Constraints associated with the use of Artificial Insemination (AI) and Natural Service (NS) in smallholder dairy herds in Tanga and Morogoro, Tanzania

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SUMMARY

This study was aimed at identifying constraints, opportunities and defining appropriate strategies for achieving better livelihood outcomes among 228 (Tanga) and 174 (Morogoro) smallholder dairy-farmers' households (HHs). A structured questionnaire was administered by direct interview of randomly selected HH heads. Of the respondents in Tanga/Morogoro, 67.3/45.0% preferred the use of NS and 32.7/45.0% preferred AI. AI service was available to 63/66.7% of the HHs in Tanga/Morogoro. In Tanga, AI services were provided by private practitioners (38%), government agents (32.4%) and projects/NGOs (20.7%) whereas in Morogoro government agents (52.3%) and private practitioners (39.1%) were the service providers. Of the 80.2/68.4% HHs using AI, the main problems related to AI service were poor results as shown by repeat inseminations (58.2/54.9%) and high costs (23.93/19.6%) charged. Problems related to the use of NS in Tanga were too many repeat services (42.6%) and low calf quality (34%) while in Morogoro problems associated with use of NS were too many repeat services (42.9%) too long distance to bull location (30.6%), high cost 10.2% and low calf quality (10.2%). In conclusion, attaining of high pregnancy rates and lowering of service costs would contribute to adoption of AI by smallholder dairy farmers because they attach a higher value to an AI-calf compared to one from NS. For successful intervention in addressing identified constraints, further studies are needed to find out underlying causes of the reported low conception/pregnancy rates following AI.

Key words: Smallholder dairy herds, constraints and opportunities, AI, NS

INTRODUCTION

Low cattle productivity in the smallholder dairy sub-sector in Tanzania is mainly a result of the inherently low genetic potential of the cattle genotypes used, poor animal health and management practices, and inadequate nutrition. Despite the existence of a number of productivity enhancing technologies that have shown potential for increasing productivity in pilot areas (Lenné and Thomas, 2006) they have not yet reached the majority of smallholder farmers due to various constraints related to scaling out/up and adoption.

Among powerful breeding tools is systematic crossbreeding programmes and creation of composite populations. Both tools offer the benefits of heterosis, breed differences and complementarity to help producers match genetic potential with market preferences, the climatic environment and available feed resources. Where the necessary physical environment and production inputs have been adequately provided, crossbreeding has

proved to be an effective means of increasing livestock production (Hammond and Leitch, 1995).

Artificial insemination (AI) of cattle is a breeding/reproduction technology used to control spread of venereal diseases, genetic improvement of local population and implementation of crossbreeding programmes. The driving force behind use of AI is to disseminate superior genes with the desired genetic merit within the population at a reasonable cost. The greatest advantage of AI is that it makes possible maximum or widespread use of outstanding sires, and dissemination of valuable genetic material even to small farms leading to faster genetic improvement and hence productivity of the national dairy herd.

Despite being introduced into the country more than 60 years ago, utilization of this important cattle genetic improvement technology has for various reasons been very limited and therefore efforts towards its wider dissemination and adoption are clearly needed. However, with hindsight of past failures and the overall slow adoption of the AI technology in Tanzania, there is need to view the establishment of a quality, effective and efficient AI service delivery as an adaptive research function. For AI to be fully adopted, appropriate and innovative research and extension methods must be used and therefore critical information is needed on the most effective technology up-take pathways.

The objective of this study was to identify constraints and opportunities associated with the use of AI and NS in smallholder dairy cattle herds kept in urban and peri-urban areas of Tanga and Morogoro in Tanzania. The information would assist in the formulation of appropriate strategies aimed at improving the efficiency of AI service delivery to smallholder dairy farmers in the two study sites and subsequently to other parts of the country with similar production systems. In the long run, efficient AI service delivery will contribute towards increased dairy productivity (milk, meat, calf crop) for enhanced household's food and nutritional security, income as well as better livelihood outcomes among smallholder dairy farmers in the country.

MATERIALS AND METHODS

Study area

This study was conducted in Tanga, specifically in areas of Mzizima-Mafuriko, Pongwe-Pingoni and Tanga Urban, and in Morogoro Municipality.

