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Factors That Limit Delivery and Adoption of Artificial Insemination in Rwanda: Case Study in Rukomo Sector of Nyagatare District, Rwanda

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Abstract: Artificial insemination (AI) is an assisted reproduction technology (ART) used worldwide for rapid genetic improvement of livestock as it is economically beneficial and ensures freedom from venereal diseases. AI was introduced in Rwanda in 1987 but its success rate is still below 53%. This study was done in Rukomo Sector of Nyagatare in 2011 to determine the factors that limit delivery and adoption of AI. Cross-sectional data were collected from a total of 70 respondents who had previously been exposed to AI technology. The adoption level of farmers using AI technology was determined by calculating the percentage of exposed farmers that was using solely AI. Quantitative data were analyzed using SPSS version 16. Adoption rate of AI was 15.71%, and it was strongly correlated with education level (r=0.743); farmer's distance to bull (r=0.769); heat detection (r=0.707); ways of communication between AI technicians and farmers (r=0.823) and veterinary extension visits (r=0.778). Farmers identified availability of AI technicians (50%), time taken by inseminators to respond to the farmer (32.86%) and communication methods (17.14%) were major factors limiting delivery of AI service. Inseminators and veterinary officers identified lack of material (42.7%), hormones for synchronization (31.1%) and transports (15.4%) as the main factors that affected delivery of AI services. It was concluded that socio-economic and technical factors influence delivery and adoption of AI technology. Policies that facilitate farmers to overcome socio-economic and technical factors are crucial of wider adoption of AI technology.

Keywords: Artificial Insemination, Delivery, Nyagatare District, Rwanda

1. Introduction

AI is used by dairy farmers for genetic improvement to increase milk production and prevent venereal diseases. [15] The success of AI depends on good animal husbandry and effective disease control measures. It is only by using AI that a gradual upgrading process is achieved, giving the farmers time to adapt to the changes in genotype which require higher levels of management [8].

AI was first introduced in Rwanda in 1987 following the setting up of an artificial insemination center at Rubirizi by the Government of Rwanda to ensure effective AI service delivery [17]. AI in Rwanda progressively increased and many AI technicians were killed and AI infrastructure demolished during the 1994 Genocide. Thereafter, the government initiated various interventions to increase milk production including AI and milk production increased to the current level of 1.8 million litres per year. However, AI technology is only reaching a few areas in the country and its success rate and adoption rate are still very low. As of today few studies have been done on AI adoption in dairy and beef cattle. [14] working in Punjab, India found that unfavorable attitude of the farmers towards AI was the major cause for its non-adoption in Haryana villages. [22] found that 68 percent

and 32 percent of the adopter farmers had high and medium level of knowledge about AI respectively, while majority of non-adopters had either lower or medium and only 10 percent had high level of knowledge.

Similar studies in India [20], [22] showed that early adoption of AI was positively significant associated with extension contact. In Uganda, the adoption rate averaged 36.1% [13] and this was mainly attributed to the age of the farmer, years of awareness of the AI technology, total farm milk production and sales, extension visits per year, and quality of AI services. Socio-economic factors affecting the adoption of AI have been studied by [21], [11], [10] and found that age of the farmers, education level, income level of the farmers, operational goal of the farm, and participation in extension studies were influential on the adoption of AI. Recent work in Rwanda [10] showed that socio-economic factors such as Age, sex, educational level influenced the efficiency of heat detection which is crucial for successfully AI service. The East African Dairy Development [9] study on constraints to the delivery of AI service in East Africa found that the main constraints to adoption of AI include low availability of the service; high cost; low capacity of farmers and technicians to effectively meet famers' needs; lack of cash to pay for AI services; and lack of effective veterinary and extension services.

