sum_{m=2}^{k} \exp(X_b\beta_m)}, \text{ if } a > 1 \end{cases}$$

where X_b is the row vector of observed values of the independent variables for the *b*th observation and β_m is the coefficient vector for outcome *m.*

RESULTS AND DISCUSSION

Farmer's Characteristics

Information about the respondents in this study is presented in Table 2. This study was categorized into five groups of bull semen, consisted of Simmental, Limousin, Ongole Grade (PO), Brahman, and others. The average of the respondents' age was 50.6 years old while the average of formal education attainment was 6.2 years. It indicated that most respondents only passed the 6th grade of elementary school in Indonesia. However, there were respondents who never attended any formal education and some respondents attended higher education and bachelor degree. Smallholder farmers in traditional farming community was mostly characterized by the low level of education and knowledge, whereas education level affect the expertise of knowledge and technology in society (Roessali *et al*., 2011). The average of total number of people in household (family member) was 3.97 members, indicating 3-4 members in a household. The cattle ownership is 1.93 TLU and land size was 1,823.1 m^2. The farmers' expenses cost to inseminate their cow was IDR 31,112.5.

Farmer's Preference in Choosing Bull Frozen Semen

Simmental bull frozen semen was the most selected breed, with 168 respondents or 42%, followed with Limousin breed (123 respondents or 30.75%) as presented in Table 2. Unfortunately, there were 12% respondents who did not recognize what breed was inseminated to their cows. They followed the inseminator's suggestion because farmers believed that they would give the best bull frozen semen that suitable for their cows. Bull semen from PO breed was chosen by 42 respondents or 10.5%, followed by Brahman breed (19 respondents or 4.75%).

A cross tabulation data has been made to show the relation between bull semen and cow breed. Table 3 shows the information that respondents with Simmental-PO as their cow breed prefer to choose Simmental as bull semen,

Table 2. Descriptive Statistics of the Characteristics of Respondents

Variables	Unit	Mean ± SD	Group of Male Breed (Mean ± S.D.)				
			Simmental n=168	Limousin n=123	PO n=42	Brahman n=19	Others n=48
Age	Year	50.6 ±12.1	51.4 ± 12.2	50.4 ± 10.6	49.6 ± 12.1	44.8 ± 16.6	51.8 ± 12.9
Education	Year	6.2 ± 3.5	6.3 ± 3.4	6.1 ± 3.6	5.8 ± 3.2	7.4 ± 2.5	5.9 ± 3.6
Member	Number	3.97 ± 1.7	3.7 ± 1.4	4.2 ± 1.7	4.1 ± 1.6	3.9 ± 1.4	4.3 ± 2.2
Cattle	AU	1.93 ± 0.9	1.9 ± 0.9	1.9 ± 0.9	1.9 ± 0.9	1.9 ± 1.4	2.2 ± 0.9
AI's cost	IDR	31,112.5 ± 25,797.1	29,702.4 ± 25,680.6	33,292.7 ± 25,275.7	31,071.4 ± 26,607.7	23,947.4 ± 24,070.4	33,333.3 ± 27,624.6
Land area	m^2	1,823.1 ± 5,139.6	1,289.3 ± 2.582.0	1,928.05 ± 5,032.28	1,074.02 ± 1,730.18	6,141.9 ± 16,207.9	2,368.4 ± 4,713.6

Table 3. Cross Tabulation between Bull Semen and Cow Breed

Cow Breed	Bull Semen					Total
	Simmental	Limousin	PO	Brahman	Others	
PO	49	23	38	2	14	126
Brahman	3	1	1	10	0	15
Simmental cross	36	8	0	1	2	47
Limousin cross	10	30	1	1	3	45
Simmental-PO	58	23	0	3	15	99
Limousin-PO	9	28	1	1	11	50
Others	3	10	1	1	3	18
Total	168	123	42	19	48	400

followed by PO cow breed and Simmental cow breed. Respondents with Limousin cow breed prefer to choose Limousin bull semen. Bull semen from PO breed is the most selected semen by respondents who have PO cow breed. PO has potential to be developed since its high adaptability towards tropical environment (Ekowati *et al*., 2018). Brahman bull semen was selected by the respondents with Brahman cow breed. These occurrences indicate that respondents prefer to choose Simmental and Limousin breed as bull semen for their cows.