Production system

In both Tanga and Morogoro the animal management systems was characterized by keeping of an average of 3 heads of cattle per HH .The animals were mostly managed in a zero-grazing system but those in Mzizima and Pongwe areas of Tanga were grazed during the day and housed during the night. Control of tick-borne diseases was mainly by knap-sack spray of acaricides.

Data collection

A structured questionnaire having both closed and open ended questions was administered to 228 HH heads in Tanga and 174 in Morogoro. The interviewed HH heads were obtained by a simple random sampling from a sampling frame for each area using a random number generator. The questionnaire was administered in August, 2010 in Tanga and April 2011 in Morogoro. Collected data were checked for completeness and accuracy before being entered into a computer for analysis. The data were analysed using SPSS© software,

version 17 (2010) where descriptive statistics were generated.

RESULTS

(a) Respondent's preference and availability of AI service

In Tanga 32.7% of the 214 respondents preferred AI to NS compared to 45% of the 169 respondents in Morogoro. A further 10% of Morogoro respondents were indifferent between AI and NS. Within the three study localities of Tanga: Mzizima, Pongwe and Tanga Urban, 14.5%, 23.5% and 61.4% of the respective respondents preferred to use AI rather than NS as a method of breeding their cattle.

On availability of AI service 63% of the 211 respondents in Tanga said the service was available, the corresponding figure in Morogoro was 66% of the 112 respondents. When the responses in Tanga were further disaggregated by their specific locality, the availability of the service was quite unequal as 27.0, 76.5 and 88.4% of HHs in Mzizima, Pongwe and Tanga Urban, respectively agreed that AI service was available. In Tanga, it was reported by 49.5% of 192 respondents) that they had actually used AI service during the last five years. Of the 163 respondents in Morogoro, only 47.9% reported that they had used the service during that period.

(b) AI service providers

Of the 174 respondents in Morogoro, 52.3% agreed that AI service by government agents was accessible in their area. Most of the HHs in Tanga said that private practitioners were the most prevalent AI service providers followed by government employed inseminators. However, there were only a few AI service providers who were members of a cooperative or farmer groups. The distribution of the different AI service providers in Tanga and Morogoro are as shown in Table 1.

(c) Costs associated with the use of AI and NS

For farmers using AI in Tanga, the mean total expenditure per HH for breeding purposes in the July 2010-August 2009 period, was quite variable and all charges for AI breeding services were per insemination and the mean payment was as shown in Table 2.

The majority of HHs (86%) in Tanga that used NS as a the breeding method of choice paid every time the service was provided although there were also 14% of them in Mzizima and Pongwe areas who were charged after a successful service i.e. per pregnancy. Although none of the respondents in Tanga Urban said that they paid for the bull service per pregnancy, still on average they paid more for breeding bulls than their counterparts in Mzizima and Pongwe as shown in Table 3. The total expenditure for breeding purpose during the past one year and the mean payment per bull service in Tanga were (Table 3).

Table 1. Providers of AI service in Tanga and Morogoro, Tanzania

Service provider category	Area	Number (%) of AI service providers
Government	Mzizima (n=69)	5 (7.2)
	Pongwe (n=69)	22 (31.9)
	Tanga Urban (n=69)	42 (60.9)
	Morogoro Urban (n=174)	91 (52.3)
Project/NGO	Mzizima (n=44)	7 (15.9)
	Pongwe (n=44)	18 (40.9)
	Tanga Urban (n=44)	19 (43.2)
	Morogoro Urban (n=174)	50 (28.7)
Private practitioners	Mzizima (n=81)	11 (13.6)
	Pongwe (n=81)	40 (49.4)
	Tanga Urban (n=81)	30 (37.0)
	Morogoro Urban (n=174)	68 (39.1)
Cooperative/farmer group	Mzizima (n=19)	3 (15.8)
	Pongwe (n=19)	10 (52.6)
	Tanga Urban (n=19)	6 (31.6)
	Morogoro Urban (n=174)	1 (0.6)

Table 2. Mean 2010 total expenditure for breeding purposes and mean payment per insemination per HH (AI) in Tanga, Tanzania

Area	n	Mean (TSh.)	S.D.
(a) Mean total expenditure for AI breeding purposes per household			
Mzizima	18	12,722.44	6,468.43
Pongwe	18	42,222.28	102,780.47
Tanga Urban	51	41,941.18	44,791.25
TOTAL	87	35,954.08	58,355.31
(b) Mean payment per insemination			
Mzizima	21	7,761.90	4,999.05
Pongwe	22	11,818.18	3,017.98
Tanga Urban	59	16,576.27	23,592.23
TOTAL	102	13,735.29	18,422.93