The government of Rwanda recognizes the improvement of dairy production for ensuring poverty alleviation and food security in rural areas. AI is regarded as one of the most important tools for improving dairy production in Rwanda and yet its performance is still relatively very low. The performance of AI is likely to further deteriorate as effects of climate change take the upper hand since these will make the technical and socio-economic factors affecting AI to be more adverse. It is therefore very important to develop policies and strategies to overcome the technical and socio-economic factors affecting delivery and adoption of AI if food security is to be realized in this era of climate change. This study therefore was undertaken to determine the socio-economic and technical factors limiting delivery and adoption of AI technology in Rwanda with Rukomo sector, Nyagatare district in the Eastern province of Rwanda as the case study.

2. Materials and Methods

2.1. Study Area

Rukomo is one of the fourteen sectors of Nyagatare district in the extreme Northeast end of Rwanda.

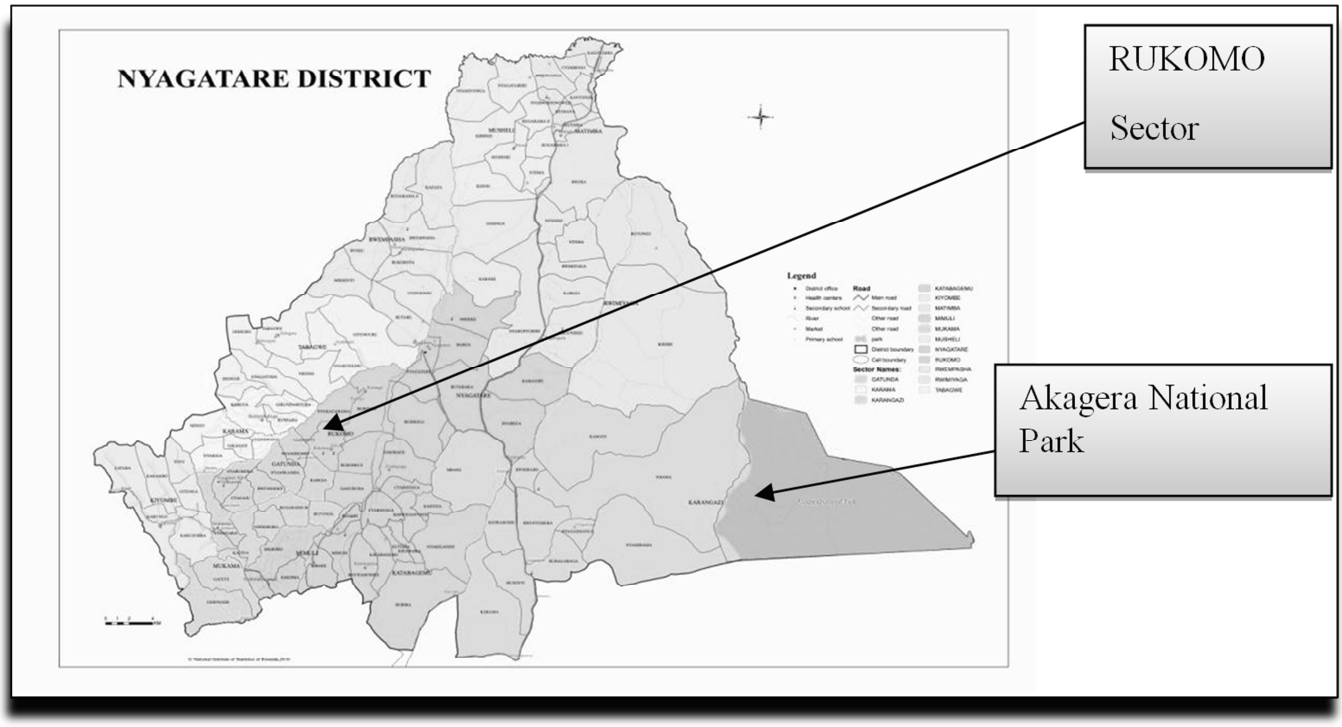

Figure 1. *Map of Nyagatare: location of study area [18].*

Rukomo sector is approximately 30 kms to the East of Akagera National Park. The area had total cattle population of 2693 [4] of which 1648 were indigenous (local Ankole), 726 cross breeds and 726 exotic-high grade. The farms are predominantly small and medium size; zero grazing unfenced farms of which only 46 are large scale fenced farms. Mixed crop livestock farming is the main economic activity.

