Original Research

Level of Adoption and Factors Influencing Adoption of Artificial Insemination for Cattle in the Kilinochchi District of Sri Lanka

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Abstract

Current study was carried out in four veterinary divisions of Kilinochchi district to study adoption of artificial insemination for cattle and the factors influencing artificial insemination in the Kilinochchi district of Sri Lanka. Out of the 640 cattle farmers 265 farmers were selected using table of random numbers. Information was collected using structured questionnaire. Data were processed using Microsoft Excel 2007 and statistical analysis was performed with Proc Freq, Chi-Square and Glm in SAS. The results revealed that salary/wages were the primary income of cattle farmers in the Kilinochchi district. The main reason for keeping cattle was milk and manure. The cattle breeds mainly found in the study area were indigenous (49%) and Jersey crosses (46%). Farmers adopting semi intensive system of management ranged from 87-97%. Overall more than 93% of the famers used Jersey crosses to inseminate their animals. Framers adopting both natural and AI were around 41%. Major reasons for adoption of AI were unavailability of good bull in herd in all divisions (22%), advantageous (easy to do) (17%) and to get healthy calves (15%). The main reasons for non-adoption of AI technology in the Kilinochchi were difficulties in heat detection, cost and distance of AI center from the farm. Credit facilities and grazing field were the major constraints for cattle farming in the Kilinochchi district.

Key words: Artificial Insemination, Cost, Heat Detection, Natural Service, Number of Inseminations Per Conception

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Introduction

Livestock plays an important role in supporting the economic livelihood of the many Sri Lankan rural communities. The total contribution of the livestock sector to the national GDP is 0.6% (DAPH, 2017); its representation to the agriculture GDP remains static even though agriculture GDP contribution continues to decline over the years. Cattle and buffalo population in the country in 2017 has been recorded as 1.39

million and 0.44 million, respectively (DAPH, 2017). Among the food of animal origin, dairy products play an important role as it is consumed across the country irrespective of religious and other social barriers. Sri Lanka is yet to achieve its self-sufficiency in dairy products and at present 61% of milk and dairy requirement is still depend on imports. Per-capita availability was recorded as 154.20 ml/day in year 2017(DAPH, 2017).

Any industry needs to use technology if it is to be improved. Similarly, artificial insemination (AI) is one of the breeding technologies used in the livestock industry. Artificial insemination (AI) has been a proven and efficient reproduction technique widely practiced in the Island. Mainly cattle and less frequently buffaloes and goats are inseminated through the trained technicians of both state and private personals. Good quality semen is produced at the artificial insemination centres located at Kundasale and Polonnaruwa, and distributed to the veterinary offices together with the liquid nitrogen which is required to maintain the keeping quality. Generally, certain quantity of semen is imported from other sources mainly to maintain the genetic diversity in the crossbred cattle population in the country. Five hundred (500) doses of Jersey and Friesian and 5,000 doses Girolando semen had been imported during the year 2016, (Department of Animal Production and Health, 2017).

The livestock sub-sector is becoming attractive to the entrepreneurs in the Northern Province. Several stakeholders i.e. government sector, private sector and NGO are involved to strengthen the sector through their various projects and programmes. In Kilinochchi there had been a complete displacement during the period of August 2009 and the resettlement initiated in January 2010. The farmers in this region had lost their herd of cattle during the displacement. After the resettlement, there has been re-emergence of cattle farming with assistance of government and non-government organizations. Technologies have to be used to accelerate the improvements. Artificial insemination being a proven tool in livestock breeding, a comprehensive study on present level of adoption of AI and its impact on milk production is crucial in planning the future development and also to assess the importance in livelihood development of the communities in the Kilinochchi district. Therefore, present study was conducted with the objectives to investigate the demographic characteristics of the farmers adopting AI technique in the Kilinochchi district and to assess the factors influencing the adoption of AI in the Kilinochchi district.

Materials and Methods

Data Collection

A structured questionnaire was designed to conduct a cross sectional survey and prepared in such a manner to gather the needed information to fulfill the objectives of the study. Questionnaire included particulars in respect to demographic status of the cattle farmers, farm size, herd structure, management systems, productive and reproductive performance, breeding methods and details about adoption of AI.

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Sampling Strategy

Present study was carried out in the Karachchi, Kandawalai, Pachchilaipalli and Poonakary veterinary divisions of the Kilinochchi district (Plate 1). From the total list of cattle farmers who have used AI facility at least once, out of the 60 farmers, 30 (50%) were selected from Pachchillipalli Vetrinary to get a reasonable sample size. To the rest of the divisions the number of respondent was decided proportionate to this minimum sample size of 30. Accordingly, a total of 265 farmers were selected for the study using table of random numbers. The number of farmers selected from the Kilinochchi, Kandawalai, Pachchilaipalli and Poonakary veterinary divisions of the Kilinochchi district were 140, 40, 30 and 35 respectively. The survey was carried out from March to June, 2018.

