Factors Influencing Smallholder Farmer's Decision to Adopt Artificial Insemination as A Cattle Reproduction Technology in Yogyakarta

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ABSTRACT

Artificial Insemination (AI) for reproduction technology has been promoted as a national policy to increase the productivity and improve the genetic quality of cattle. Recently, Government had launched the new national policy of SIWAB (*Sapi Indukan Wajib Bunting*) which encourages to a cow to be pregnant at farmer level. In this policy, AI program will be the backbone for a massive and efficient reproduction at farm. However, with the dominant small-scale mixed cattle farming practice in Indonesia, information on how smallholder farmers decide to adopt AI technology instead of natural breeding should be provided. This paper aims to determine the influence factors of farmer's decision to adopt the AI for their cattle. A cross-sectional survey was conducted by involving 188 smallholder farmers who are practicing mixed crops and livestock farming in Yogyakarta. Decision to adopt the technology was coded as binary dependent variable that will be analyzed by applying Logit regression. The results show that the smallholder decision on adopting AI is influenced by the cattle ownership, the membership of farmer's group, the knowledge of the technology's utility, and the active seeking of the relevant information about the technology. Prior to decision, the household resources such as the cattle ownership are considered as a farmers' constraint in adopting the AI. Moreover, smallholders require the prior knowledge about the technology which can drive to better understanding about the technology's utility.

Keywords: Artificial Insemination; Cattle Production; Decision Making Process; and Information Access

INTRODUCTION

Reproduction technology of cattle, Artificial Insemination (AI), is well known as the most successful program to improve the quality, productivity, and economic benefit among farmers (Howley, Donoghue, & Heanue, 2012). As an opposed of AI, natural mating has been the main approach of traditional cattle reproduction for decades (Foote, 1975; Senger, 1994; Van Eerdenburg et al., 1996). Nowadays, AI becomes easier with improvement of the technology to prepare the semen. In early development, AI was very limited in facilities, with a modified existing barn to house bulls, an area equipped to serve as a simple laboratory, and a semen collection chute, often outdoors (Kaproth & Cooperative, 2011). The development of AI is more significant with appropriate facilities and instrument to conduct a high-quality product. However, the implementation at farm level essentially requires highly trained field staff and skilled inseminators to assure the sustainability of AI (Kaproth & Cooperative, 2011).

In cattle reproduction, AI can be included as an innovation with some specific characteristic such as; (1) its relative advantage; (2) the compatibility with the existing values, past experience, and needs of potential adopter; (3) complexity of the innovation; (4) trial-ability, the degree to which an innovation may be experimented with on a limited basis; and

(5) observe-ability, the degree to which the results of an innovation are visible to others (Rogers, 1995). Those innovation characteristics form the parameter to diffuse a new technology into a society. The technology diffusion refers to the decision making process that can be defined as the process through which farmers pass (1) first knowledge of an innovation; (2) forming an attitude toward the innovation; (3) decision to adopt or reject; (4) implementation of the new idea; and (5) confirmation of the decision (Rogers, 1995). Decision-making is a process where although distinct phases can be delineated, they have several feedback loops and iterations of adjustment (Singh, Dorward, & Osbahr, 2016). Decisions are also taken across temporal scales (e.g. farmer decisions before, in and after a cropping season) with more risk attached to immediate and personally relevant threats compared to those expected in the future (Singh et al., 2016).

With such benefits for farmers especially on larger distribution of advantageous genes and eliminating venereal diseases, (Cseh, Faigl, & Amiridis, 2012).This paper aims to determine the influence factors of farmer's decision to adopt the AI for their cattle. A cross-sectional survey was conducted by involving 188 smallholder farmers who are also practicing mixed crops and livestock farming in Yogyakarta. Decision to adopt the technology was coded as binary dependent variable that will be analyzed by applying Logit regression.

MATERIALS AND METHOD

The study was designed as a cross-sectional study involving 188 mixed farmers as respondents. Data were collected through personal interviews by using a questionnaire. The Yogyakarta Province was selected as the area of research where more than 80% of the farmers are smallholders practicing mixed farming (BPS, 2013). Mixed farmers are considered as smallholder with practicing intensive farming by integrating crops and livestock. Smallholder farmer is defined as those who cultivate less than 0.5 Ha (BPS). The technology adoption is seen as a binary decision which two opposite outcomes (adoption or non-adoption) are observed. The parameters of decision behavior among smallholder farmers can be estimated based on personal characteristics, household economic status, farm characteristics, knowledge about the technology and access of information about the specific technology (Table 1). The logit was chosen as the estimation approach according to its computational convenience reasons (Burton, Rigby, & Young, 1999; Walekhwa, Mugisha, & Drake, 2009). Thus, in the decision of AI adoption, it is assumed that the farmer weighs the marginal advantages and disadvantages of AI technology use. Following (Burton et al., 1999), parameters of technology adoption are not usually observable. However, a linear relationship of the AI adoption can be assumed and expressed as a latent variable, y_i^*, a function of observed explanatory variables, x_i, and an error term, ε_i:

$$y_i^* = x_i'\beta + \varepsilon_i \quad (1)$$

The adoption of the AI is a binary model of two answers: if yes, y = 1 and no, y = 0. The probability of y = 1 is modeled by a general equation as following:

$$Pr(Y_i = 1 \mid x_i) = G(x_i, \beta) \quad (2)$$

where G is a function with the only values zero and one (Wooldridge, 2009) and specifically mentioned as:

$$\Pr(Adopt = 1) = G(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k + e) \quad (3)$$

where the Pr(*Adopt* = 1) is the probability of technology adoption by the individual farmer given the explanatory variables $x_1, ..., x_k$. The β_0 is the intercept and $\beta_1, \ldots, \beta_k$ are the estimated parameters for the explanatory variables while e is an error term. Meanwhile, the logit model is based on the logistic distribution:

$$G(z) = \frac{\exp(z)}{1+\exp(z)} \quad (4)$$

Which the logistic distribution is a cumulative distribution function (CDF) for a standard logistic random variable (Wooldridge, 2009).

RESULTS AND DISCUSSION

Table 1 shows the list of variables that were included as into the model on farmer decision to adopt AI technology. The adoption of AI is defined as the participation of framers in using AI on the reproduction management at their farms. The independent variables consist of the age of respondents, formal education level, ownership of cattle in animal unit, membership of farmer group, having income from non agricultural activities, knowledge on AI technology, effort on actively seeking the information about AI, and involving women into the decision process.

Table 1: List of the variables

Acronym	Variable description	Type of Measurement	Expected Sign
Dependent variable			
participation	Adoption of the artificial reproduction technology	Dummy (1=Yes, 0=No)	
Independent variable			
area	Mixed farmers' area of living	Discrete (1 = Sleman; 2 = Kulonprogo; 3 = Sleman)	
age	Age of respondents	Years	-/+
educ	Formal education level	Years	+
TLU	Tropical Livestock Unit of animal ownership	Numbers	+
member	Membership of a farmer's group	Dummy (1=Yes, 0=No)	+
nonag	Having income from non-agriculture activities	Dummy (1=Yes, 0=No)	+
knowledge	Having a knowledge about AI	Dummy (1=Yes, 0=No)	+
active	Seeking information about AI actively	Dummy (1=Yes, 0=No)	+
wife	Women involvement in decision making	Dummy (1=Yes, 0=No)	+

[a] TLU is a Tropical Livestock Unit where a 250 kg mature cow equals 1 TLU (Njuki et al., 2011)

The descriptive analysis showed that there were some different attributes among AI adopters and non adopters especially on ownership of cattle, membership of farmer group, having income from non agricultural activities, and effort on actively seeking the information about AI technology.

Table 2: Descriptive summary statistics of the explanatory variables

Variables	Min	Max	Mean	
			Participants (n=170)	Non-participants (n=18)
area	1	3	-	-
age	25	81	52.89 ± 10.51	49.52 ± 11.46
educ	0	21	8.33 ± 4.08	7.50 ± 4.41
TLU	0.5	13.5	3.08 ± 2.33***	1.86 ± 1.31
member[1]	0	1	0.81 ± 0.39**	0.50 ± 0.51
nonag[1]	0	1	0.49 ± 0.50	0.72 ± 0.46*
knowledge[1]	0	1	0.98 ± 0.11	0.83 ± 0.38
active[1]	0	1	0.83 ± 0.38**	0.44 ± 0.51
wife[1]	0	1	0.81 ± 0.39	0.78± 0.43

[1)]Mean of dummy variables is a frequency of 1
*P < 0.05; **P < 0.01; ***P < 0.001; the signs indicated the direction of one tail t-test

The results of logit regression showed that the number of cattle owned by the farmers positively increase the probability in adopting the AI technology. Joining as a member of farmer group also gave the similar effect in AI adoption. The understanding and the active effort on seeking the information about the technology remain the positive effect to the adoption technology.

Table 3: Logit regression analysis predicting the determinant factors artificial insemination participation

Variables	Model	
	Coefficients (SE)	Marginal Effects (SD)
Constant	-6.55 (3.08)*	NA
Area	0.52 (0.52)	0.04 (0.04)
Age	0.04 (0.03)	0.003 (0.002)
Educ	0.04 (0.08)	0.002 (0.005)
TLU	0.51 (0.25)*	0.04 (0.02)*
Member	1.15 (0.58)*	0.06 (0.05)*
Nonag	-0.54 (0.67)	-0.02 (0.03)
Knowledge	2.32 (1.09)*	0.25 (0.22)*
Active	1.54 (0.62)*	0.09 (0.05)*
Wife	0.81 (0.70)	0.04 (0.04)
Number of observations	188	
McFadden Pseudo R^2	0.2587	
Log-likelihood	-43.9874 (df=10)	
Chi-Square	30.7024***	
Total correctly predicted (%)	92.55	
% correctly predicted (adopters)	33.33	
% correctly predicted (non-adopters)	98.82	

- Marginal Effect is the Partial Effect of Average (PEA), SE (Standard Error), SD (Standard Deviation), NA (Not Applicable)
- *P < 0.5; **P < 0.01; ***P < 0.001

CONCLUSION

Farmers who adopt the AI technology can be attributed by those who have more cattle and more focus on the livestock business. The logit regression confirmed the attributes by showing the results that cattle ownership, membership of farmer group, knowledge of the AI technology, and effort on active seeking information about technology are the prominent factors of the AI adoption.

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