2.2. Materials

Semi structured questionnaires; one for farmers and another for inseminators were prepared, pretested, and then administered to 70 farmers and seven inseminators.

2.3. Determination of Sample Size

A total sample of 70 farmers was obtained from a sampling frame of 678 farmers comprised of all those households that were keeping cattle. All the two public inseminators from Rukomo sector and five private inseminators from Eastern Region for Animal Genetic Improvement association (ERAGIC) were considered in the study.

2.4. Data Collection

Data were collected by personal interviews for both farmers and inseminators to elicit information on Bio-data, socio-economic and technical factors that could bear on AI delivery and adoption.

2.5. Data Analysis

Quantitative and qualitative data were analyzed using Special Package for Social Science program [23] version 16.0.0) to generate descriptive statistics that were presented in tables. Inferential statistics were done to determine the levels of significance of relationship between delivery and adoption with independent variables under investigation. Finally inseminator and farmers' view on factors limiting delivery of AI service among Rukomo dairy farmers.

3. Results and Discussion

It was found that 15.71% of respondents had totally adopted AI indicating that the technology is not yet very popular in study area. The age of farmers was slightly associated (r=0.5321), to adoption of AI (Min, 16 & Max, 78) which is similar to the findings in Uganda [13], [19] where the farmers who had adopted AI were significantly older than non-users by about 5 years on average.

The education level of the respondents was strongly correlated (r=0.743) with adoption yet 50% of the respondents had no formal education and only 14% of the respondents had post primary education. This reveals how education level is constraining adoption of AI technology. This agrees with the findings of [25], [24] in Kenya and [6] in Mexico, who reported that improving education status of farmers led to an increase in the likelihood that they would use AI (table 1).

Table 1. *Summary descriptive statistics of variables used in this study (N=70).*

Variables and its code	frequency	percentage	Mean	Standard deviation
Age of respondent:				
16-30 years	8	11.4		
30-40 years	16	22.9	48	±16.23572
40-50 years	17	24.3		
>50 years	29	41.4		
Total (N=70)	70	100.00		
Education level of respondent:				
1=never went to school;	35	50		
2=attended primary school;	25	35.71	1.67	±0.793
3=secondary school;	8	11.43		
4=post-secondary school)	2	2.86		
Total (N=70)	70	100.00		
Breeding method:				
1= farmer using AI,	11	15.71		
2= farmers using both AI and natural mating,	14	20	-	-
3= farmers using natural breeding method only)	45	64.29		
Total (N=70)	70	100.00		
Farming system:				
1= zero-grazing system,	25	35.7		
2= semi-intensive,	23	32.9	1.54	±0.247
3=extensive/communal grazing system	22	31.4		
Total (N=70)	70	100.00		
Farm record keeping:				
1=farmers keeping records;	10	85.7	1.86	±0.352
2= farmers not keeping records	60	14.3		
Total (N=70)	70	100.00		
Time farmers spent on farm supervision				
1=1 hour on farm per week;	1	1.43		
2=1-5 hours on farm per week;	14	20	-	-
3=5-10 hours on farm per week;	8	11.43		
4= > 10 hours on farm per week	47	67.14		
Total (N=70)	70	100.00		
Farmers' Heat signs frequency detection				
1=once per day;	30	42.86		
2= twice a day;	25	35.71	1.87	±0.947
3= 3 times a day;	9	12.86		
4= 4 times a day)	6	8.57		