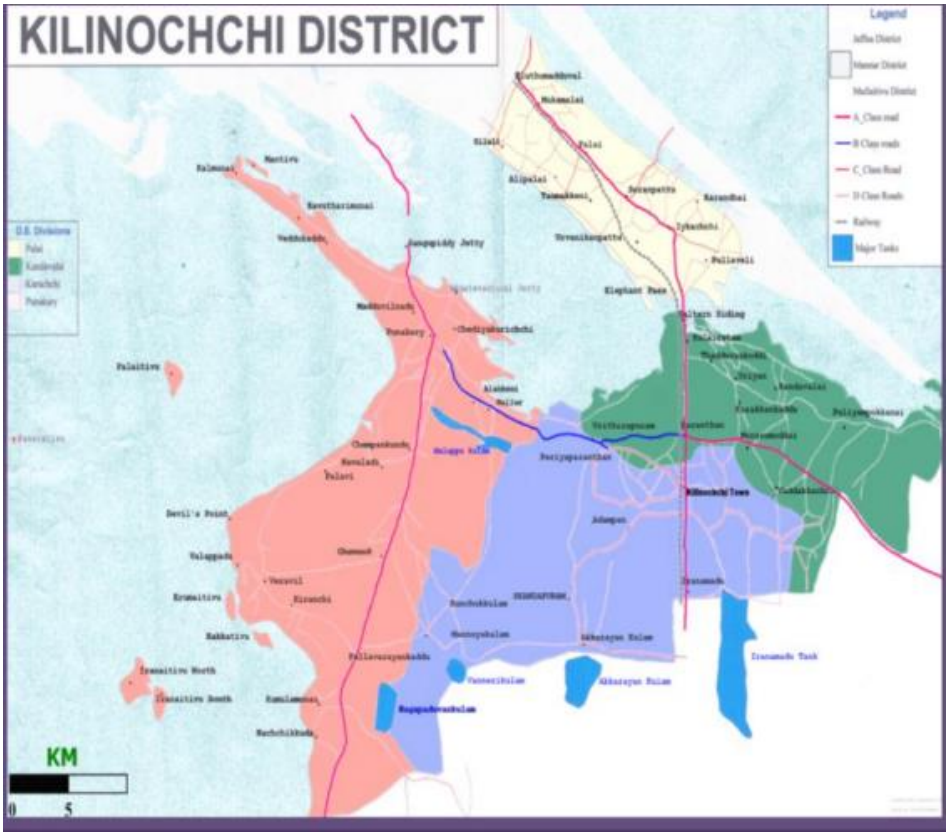

Plate 1: Map of Kilinochchi district

Statistical Analysis

After completion of the field survey, data were coded and summarized on a spread sheet using the computer package "Microsoft Excel 2007". Statistical analysis was performed using Proc Freq, Chi-Square and GLM procedures with SAS statistical software.

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Results

Table 1: Demographic characteristic of cattle farmers in the Kilinochchi district (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Age						
10-19	0	1.67	0	0	0.41	0.17
20-40	37.14	25	33.33	54.29	37.44	
41-65	59.29	71.67	66.67	42.86	60.12	
Above 65	3.57	1.67	0	2.86	2.02	
Total	100	100	100	100	100	
Years of Farming						
01-10	51.43	60	53.33	80	61.19	0.03
11-20	30	25	26.67	14.29	23.99	
21-30	14.29	13.33	10	2.86	10.12	
31-40	4.29	1.67	10	2.86	4.7	
Education Level						
Illiterate	5	45	16.67	0	16.66	<0.001
Up to primary	20.71	6.67	30	54.29	27.91	
Above primary up to middle	43.57	36.67	40	37.14	39.34	
Above middle up to high school	10	11.67	13.33	8.51	10.87	
Above high school	20.71	0	0	0	5.17	
Civil Status						
Single	5	8.33	6.67	5.71	6.43	0.6
Married	87.86	80	83.33	91.43	85.65	
Widow/widower	5.71	11.67	6.67	2.86	6.73	
Divorced	1.43	0	3.33	0	1.19	
Own Land						
No land	1.43	1.67	0	0	0.77	0.5
<1 ac	30	30	33.33	20	28.33	
1-2 ac	45.71	38.33	60	51.43	48.87	
>3 ac	22.86	30	6.67	28.57	22.02	
Leased Land						
No land	80	73.33	73.33	65.71	73.09	0.75
<1 ac	7.14	11.67	23.33	22.86	16.25	
1-2 ac	6.43	8.33	3.33	8.57	6.66	
>3 ac	6.43	6.67	0	2.86	3.99	
Total	100	100	100	100	100	
No land	99.29	100	100	100	99.82	0.42
<1 ac	0	0	0	0	0	
1-2 ac	0	0	0	0	0	
>3 ac	0.71	0	0	0	0.18	
Primary Income						
Livestock	10	10	6.67	8.57	8.81	0.58
Crops	30.71	33.33	26.67	42.86	33.39	
Salary/wages	56.43	53.33	66.67	48.57	56.25	

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Home industries	2.86	3.33	0	0	1.55	
Secondary Income						
Livestock	55.49	59.34	64.15	58.33	59.33	0.41
Crops	29.12	28.57	22.64	25	26.33	
Salary/wages	11.54	9.89	11.32	16.61	12.34	
Home industries	3.3	2.2	1.24	0	1.68	
Others	0.55	0	0	0	0.14	
Family Size						
Up to 3	13.38	17.11	6.67	5.71	10.72	0.17
04-05	45.07	36.84	56.67	40	44.64	
06-07	40.14	44.74	36.67	51.43	43.24	
>7	1.41	1.32	0	2.86	1.4	

X2 test is performed to test the significance of differences among the veterinary divisions