SD; Standard deviation

Table 3. Mean total 2010 expenditure for breeding purposes (NS) and mean charges per service per HH in Tanga, Tanzania

Area	n	Mean (TSh.)	S.D.
(a) Mean total expenditure for NS breeding purposes per household			
Mzizima	27	10,407.56	7,947.99
Pongwe	38	12,539.47	17,711.80
Tanga Urban	15	21,733.33	16,662.48
TOTAL	80	13,543.80	15,280.70
(b) Mean payment per insemination			
Mzizima	37	4,675.68	2,345.85
Pongwe	44	6,375.00	7,023.32
Tanga Urban	20	12,100.05	20,860.16
TOTAL	101	6,886.15	10,640.92

For the HHs in Morogoro that had used AI service (n=77 respondents), the total AI breeding expenditure for services received in the last 12 months (July 2010 to June 2009) was reported to vary between TSh. 1,000 to 50,000 by 64.9% and TSh. 51,000 to 500,000 by 35.1% of the 77 HHs. On the other hand, for the 98 respondents that used natural service), the total bull breeding expenditure for services in the last 12 months (July 2010 to June 2009) was reported to be TSh. 1,000 to 50,000 by 85.7%, TSh. 51,000 to 500,000 by 12.2% and more than TSh. 500,000 by 2.0% of the respondents. In Morogoro municipality, 77.5% of the 80 respondents who used AI reported that they were charged per service and 22.5% said they were charged per pregnancy. Of the 100 respondents who used NS, 60.0% reported that they were charged per service and 40.0% said they were charged per pregnancy.

(d) Who decides on the method of breeding (AI or NS)

For the majority of HHs, in both Tanga and Morogoro, the decision to use AI as the method of breeding was mainly made by the respective household head as shown in Table 4.

Again, in both Tanga and Morogoro it was the HH head who decided on the use of a particular bull for breeding purposes as shown in Table 5 and as for AI, hired animal attendants were generally not entrusted with decisions on the breeding method to be used.

Table 4. Who decides to use AI service for breeding in households keeping dairy cattle in smallholder units in Tanga and Morogoro, Tanzania

Who made decision to use AI service	Tanga (N=98)					Morogoro (N=79)	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	% (n/N)	Total (n)	% (n/N)
Household head	12	18	33	63	64.3	50	63.3
Spouse	2	1	6	9	9.2	15	19.0
All household	4	3	7	14	14.3	11	13.9
Head's father	1	1	3	5	5.1	3	3.8
Head's mother	1	0	5	6	6.1	-	NA
Hired worker	0	0	1	1	1.0	-	NA
TOTAL	20	23	55	98	100.0	79	100.0

NA; not applicable; for Tanga n= $n_1+n_2+n_3$

Table 5. Person responsible for decision on the use of a particular bull for natural service in Tanga and Morogoro, Tanzania

Who made decision to use NS	Tanga					Morogoro	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	% (n/N)	Total (n)	% (n/N)
Household head	24	36	7	67	60.9	62	60.2
Spouse	2	0	4	6	5.5	14	13.6
All household	8	7	4	19	17.3	13	12.6
Head's father	3	2	1	6	5.5	7	6.8
Head's mother	4	3	2	9	8.2	3	2.9
Son	0	2	0	2	1.8	-	NA
Daughter	-	-	-	-	NA	1	1.0
Hired worker	0	1	0	1	0.9	3	2.9
TOTAL	41	51	18	110	100	103	100.00

NA; not applicable; for Tanga n= $n_1+n_2+n_3$

(e) **Problems related to the use of AI and NS**

The majority of the 81 respondents in Tanga i.e. 80.2% indicated that they had experienced some problems in AI delivery when they needed the service. On the other hand in Morogoro, of the 76 respondents to the same question, majority of them i.e. 52 (68.4%) indicated that they had also experienced some problems in AI service delivery when they needed the service. In both Tanga and Morogoro, the main problem with the service was poor AI results leading to many repeat inseminations per cow. Other problems that were mentioned in relation to use of the service were as shown in Table 6.