Factors that Influence the Farmer's Decision Making

The Multinomial Logit results shows that the pseudo R^2 was 0.34 and the Prob>Chi^2 was significant (Table 4). This result means that the all information in the model can significantly explain the decision strategy of smallholder farmers. In this multinomial logit model, "Simmental" bull semen as a baseline category was used. This study used "Cow Breed PO" and "Geo Grobogan" or Geographical Factor of Grobogan as a baseline category. Multinomial logit results indicated that smallholder farmer's decision strategy to select bull semen is associated with family member, AI's cost, land ownership, cow breed which lastly being inseminated, geographical factor, and farmer's knowledge about the inseminators.

The information presented in Table 4 showed that an increase of family member, increased the likelihood of farmers to choose Simmental bull frozen semen than Brahman bull frozen semen. An increased of AI's cost, increased the likelihood of farmers to choose Simmental bull frozen semen than choose to believe the decision of the inseminator. Farmers who had larger land, prefer to choose frozen semen from Brahman breed. Farmers having Limousin Cross as cow breed prefer to select Limousin bull frozen semen than Simental bull frozen semen. Farmers having Limousin–PO as cow breed tend to choose Limousin bull frozen semen than Simmental bull frozen semen. If we compare it with PO bull frozen semen, farmers who have Limousin-PO cow breed prefer choosing Simmental bull frozen semen to choosing PO bull frozen semen. Farmers who have Brahman cow breed tend to choose Brahman bull frozen semen than Simmental bull frozen semen. Farmers who had Simmental-PO cow breed tend to choose Simmental bull frozen semen than decide to just believe the decision of the inseminator. Farmers in Gunungkidul region have likelihood to choose Simmental than Limousin bull frozen semen. In Bantul region, farmers tend to choose Simmental than Limousin bull frozen semen too. They had lower likelihood to choose to believe the inseminator's decision than to choose Simmental bull frozen semen. Farmers who had more familiar with local inseminator prefer to choose Brahman bull frozen semen.

Farmers Experience in Selling Beef Cattle

The discussion about the experience of farmers in selling beef cattle is used to strengthen the results of research previously discussed in Tables 3 and 4. This data was based on the

Table 4. Multinomial Logit Results

Variables	Limousin	PO	Brahman	Others
Constanta	-1.5256	0.3148	-2.3392	0.6402
Age	0.0033	-0.0124	-0.0692	0.0074
Education	0.0509	-0.0480	0.1218	0.0355
Member	0.0902	0.0332	-0.7676*	0.0462
Cattle	-0.2493	-0.0288	0.0463	0.0073
AI's Cost	-8.89e-07	0.00001	-2.33e-06	-0.00002*
Land Area	0.00003	0.00005	0.0003**	0.00006
Cow breed Brahman	-0.3357	-1.0351	6.4293**	-28.8409
Cow breed Simmental Cross	-0.2129	-18.4208	0.0799	-1.1211
Cow breed Limousin Cross	2.5179**	-2.1317	0.9657	0.1471
Cow breed Sim-PO	-0.6008	-18.6389	0.2068	-1.3098*
Cow breed Lim-PO	1.2726*	-2.3219*	0.8223	0.1247
Others cow breed	1.5678*	0.3258	3.5490*	1.0848
Participation	-0.0901	0.5578	-0.6435	-0.6013
Geo Sukoharjo	-0.0315	-16.0022	-17.9762	-1.7693
Geo Karanganyar	-0.1110	-15.4681	-17.7512	-0.3430
Geo Sragen	0.5603	-16.3837	-22.2948	-0.8213
Geo Klaten	-1.3887	0.7874	-16.3526	-0.4323
Geo Rembang	-0.8718	-0.2333	-19.0506	-19.1934
Geo Blora	0.3288	0.0664	-0.0642	-18.0649
Geo Wonogiri	0.6905	1.2303	0.2373	1.4948
Geo Gunungkidul	-1.3712*	-0.2160	-2.0896	-18.5360
Geo Bantul	-2.9035**	-1.3965	-17.5844	-2.6334*
Inseminator	0.08519	-0.4142	4.8251*	-0.2112