Table 1 represents the demographic characteristic of cattle farmers in the Kilinochchi district. Overall higher percentage of cattle farmers fell into the age group of 20-40 and 41-65 years. From results, potential age group for cattle farming could be considered as 20-65 years. Reason for higher percentage of the farmers with less than 10 years' experience could be as a result of complete displacement of public during the period of August to September 2008 and commencement of resettlement from January 2010 onwards due prevailed unrest situation in Sri Lanka and recommencement of all the activities afresh. Majority of the farmers' education level in the Karachchi, Pachchilaipalli, Kandawalai and Poonakary veterinary divisions were above primary up to middle (43.57%), above primary up to middle (40%), illiterate (45%) and up to primary (54.29%), respectively. There was no significant difference ($P<0.6$) in civil status of farmers across the veterinary divisions. The percentage of farmers with the marital status in the Karachchi, Kandawalai, Pachchilaipalli and Poonakary, were 87.86%, 80%, 83.33 and 91.43%, respectively. The percentage of farmers with the land holding size of 1-2 ac in the Karachchi, Kandawalai, Pachchilaipalli and Poonakary, were 46%, 38%, 60% and 51%, respectively. The percentage of farmers with the major source of income of salary or wages in the Karachchi, Kandawalai, Pachchilaipalli and Poonakary were 56%, 53%, 67% and 49%, respectively. Majority of the farmers reported secondary source of income as livestock. In all veterinary divisions majority of the farmers had the family size of 4-5 (43%) and 6-7 (42). Cattle farmers with more than 7 members in the family were around 1%. Chi square results ($P>0.05$) revealed that there was no significant difference in the family size among veterinary divisions.

The purpose of rearing cattle in the study area is summarized in Table 2. The main reason for keeping cattle was milk and manure. The purpose of rearing did not differ significantly ($P<0.69$) among the veterinary divisions. It is interesting to note that around 1% of the farmers in Karachi veterinary division mentioned they keep cattle as one of the sources of Dowry.

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Table 2: Purpose of rearing cattle in the Kilinochchi district (%)

Descriptor	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall
1	0	0	3.33	0	0.83
15	37.86	30	36.67	40	36.13
125	10	13.33	10	2.86	9.05
135	12.86	13.33	6.67	25.71	9.76
145	7.14	1.67	6.67	0	10.48
156	2.86	1.67	0	0	1.13
158	0	0	0	2.86	0.72
1235	11.43	20	20	14.29	16.43
1236	0.71	0	0	0	0.18
1245	11.43	11.67	0	2.86	6.49
1256	0.71	6.67	0	0	1.85
1345	4.29	1.67	16.67	11.43	8.51
1356	0.71	0	0	0	0.18

1-milk, 2-regular cash income, 3-meat, 4-insurance/emergency, 5-manure, 6- dowry, 7-cultural rites, 8-breeding

Table 3: Source of animals and management systems by veterinary division

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	P value
Source of Animals						
23	100	100	100	100	100	
Management System						
Intensive	7.86	6.67	3.33	2.86	5.18	0.46
Semi intensive	87.19	90	96.67	91.43	91.32	
Extensive	5	3.33	0	5.71	3.51	
Total	100	100	100	100	100	

[2]-bred on the farms [3]- other sources

In the study area 87-97% of the farmers adopted semi intensive system of management. None of the farmers in the Pachchilaipalli Veterinary division adopted extensive system of management. The information on livestock and poultry species owned by the cattle farmers is given in Table 4. It revealed that the percentage of the farmers owning only cattle, and cattle and layers were 32% and 34%, respectively. Around 25% of the farmers had goats as one of the components of livestock.

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Table 4: Livestock and poultry species owned by farmers in the Kilinochchi district (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
1	28.57	45	23.33	31.43	32.08	0.07
12	15.71	18.33	23.33	2.86	15.06	
13	3.57	0	0	0	0.89	
14	35.71	26.67	40	37.14	34.88	
123	0.71	0	0	0	0.18	
124	14.29	8.33	10	22.86	13.87	
134	0	0	3.33	0	0.83	
146	0.71	0	0	0	0.18	
1234	0.71	1.67	0	5.71	2.02	

1-Cattle 2-goat 3-broiler 4-layer 5-rabbit 6-other

Table 5: Cattle breeds and herd structure by veterinary division

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Breed (%)						
Indigenous	41.96	50.62	53.33	52.83	49.68	0.04
Sahiwal	1.34	2.47	4.44	0	2.06	
Jersey cross	52.23	45.68	42.22	45.28	46.35	
Friesian cross	0.89	1.23	0	0	0.53	
Girolando	1.34	0	0	0	0.34	
Others	2.23	0	0	1.89	1.03	
Herd structure (Mean and SD)						
Male calf	1.41±1.71	1.76±1.79	1.6±1.03	2.00±1.94	1.69±1.61	
Female calf	2.01±2.62	2.11±2.67	1.66±1.15	1.68±1.45	1.87±1.70	
Young male	1.02±2.20	0.58±1.13	1.13±1.47	0.71±1.46	0.86±1.57	
Young female	1.71±2.14	2.26±4.05	1.66±1.60	1.65±1.62	1.82±2.36	
Cow	8.18±11.34	7.91±10.72	6.86±3.74	6.74±5.81	7.42±7.90	
Bull	0.74±2.57	0.22±0.55	0.23±0.50	0.34±0.76	0.38±1.10	
Average herd size	14.35±17.21	17.11±24.53	13.16±6.74	13.14±9.42	14.04±16.24	

The breed distribution consisted mainly indigenous (50%) and Jersey crosses (46). Karachi veterinary division had comparatively higher percentage of Jersey crosses and lesser percentage of indigenous cattle compared to other veterinary divisions. Herd size did not differ significantly among veterinary divisions. The overall adult male: female ratio was 1:8. Comparatively higher percentage of herd size was observed in Kandawalai veterinary division.