Variables and its code	frequency	percentage	Mean	Standard deviation
Total (N=70)	70	100.00		
Years of awareness of AI technology				
1= 1-5 years farmer was aware of AI;	53	75.71		
2= 5-10 years farmer was aware of AI,	14	20		
3= > 10 years farmer was aware of AI)	3	4.29		
Total (N=70)	70	100.00		
Restrain methods use during insemination				
1= farmers using crush;	7	10		
2= farmers using ropes;	20	28.75	2.51	±0.676
3= farmers do not restraining)	43	61.43		
Total (N=70)	70	100.00		
Farmers views on AI service results				
1= AI service results is efficient,	12	17.14		
2= AI service results is moderate;	14	20	2.46	±0.774
3= AI service results not efficient	44	62.86		
Total (N=70)	70	100.00		
Delivery of Veterinary extension service				
1=farmers who did not receive extension visit,	36	51.43		
2= farmers received extension visit 1-3 times a year,	26	37.14	1.67	±0.863
3= farmers received extension visit 3-4 times a year;	3	4.29		
4= farmers received extension visits more than 5 times a year)	5	7.14		
Total (N=70)	70	100.00		

The study also found a strong correlation (r=0.707) and a mid-correlation (r=0.628) between knowledge on heat detection and frequency of heat detection respectively with AI adoption. This is possibly true because farmers with little knowledge of heat detection can serve the cows while they were not in true estrus leading to very low conception rate thus farmers' frustration and low adoption of AI. This result are in agreement with that of [16], [22] who found that 68 percent and 32 percent of the adopter farmers had high and medium level of knowledge about AI respectively, while majority of non-adopters had either lower or medium and only 10 percent had high level of knowledge.

It is not surprising that in this study, farm record keeping was found to be strongly correlated (r=0.739) with Adoption of AI technology which may lead to low efficiency and adoption rate of AI technology as date of insemination, animals on heat were not recorded. Grazing system and farming system were slightly correlated with AI adoption technology at (r=0.517) and (r=0.453) respectively similar results was reported by [6], [5] The medium correlation between restraint facilities (r=0.578) and AI adoption shows that the absence of restraint facilities could lead to low conception rate due to improper deposition of semen leading to farmers frustration and fail to adopt AI. In Kenya, [12] found that (98.2%) of farmers using AI service reported having restraining facilities at their farms. This is also similar to the work of [2], [27].

Table 2. *Correlation coefficients between adoption of AI and independent variables among dairy farmers in Rukomo sector.*

	Correlation coefficients	Chi-square test
Socio-Economic Variables		
Age	0.5321**	0.005
Education level of the respondents	0.743***	0.002
Farming system	0.453*	0.000
Farm record keeping	0.739***	0.000
Cost of AI service	0.326***	0.007
Socio-technical Variables		
Duration of farm supervision	0.526**	0.000
Grazing system	0.517**	0.000
Duration (years) farmers were aware of AI technology	0.534**	0.001
Knowledge on heat detection	0.707***	0.000
Heat signs frequency	0.628**	0.000
Trained persons for heat detection	0.476*	0.0012
Veterinary extension visits	0.778***	0.000
Restrain facilities	0.578**	0.000
Communication ways	0.823***	0.0001
Farmers distance to AI technician	0.369***	0.006

N.B. * 5 percent level of significance. +0.3 to +0.5 weak positive association, +0.5 to+0.69 mid association. +0.7 to +1.0 strong positive association. (Phi and Cramer's V test) (It's correct)

There was a high correlation between veterinary extension visits (0.778) and AI adoption. Extension as a source of agricultural information has been reported to increase adoption and use of new agricultural technologies [21], [6]. The more frequently a dairy farm is visited by extension personnel, the more likely that the corresponding proprietors will access information on the benefits of AI, and how to manage an AI program at all levels [26], [7]. There was a weak significant correlation between cost of AI service (0.326) and adoption of AI technology. The study showed that most of farmers 75.71% were aware of AI technology between 1-5 years. This may also explain why AI adoption level is very low because a big number of farmers were exposed to AI technology within a short period of time. The longer farmers are exposed to agricultural technology they are more likely they are to continue using the technology.

The majority of farmers (62.9%) reported that the AI result was not efficient. This could limit the level of AI adoption because when an animal does not conceive at first service; there a risk that farmers will be frustrated leading to non-adoption of the technology. The results are not similar with

the findings of [13], [3] who found that more than 67% of farmers in the AI user category reported conception at first service. A half of farmers (50%) identified availability of AI technicians, time taken by inseminators to respond to the farmer (32.86%) and communication methods (17.14%) were the major factors limiting delivery of AI service. Farmers could have at least two or more technicians to be in better position to compare and choose the best technician to use and access reliable AI services (Table 2).