* = significant (P<0.05); ** = highly significant (P<0.01)

experience of farmers in selling cows, bulls, and calves that have been carried out for the past year. Descriptive statistical analysis was used to answer whether it is true that cross-breed cattle have a higher selling price in the market than local cattle. Table 5 provide an overview of the experience of farmers in selling cows in the past year. The discussion of this data is based on the selling price of the cows in each breed.

Crossbred cows had a higher selling price compared to PO cows as presented in Table 5. PO cows had the lowest selling price, as well as cows with Brahman breeds. The main cow with the highest average selling price was Brangus which was a cross between Brahman cattle and Aberdeen Angus cattle. Other cow breeds that have high selling prices were Lim-PO (Limousin-PO) and Sim-PO (Simmental- PO). The experience of farmers in selling cows was taken under varying age conditions for the cow. In this study, the age range of cow was sold between 1-11 years.

Table 5. Cow's Selling Price

Breed	Cow's Age (Year)	Selling Price (IDR)	
		Mean	S.D.
PO	1-9	10,894,736.84	2,508,756.59
Brangus	1-4	14,750,000.00	353,553.40
Lim-PO	1-10	14,182,143.00	4,654,970.00
Sim-PO	1-11	13,973,333.00	5,030,934.00
Brahman	1.5-2	13,250,000.00	3,889,087.00

Table 6. Bulls's Selling Price

Breed	Bull's Age (Year)	Selling Price	
		Mean	S.D.
PO	1-9	13,326,667	5,267,212
Brangus	1.5-4	18,066,667	1,778,576
Lim-PO	1-3	22,062,500	5,534,362
Sim-PO	1-6	18,576,923	5,037,246

Table 7. Calve's Selling Price

Breed	Calve's Age (Year)	Selling Price	
		Mean	S.D.
PO	0.004-0.92	8,617,567.57	3,694,557.11
Lim-PO	0.25-0.83	10,050,000.00	2,927,285.43
Sim-PO	0.16-0.92	10,137,692.31	3,921,097.09

In addition to cows, farmers involved in this study also had prior experience in selling bulls. The selling price of bulls in this study is presented in Table 6. The selling price of the bull in this study varies based on breed. Table 6 showed that bull with Limousin-PO breed had the highest selling price compared to bull of other breeds, then continued with Sim-PO, Brangus, and PO bull cattle. This showed that cross breeds bull have a higher price on the market than local bulls. An analysis of market prices on calves selling prices was also conducted. The results of this study will take into account the calves selling prices based on breeds (Table 7). This study succeeded in distinguishing calve selling prices based on 3 breeds, including PO, Lim-PO, and Sim-PO. The selling price is obtained based on the experience of farmers in selling calve for the past year. The results showed that calve with Sim-PO breeds have the highest selling prices among the three other breeds, while calve with Lim-PO breeds are second only to Sim-PO. The cheapest calve selling price is calve with PO breed.