Table 6: Breed of stud bulls preferred for AI by veterinary division (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
1	92.79	97.14	100	92.59	95.63	0.48
13	3.6	0	0	7.41	2.75	
123	0.9	0	0	0	0.23	
124	0.9	0	0	0	0.23	
134	1.8	2.86	0	0	1.17	

1-Jersey cross 2-Giroland 3-Sahiwal 4-Freisian

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Overall more than 93% of the famers used Jersey crosses to inseminate their animals. Around 3% of the farmers used Sahiwal and Giroland.

Table 7: Decision making on selection of bull semen by the cattle farmers in the Kilinochchi district (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
1	69.37	85.71	76.19	55.56	71.71	0.3665
2	27.93	14.29	23.81	44.44	27.62	
12	1.8	0	0	0	0.45	
13	0.9	0	0	0	0.23	

1-Farmer 2-Inseminator 3-Others

Major decision makers regarding selection of bull for AI was farmers however in the Poonakary veterinary division the percentage was less compared to other veterinary divisions (Table 8).

Table 8: Calving to service interval, and number of insemination per conception

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Calving to service interval						
Indigenous						
2 months	46.51	15.38	15.38	30.43	26.93	0.34
3 months	44.19	76.92	84.62	69.57	68.83	
4 months	9.3	7.69	0	0	4.25	
Crosses						
2 months	68.75	66.67	33.33	65.22	58.49	0.16
3 months	31.25	33.33	66.67	34.78	41.51	
Exotic						
3 months	100	0	0	0	25	-
No. of Insemination						
Indigenous						
One	32.53	14.29	0	21.43	17.06	0.02
Two	34.94	35.71	30.77	35.71	34.28	
>Two	32.53	50	69.23	42.86	48.66	
Crosses						
One	21.43	22.86	26.32	13.04	20.91	0.8042
Two	53.57	40	57.89	60.87	53.08	
>Two	25	37.14	15.79	26.04	25.99	
Exotic						
One	0	0	50	0		0.6
Two	100	0	50	0		

Calving to service interval for indigenous and crosses among the veterinary divisions did not differ significantly (Table 8). Comparatively crosses (64%) had lower calving to service interval (2 months) than indigenous cattle. The number of inseminations needed per conception (≤2) for indigenous and crosses were around 60% and 73%, respectively. Similarly, more than two inseminations per conception for indigenous and crosses were 40% and 26%, respectively. In Karachchi, Kandawalai, Palai and Poonakary,

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veterinary division the success rate of conception with one insemination were 21.43%, 22.86%, 26.32% and 13.04%, respectively.

Table 9: Type of service and distance to AI center (%)

Service	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2P value
Service						
NS	16.43	41.67	30	22.86	27.74	0.07
AI	35.71	33.33	23.33	42.86	33.81	
Both	47.86	25	46.67	34.29	38.46	
Distance						
1-5 Km	13.57	25	26.67	28.51	23.43	0.0001
6-10 Km	16.43	33.33	10	17.14	19.23	
11-15 Km	33.57	20	40	45.71	34.82	
16-20 Km	20.71	10	23	5.71	14.86	
Above 20 Km	15.71	11.67	0	2.28	7.42	

Percentage of farmers adopting natural service was around 28% (Table 9). Framers adopting both natural and AI were around 41% but this category mostly fell into the natural service because these farmers are the ones who try AI when it is not successful, they continue with natural service. Percentage adoption of natural service or AI did not differ significantly among veterinary divisions. Majority of the farms were located around 1-5km and 11-15km from the veterinary division and the percentages were 19 and 35, respectively. Distance from the house hold to the veterinary office differed among the veterinary divisions. Sixty two percent of the farmers stated that AI calls were attended on time while around 38% of the farmers said no timely response and no attention at all (Table 10).

Table 10: Response to AI calls by veterinary division (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Response to call						
Yes	58.47	71.43	76.19	51.85	64.49	0.7204
No	15.25	8.57	4.76	7.41	9	
Slightly delay	26.27	20	19.05	40.74	26.52	

Majority of the farmers did twice a day observation for heat detection while the animals are in the holding pens (Table 11). Observation was directed based on the memory recall of expected date of returns. None of the farmer in the study area used heat detection aids to detect heat. Percentage of farmers relied on primary heat sign to detect heat was only18. Rest of the 82% of the farmers relied on secondary signs to detect heat (Table 12).