Table 3. *Farmers' view on the factors affecting delivery of AI services in Rukomo sector.*

Factors	Famers frequency	% of respondents
Small number of AI technicians	35	50
Communication to AI technicians	12	17.14
Time taken by inseminators to respond the farmers	23	32.86
Total	70	100

Inseminators and veterinary officers identified lack of material (42.7%), hormones for synchronization (13.1%) and transports (15.4%) as the main factors that affected delivery of AI services (Table 3).

Table 4. *Inseminators' view on the factors limiting delivery of AI services in Rukomo sector.*

Factors	Inseminators and veterinary officer	% of respondents
Lack of material	3	42.7%
Lack of hormones for synchronization	2	31.1%
Transport	1	15.4%
Communication	1	10.8%
Total		100

In general the results of this study are in agreement with the results of a number of studies [21], [11], [10], [22] that found that Socio-economic factors such as age of the farmers, education level, income level of the farmers, operational goal of the farm, participation in extension were influential on the adoption of AI technology.

More specifically the results confirm those of [9], [1] where it was found that the main constraints to adoption of AI include low availability of the service; high cost; low capacity of farmers and technicians to effectively meet famers' needs; lack of cash to pay for AI services; and lack of effective veterinary and extension services.

The challenges

The difficulty with AI is the level of herd and semen management required. An AI programme can fail in several ways. The first is incorrect heat detection. Identification of cattle in heat is critical especially in large herds as with the case in Rwanda. The farmer must closely monitor those cattle exhibiting oestrus to decide when they are in standing heat and ready to breed. Ear tagging, when done properly, is a foolproof cow identification procedure.

A recent study by part of the EADD team shows that in the operational zone, only 6% of the farmers are able to correctly pinpoint true oestrus (heat) in animals. This is a major challenge which weighs down on AI following natural heat detection. The challenges of heat detection in the project area gave further impetus for EADD Rwanda to adopt synchronisation and time breeding to avoid the inefficiencies associated with poor heat detection. Careless semen handling is the second way AI can fail similar results was reported by [4], [3]. The bull semen must be stored, transported and thawed correctly to ensure that it remains viable. The third area is improper insemination technique. Lack of handling facilities makes it difficult for the inseminators to follow proper semen handling procedures and times. Proper training and experience are necessary to be successful. The farmer often overlooks the last area. Record-keeping is important for following individual cows' cycles, birthing dates and missed breeding. EADD has so far trained 336 farmers in record-keeping this was also reported by [9].

4. Conclusion

The adoption rate for AI technology in Rukomo sector in this study was 15.71% which is very low. Socio-economic factors such as education level of respondents, farm record keeping were strongly correlated with the adoption of AI technology. Socio-technical factors such as heat detection, frequency of veterinary extension visits and communication means were also shown to be most, positively correlated with adoption of AI technology.

The farmers were of the views that scarcity of AI technicians, time taken by inseminators to reach the farm after call and communication methods were the major factors limiting delivery of AI services. Inseminators and veterinary officers identified lack of material, hormones for synchronization and transports as the main factors that affected delivery of AI services.

Recommendation

It will be very important for government and private sectors to develop policies and strategies that overcome social economic and social technical factors affecting delivery and adoption of AI in Rwanda. There is therefore need for strengthening the research and extension services in Nyagatare district to address the knowledge and skill gaps of the farmers especially with regard to heat detection, keeping of farm records, dairy nutrition, facilities for restraining animals and other good dairy management practices. The

dairy farmers should be mobilised to form strong farm organisations through which they can be trained and also access the farm inputs, and easily market of their farm produce. This study covered a limited area in the eastern province. Further studies covering bigger geographical area should be undertaken to get clearer situation of the status of AI delivery and adoption in Rwanda.

Conflict of Interest

All the authors do not have any possible conflicts of interest, whatsoever in this publication.

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