Simmental and Limousin bull semen were the most selected bull semen among farmers. Those superior bull breeds were included as

European beef breeds. Smallholder farmers in Java Island believe that crossbreeding their local cattle with Simmental give more benefits for them. They selected crossbreeding because of their good appearance, high growth rate, and higher market price than local cattle (Widi, 2015). This is the reason why farmers with PO cow breed preferred Simmental bull semen than PO bull semen. Based on the results of the analysis of the selling price of cows, bulls, and calve, the three have the same results. These results indicated that crossbreed cattle have a higher selling price in the market compared to the selling price of local cattle, for example, PO. This is the reason why farmers prefer to keep crossbreed cattle compared to local cattle. Apparently, the aim of the AI has shifted to know this evidence. AI is no longer used as an effort to increase the beef cattle population quickly, effectively and efficiently, but as an effort to get cows, bulls, or calve at high prices on the market. Farmers see crossbred beef cattle as assets that can be kept and then sold to consumers/markets when they need them.

Furthermore, Limousin bull frozen semen was chosen by farmers who had Limousin cow breed, and Brahman bull frozen semen was chosen by farmers who had Brahman cow breed. These evidences indicated that farmers prefer to choose bull frozen semen from the same breed with their cows. This might be they had an existing knowledge to maintain the chosen breed. Thus, farmers were more able to maintain calves from the same breed. There were several important factors that determine the decision making process. The key factors are farmer's prior knowledge and experience (Bettmen and Park, 1980). Previous research of prior knowledge defined prior knowledge as individual characteristic that influencing the process of product purchase (Karimi *et al.*, 2015; Moore and Lehmann, 1980), and prior experience as people's minds fundamental when making a decision about suggested behavior (Cismaru and Lavack, 2006).

In other case, farmers usually follow the inseminator's decision to select bull frozen semen and they had no awareness about the type of breed used to inseminate. Farmers assure that the inseminator would provide the most suitable bull frozen semen for their cows. The inseminator regarded as opinion leader by beef cattle farmers. An opinion leader is someone who has competent knowledge about products and whose suggestion is taken by others. This process is known as opinion leadershirp (Solomon *et al.*, 2006). . Building up mutual trust and facilitating effective communication between farmers and inseminators as stakeholders was therefore important to understand the process and consequences of farmer innovation diffusion (Wu and Zhang, 2013). They were two individual differences in consumer decision goals, *maximizers* and *satisficers*. *Maximizers* are those who always make the best possible decision and need longer time to make decision than *satisficers*, whereas *satisficers* are those who are willing to settle for a "good enough" option (Chowdhury *et al.*, 2009; Schwartz *et al*., 2002). In this case, farmers belong to the *satisficers* category. They could make decision especially when purchase decision was made quickly. Farmers had to make a quick decision when the cow showing estrus. Accurate estrus detection was a key to efficient reproduction (Foote, 1974). When the cow was showing estrus, farmers had to decide which bull semen should be inseminated to their cow as soon as possible.

Multinomial logit model in this research fits significantly (Prob> Chi^2 = 0.0000). From the multinomial logit result, AI's cost was significant difference ($P<0.05$). It assumed that economic factors influence the cost of bull semen, cost of artificial insemination as well as prospect of success affect the possibility of farmers using reproduction technology (Howley *et al.*, 2012). Furthermore, geographical factors are significant difference in Gunung Kidul ($P<0.05$) and Bantul ($P<0.01$). Farmers in Gunung Kidul and Bantul prefer choosing Simmental bull breed as frozen semen for their cows. It indicated that geographical location was one of average important factor in the decision to select a source of supply (Dickson, 1966). On the other hand, the significance of location may also indicate that the local government policy plays important role on bull semen dissemination.

CONCLUSION

Farmers prefer to choose frozen semen from Simmental and Limousin breeds to produce a calf with a good appearance, high growth rates, and have a higher market price compared to local cattle. Farmers also select bull frozen semen from the same breed with their cow because they have an existing knowledge to rear the chosen breed and able to prepare the maintenance of calves. The farmer's decision to choose frozen semen was

influenced by family member, AI's cost, land ownership, cow breed which lastly being inseminated, geographical factor, and farmer's knowledge about the inseminators.

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