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Table 11: Frequency of heat observation, location of observation and heat detection methods (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Observation						
Once	10	10	3.33	5.71	7.26	0.837
Twice	75.51	78.33	86.67	82.86	80.84	
More than twice	14.29	11.67	10	11.43	11.85	
Location						
1	7.14	0	0	0	1.79	0.624
3	81.43	90	90	85.71	86.79	
13	4.29	3.33	0	2.86	2.62	
34	5	6.67	10	11.43	8.28	
134	2.14	0	0	0	0.54	
Detection methods						
Recall from memory	94.29	95	90	80	89.82	0.009
Recall and records	5.71	5	10	20	10.18	

Table 12: Heat signs used to detect the animals in oestrus

Heat signs	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Clear mucous discharge	19.55	16.47	15.17	16.58	16.94	
Restless	6.65	5.59	7.3	2.59	5.53	
Mounted by other animal	18.88	17.65	16.85	17.62	17.75	
Bellowing	18.88	17.35	16.85	17.62	17.68	
Reduction in yield	8.64	12.35	16.29	11.4	12.17	0.002
Low feed intake	5.85	3.24	2.25	1.55	3.22	
Separate from herd	0.8	1.47	1.12	3.63	1.76	
Frequent urination	10.51	11.76	8.43	12.95	10.91	
Raising the tail head	10.24	14.12	15.73	16.06	14.04	

Table 13: Performance of cattle breeds in the Kilinochchi district (%)

Parameters	Milk yield (lit)	Lactation length(mon)	Calving interval(mon)
Karachchi			
Indigenous	2.15±0.87	7.16±1.17	12.96±0.80
Sahiwal cross	3	6	13
Jersey cross	4.06±1.93	7.17±0.76	13.09±0.79
Friesian	5.33±2.31	7.67±0.58	13.33±1.15
Kandawalai			
Indigenous	1.78±0.48	6.88±0.56	13.05±0.21
Sahiwal	5	7	13
Jersey cross	3.72±1.06	7.03±0.44	13.04±0.26
Pachchilaipalli			
Indigenous	1.81±0.61	7.10±0.61	13.21±0.45
Sahiwal	6	7	13
Jersey cross	3.50±0.88	7.11±0.31	13.04±0.19
Poonakary			
Indigenous	2.28±0.86	6.93±1.23	13.44±0.87
Jersey cross	4.49±2.04	7.24±0.65	12.92±0.27

The variation in milk yield, lactation length, and calving interval recorded in the study area is shown in Table 13. The milk yield of indigenous animals was lower than the other breeds while differences among

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other breeds were not significant. Similar values for lactation length (6-7 months) and calving intervals (12 to 13 months) were observed for all the breeds. The costs per AI among the veterinary divisions vary. However, majority of the farmers paid Rs 300, Rs 350 and Rs 400 per insemination the percentages were 35, 27 and 25, respectively (Table 14).

Table 14: Cost for first insemination (%)

Vet div	100 Rs	200 Rs	250 Rs	300 Rs	350 Rs	400 Rs	450 Rs	500 Rs	X^2 P value
Karachchi	3.6	4.32	0.72	17.99	28.06	33.09	0.72	11.51	0.0265
Kandawalai	0	0	0	34.29	31.43	31.43	0	2.86	
Pachchilaipalli	5	5	0	65	20	5	0	0	
Poonakary	3.7	3.7	3.7	25.93	29.63	29.63	0	3.7	
Overall	3.75	3.26	1.11	35.8	27.28	24.79	0.18	4.52	

In all veterinary divisions the major reasons listed for adoption of AI were unavailability of good bull (22%), advantageous (17%) and expectation of healthy calves (15%) (Table 15).

Table 15: Reasons for adoption and non-adoption of AI (%)

Descriptors	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Adoption						
Easy to do	14.65	20.42	17.65	20.47	18.29	0.06
Good Conception Rate	13.5	7.1	8.82	6.3	8.93	
Poor availability of bull	23.11	20.12	18.63	20.47	20.58	
Human resource	11.9	13.02	6.86	9.45	10.3	
Nominal charges	8.01	5.92	9.8	2.36	6.52	
Healthy calves	15.56	12.43	13.73	18.9	15.15	
Increased safety	11.21	17.16	17.65	16.54	15.64	
Reduced disease	2.06	4.14	6.86	5.51	4.64	
Non adoption						
Estrus Detection difficult	16.04	17.27	19.17	16.51	17.24	0.81
Poor Conception Rate	11.39	15.91	8.33	12.84	12.11	
Cost	15.35	17.27	16.67	18.35	16.91	
Lack of skill	11.88	3.18	13.33	11.01	9.85	
Unhealthy calves	8.17	6.82	8.33	4.59	6.97	
More disease	2.48	0	0.83	0	0.82	
Own bull	6.68	1.82	0	0.92	2.35	
Maintenance	7.92	10.91	10	10.09	9.73	
Do not have time	5.94	7.27	10	5.5	7.17	
Ethnic problem	0.74	1.36	0	4.59	1.67	
Distant	13.37	18.18	13.33	15.6	15.12	

The main reasons for non-adoption of AI technology in the Kilinochchi were estrous detection is very difficult (17%), high cost (17%) and distance of AI centre from the farm or household (15%). The major constraints for cattle farming listed by the farmers across the veterinary divisions were credit facilities (29%) and grazing field (20%) (Table 16). Other major reasons listed were unprotected railway crosses

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(Poonakary-14% and Pachchilaipalli-11%) and scarcity for drinking water (9%) to animals during dry period.

Table 16: Constraints faced by cattle farmers by veterinary division (%)

Problems	Karachchi	Kandawalai	Pachchilaipalli	Poonakary	Overall	X^2 P value
Lack of grazing field	22.93	17.54	19.05	23	20.63	0.51
Lack of credit facilities	23.17	31.58	29.76	32	29.12	
Lack of assistance for housing	2.6	1.75	1.19	1	1.63	
Water problem	8.75	11.7	7.14	7	8.64	
Price fluctuation	4.26	8.77	2.38	1	4.1	
Inadequate support	19.39	9.94	8.33	7	11.16	
Poor bull in herd	8.75	4.68	5.95	8	6.84	
Railway track	9.46	5.26	10.71	14	9.85	
Theft	0.71	8.77	15.48	7	7.99	

Factors Affecting Adoption of AI

Landholding size did not influence adoption of AI (Table17).

Table 17: Number and percentage of farmers using AI by land holding size

Land holding size	Non adoption		Adoption		Partial adoption				
	No. of farmers	%	No. of farmers	%	No. of farmers	%	Total	Row %	X^2 P value
No land	0	0	2	0.75	1	0.38	3	1.13	0.32
<1 ac	25	9.43	23	8.68	29	10.94	77	29.06	
1-2 ac	25	9.43	48	18.11	50	18.87	123	46.42	
>3 ac	15	5.66	19	7.17	28	10.57	62	23.4	
Total	65	24.52	92	34.71	108	40.76	265	100	

The influence of main occupation of the farmers on adoption of AI was not significant (Table 18).

Table 18: Number and percentage of farmers using AI by main occupation of the family

Occupation	Non-Adoption		Adoption		Partial adoption				
	No of farmers	%	No of farmers	%	No of farmers	%	Total	Row %	X^2 P value
Livestock	6	2.26	9	3.4	10	3.77	25	9.43	0.64
Crops	19	7.17	30	11.32	37	13.96	86	32.45	
Salary/wages	40	15.09	50	18.87	58	21.89	148	55.85	
Home industries	0	0	3	1.13	3	1.13	6	2.26	
Total	65	24.53	92	34.72	108	40.75	265	100	

Adoption of AI was significantly influenced by distance of veterinary office from the farm (Table 19). When the distance goes beyond 15km the adoption rate decreased.

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Table 19: Number and percentage of farmers using AI by distance

Distance (km)	Non-Adoption		Adoption		Partial Adoption				
	No. of farmer	%	No. of farmers	%	No. of farmer	%	Total	Row %	X^2 P value
01-05	25	9.43	11	4.15	16	6.04	52	19.62	0.0007
06-10	16	6.04	20	7.55	16	6.04	52	19.63	
11-15	10	3.77	38	14.34	39	14.72	87	32.83	
16-20	6	2.26	14	5.28	24	9.06	44	16.5	
>20	8	3.02	9	3.4	13	4.9	30	11.32	
Total	65	24.53	92	34.72	108	40.75	265	100	

Family size had an influence on adoption of AI (Table 20).

Table 20: Number and percentage of farmers using AI by family size

Family size	Non-Adoption		Adoption		Partial adoption				
	No. of farmers	%	No. of farmers	%	No. of farmers	%	Total	Row %	X^2 P value
Up to 3	29	10.94	36	13.58	57	21.51	122	46.04	0.49
04-05	30	11.32	45	16.98	41	15.47	116	43.77	
06-07	6	2.26	10	3.77	7	2.64	23	8.68	
>7	0	0	1	0.38	3	1.13	4	1.51	
Total	65	24.53	92	34.72	108	40.75	265	100	

Education level of livestock farmers significantly influenced adoption rate of AI (Table 21). Illiterate to middle level the AI adoption rate increased, thereafter the adoption rate decreased.

Table 21: Number and percentage of farmers using AI by education level

Education level	Non-Adoption		Adoption		Partial Adoption				
	No. of farmers	%	No. of farmers	%	No. of farmers	%	Total	Row %	X^2P value
Illiterate	16	6.04	9	3.4	14	5.28	39	14.72	0.03
Up to primary	11	4.15	28	10.57	22	8.3	61	23.02	
up to middle	23	8.68	39	14.72	46	17.36	108	40.75	
up to high school	7	2.64	11	4.15	10	3.77	28	10.57	
above high school level	8	3.02	5	1.89	16	6.04	29	10.94	
Total	65	24.53	92	34.72	108	40.75	265	100	

As far as the herd size is concerned, though the differences were not significant (>.08) there was a decreasing trend of adoption AI with increase in the herd size (Table 22).

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Table 22: Number and percentage of farmers using AI by herd size

Herd size	Non adoption		Adoption		Partial adoption				
	No of farmers	%	No of farmers	%	No of farmers	%	Total	Row%	X^2P value
Up to 5	7	2.64	24	9.06	22	8.3	53	20	0.08
6-10	28	10.57	33	12.45	24	9.06	85	32.08	
11-20	18	6.79	23	8.68	44	15.09	85	30.57	
21-30	6	2.26	6	2.26	11	5.66	23	10.19	
31-40	3	1.13	1	0.38	1	0.38	5	1.89	
>40	3	1.13	5	1.89	6	2.26	14	5.28	
Total	65		92		108		265	100	

Discussion

The survey on the four veterinary divisions of Kilinochchi district revealed that the overall level of adoption of AI was 35 percent and partial adoption of AI 41 percent while rests depend on natural service to breed their animals. These results are in agreement with the AI adoption levels of 37 percent by Sinniah and Pollot (2006) in the dry zone of Sri Lanka and Borden *et al.* (2017) in Nyagatare in Africa. The figure is much higher than the 4 percent reported by Abdallah (2011) in Tanzania. A very high level of adoption of AI of around 85% and 90% for the dairy animals was reported by Dhami *et al.*, 2018 in the arid and semi-arid areas of Kutch and North Gujarat of India. The differences in adoption level may be attributed to several factors such as interest and education level of the farmer, AI success rate etc.

Demographic Characteristics of Cattle Farmers

Majority of the farmers fell in the age group of 41-65 years. Abdallah (2011) in Tanzania reported that most of the respondents were between 46 – 60 years of age he further stated that the absence of youths in this study among others was due to the fact that youngsters do not have enough time to accumulate substantial resources to enable them to own properties. The reason for higher percentage of farmers with less than 10 years' experience could be as a result of complete displacement during 2008 and commencement of resettlement from January 2010 onwards due prevailed unrest situation in Sri Lanka. Abdallah (2011) in Tanzania reported adoption of AI technology is associated with number of years in dairying. Education level had a profound effect on the choice of type of service by the farmers. In this case adoption rate increased from Illiterate to up to middle level of education. Sinniah and Pollot (2006) reported that the number of farmers who adopted AI was low due to low level of knowledge about AI. Borden *et al.* (2017) reported that education level positively influenced the adoption of AI in Africa. The majority (86%) of respondents were married. The probable reason was that married households had more advantages over the other categories on effective use of owned resources, sharing ideas and managerial skills within the family and provision of labour force. Abdallah (2011) reported that 76% of cattle farmers were married in

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Tanzania. Farmers with smaller hectares (1-2 ac) tend to adopt AI more as they do not have extra space on which to raise bulls. Borden *et al.*, 2017 reported contradicting to the present findings who stated a positive correlation between AI adoption and farm size (Borden *et al.*, 2017) in Africa. The study showed that families with members getting salary or wages opted for AI than other groups. Borden *et al.* (2017) in Africa, reported that families with members working primarily in the agriculture sector and other sectors (other than animal husbandry) had the least interest in adopting AI possibly due to lack of exposure to information on the advantages of AI. The family size did not influence the AI adoption rate. Sinniah and Pollot (2006) found a non-significant effect of family size on adoption of AI. Borden *et al.* (2017) reported most of the farmers with 6 to 7 family members showed a significant preference to AI whereas those with small families (up to 3 members) and those with very large families (with over 7 members) preferred to use natural service for breeding in Africa. Abdallah (2011) reported that adoption of AI technology was not necessarily associated with family size in Tanzania.

Purpose of Rearing and Use of AI

The percentage of farmers adopting AI was high when cattle were kept for 'milk and manure' and 'milk, meat and manure' (7%). The general trend was that among the farmers adopting AI (35%) almost all the farmers had milk as one of the main purposes for rearing cattle. In the dry zone of Sri Lanka also most farmers reared cattles for milk and manure purpose (Sinniah and Pollot, 2006).

Management Systems

The farmers (87-97%) adopted semi intensive system of management. These animals were paddocked or housed during night to protect from theft and unfavorable environmental conditions. Camila, 2016, reported that over 94% of farmers practice intensive system while only 5.8% of farmers practice semi-intensive system in Rwanda.

Breed of Stud Bulls Preferred for AI

In Kilinochchi Jersey cross semen was preferred by farmers. There was no pure Jersey semen from veterinary divisions. Camila (2013) in Uganda reported to select semen doses for AI from the most suitable bull which will improve the low performance traits of the dams in the next generation offspring. Majority of farmers liked Jersey type of semen to use their cattle herds (Geethapriya, (2008)) in Anuradhapura.

Herd Size

A general trend of reduction in AI adoption rate with increasing herd size was observed in the present study. Large herd size is uneconomical due to the fact that the use of AI requires a high level of management in terms of input like feeding, routine herd observation and communication with inseminator; therefore as

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herd size increases the farmers' ability to manage and pay for AI services is constrained (Abdallah, (2011)) in Tanzania. Geethapriya (2008) in Anuradhapura reported that farmers with large herds not much involve in the AI and those farmers practicing extensive management system.

Natural Service

The majority of farmers depending on a neighbour's bull to service their animals. The drawback of depending on neighbour's bull were that the bulls available were not superior ones. This study supports the finding by Sinniah and Pollott (2006) that the percentage of farmers relying on neighbours' bulls were higher than those who depended on their own bulls and that availability of own and neighbours' bulls negatively affected the use of AI.

Distance

AI adoption rate increased from 1-5km to 11-15km thereafter the rate of adoption decreased. Borden et al (2017) in Africa found that most farmers within walking distance adopted AI, whereas those more than 15km away from AI centres preferred natural service because of the costs involved in the movement of personnel and equipment for the AI procedure. Distance of a farm from the AI centreis a critical factor affecting its uptake (Sinniah and Pollot, (2006)).

Response to AI Calls

Forty percentage of the AI adopters pointed out that the delay in attending the AI calls is one of the constraints which influence the adoption rate. Delay in attending the AI calls on time leads to a big number of cows having long intervals of calving. Lack of mobility and large area of operation are the main constraints for the technicians (Geethapriya, 2008) in Anuradhapura. Camila (2013) in Uganda found that half of the interviewees also said that the fact that the AI technician did not come on time was one of the problems with using AI.

Calving to Service Interval

Crosses showed (2 months) comparatively lower calving to service interval than the indigenous ones. A study at National Dairy Research Institute, Karnal, India conducted by Puble Japheth *et al*. (2018) on Friesian crosses revealed that the optimum calving to service interval to obtain maximum milk yield as 52-70days. The differences between indigenous and crosses may be attributable to differences in the management systems where indigenous animals mostly under the extensive system of management while crosses are under semi intensive system of management.

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Number of Insemination Per Conception

The number of inseminations for successful conception was significantly different ($P < 0.05$) among breeds with indigenous breeds recording higher number of inseminations per conception compared to exotics and crossbred cows. The possible reason for lower proportions of indigenous cows conceiving at first insemination may inadequate heat detection, improper time of insemination and shorter duration of oestrus in zebu animals. Camila (2013) in Uganda reported that estrous in the Zebu tends to be shorter and is often subdued and furthermore, Zebu cows often refrain from repeated mounting. The number of inseminations per conception indicates the quality of AI service provided coupled with farmers' ability to detect the heat signs of their cows and time of insemination. Sinniah and Pollott (2006) reported that there is a possibility to increase the percentage of farmers adopting AI by taking action to reduce the number of inseminations required per conception. Abdallah (2011) in Tanzania reported that farmers ability to detect heat and time of insemination were crucial because when an animal does not conceive at first insemination there was a loss in terms of delayed conception, calving, loss of milk production and cost of repeated insemination.

Heat Signs

Heat detection plays an important role in the AI service. Farmers' ability to detect the heat signs of cows and time of heat detection are important. Generally, more respondents depended on secondary heat signs that were clear mucous from the vulva (17%), bellowing (18%), reduced milk yield (12%), frequent urination (11%) and raising tail head (14%). A thorough heat detection and insemination at an optimal time are factors known to influence the pregnancy result (Camila, 2013). Sinniah and Pollott (2006) reported similar findings when studying breeding activities and adoption of AI amongst dairy herds in dry zone of Sri Lanka, that major signs used were bellowing (10 - 74%), mucous discharge (6 - 71%), restlessness (1 - 23%), loss of appetite (2 - 27%) and mounting of other animals or mounted by other animals (9 - 49%) and drop in milk yield (0 - 16%). Abdallah (2011), reported, signs used were bellowing (31.1%), mucous discharge (36.7%) and mounting other animals or being mounted by others (35.6%) in Kinondoni district. To reach a good pregnancy result using AI, the farmer must be well educated in heat detection and check for heat regularly in the herd (Galloway and Perera, 2003).

Cost for Insemination

High cost of AI was one of the concerns of the AI adopting farmers. Geethapriya, 2008, found that in the Sri Lanka, farmers have to pay charge for the semen dose plus technician expenses. For the second or more than two inseminations, farmers paid for the transport cost to technician higher cost for AI service was one of the reasons for non-adoption of AI (Prakashkumar *et al.*, 2017) in India. Eklundh (2008) in Uganda found that several of the interviewees said that the costs for AI were too high.

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Milk Yield

The farmers in this region possess breeds of Indigenous, Jersey cross, few Sahiwal and very few Friesian. Jersey crosses produced a range of 3.5 to 4 litres of milk in study area which is much lower than the expected values under intensive management systems in the tropical regions. The production levels can be increased by proper housing, feeding and other management practices. Camila *et al.* (2016) in Rwanda found that cross breeds of 75% of Jersey breeds produce an average of 16 litres of milk per day; cross breeds of more than 85% produce an average of 22 litres per day while pure exotic breeds produce an average of 30 litres of milk per day. Exotic pure breeds could be attributed to the high milk yield of crossbreeds compared to local breeds Exotic cattle breeds, as the Holstein-Friesian, have the genetic capacity to produce a higher milk yield than the indigenous breeds and are therefore preferred by the farmers (Camila, 2013) in Uganda.

Calving Interval

Calving interval for the breeds available in the study area ranged from 12 months to 14 relies within the optimum range recommended for cattle. Camila *et al.*, 2016 in Rwanda reported period between births was between 11 – 13 months.

Non-Adoption of AI

The main reasons for non-adoption of AI technology in the Kilinochchi were Estrous detection is very difficult, high cost and distant AI centre from the farm or household. The negative influence of distance to veterinary institution implies that as the distance to veterinary institution increased, the farmer tends to move towards non-adoption from partial and full adoption (Prakashkumar *et al.*, 2017) in India. Very few farmers said that adoption of AI was by reduced transfer of venereal disease. Camila, 2013 in Uganda stated that farmers preferred AI as a means of preventing transmission of venereal diseases. Cattle farmers were not able to explain clearly the calving to conception interval and first service conception rate and calf growth. But they were able to elaborate all these concepts in an overview of since they started practicing AI services up to today.

Conclusion

The overall artificial insemination adoption rate of 35% is inadequate for the genetic improvement of the cattle in the study area. Addressing the constraints for AI mentioned by the farmers would be a strategy to increase AI adoption rate. The lower productivity of the indigenous and crossbreds can be addressed through educating the farmers regarding appropriate management practices which will increase income of the farmers while ensuring the sustainability of the dairy industry in the Kilinochchi district. Apart from AI, establishing stud centre services and issue of improved bulls would be a way forward to increase the productivity of the indigenous animals.

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Conflict of Interest

Authors declare that they have no conflict of interest on this publication.

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