Of the 73 HH heads in Tanga, who responded to the question on whether they had experienced any problem when using NS as a breeding method, 61.6% of them indicated that they had actually experienced problem. The most common problems related to the use of bull service in Tanga were too many repeat breeding and low calf quality than expected whereas in Morogoro it was also too many repeat breedings and long distance to the bull location as shown in Table 7.

Payment for bull service was mostly effected by cash as indicated by 86.5% (Tanga) and 88.8% (Morogoro) of respondents. In Tanga other modes of payment were by credit or after milk sales as indicated by 9.2 and 3.5% of respondents, respectively. Only one farmer in Tanga among 141 who indicated that (s)he accessed bull service free of charge. In Morogoro, other modes of payment were by credit or after milk sales as indicated by 12 (7.9%) and 5 (3.3%) of respondents, respectively.

(f) Main signs relied upon for heat detection

In Tanga majority of farmers relied on cows/heifers either mounting others and/or exhibiting vulval mucus discharge as reliable signs of heat while in Morogoro detection of heat was mainly based on cows/heifers either mounting others and/or making noise or being restless as reliable signs of heat (Table 8).

Table 6. Problems related to use of AI in smallholder dairy cattle herds in Tanga and Morogoro, Tanzania

Problem related with the use of AI	Tanga					Morogoro	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	% (n/N)	Total (n)	% (n/N)
Too expensive	1	6	9	16	23.9	10	19.6
Long distance	1	0	0	1	1.5	7	13.7
Too many repeats	8	8	23	39	58.2	28	54.9
Low quality of semen	-	-	-	-	-	1	2.0
Low calf quality	3	2	4	9	13.4	1	2.0
No variety of bulls	0	1	1	2	3.0	1	2.0
TOTAL	13	17	37	67	100	51	100.0

For Tanga n= $n_1+n_2+n_3$

Table 7. Problems associated with the use of natural service in smallholder dairy farms in Tanga and Morogoro, Tanzania

Problem related to use of natural service	Tanga					Morogoro	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	%(n/N)	Total (n)	%(n/N)
Too expensive	3	1	3	7	14.9	5	10.2
Long distance to bull	0	1	2	3	6.4	15	30.6
Too many repeats	8	11	1	20	42.6	21	42.9
Low calf quality	5	7	4	16	34.0	5	10.2
No variety of bulls	1	0	0	1	2.1	3	6.1
TOTAL	17	20	10	47	100.0	49	100.0

For Tanga n= $n_1+n_2+n_3$

Table 8. Main signs displayed by cows/heifers presumed to be in heat in smallholder dairy herds in Tanga and Morogoro, Tanzania

Signs displayed by cows/heifers in heat	Tanga (N=87)					Morogoro(N=97)	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	%(n/N)	Total (n)	%(n/N)
Mount other animals	11	18	41	70	80.5	50	51.5
Vulval mucus discharge	11	19	39	69	79.3	7	7.2
Make noise/ restless	10	10	32	52	59.8	40	41.2
Loss of appetite	2	5	4	11	12.6	0	0.0
Swelling of vulva	0	0	7	7	8.0	0	0.0

Percentages and totals are based on respondents; for Tanga n= $n_1+n_2+n_3$

g) Communication with inseminators

In both the study sites, the main means of communication between farmers and inseminators was mainly by telephone; with 92.6% (Tanga) and 99% (Morogoro) of HHs using cell phones and 1.5% (Tanga) and 1.0% (Morogoro) using fixed phone lines. However, in Tanga there were also 2.9% of HHs who made a physical visit to contact inseminators. In Tanga, 79% of the HHs agreed that the inseminators usually attended to their calls immediately after contact was made and a similar response was made by 98.9% of respondents in Morogoro.

(h) Number of AI or NS per conception /pregnancy

Almost 20% of respondents in Tanga and 27.1% in Morogoro indicated that their cows/heifers needed three or more inseminations (AI) before conception /pregnancy occurred (Table 9).

The majority of respondents in Tanga (78.1%) and Morogoro (66.7%) who use

NS do not own the breeding bulls but rather they depended on bulls owned by other farmers. For farmers in Tanga, who use self-owned breeding bulls, the mean age (years) of the bulls were as shown in Table 10.

For self-owned breeding bulls in Tanga, 41.4, 41.4 and 17.2% were raised within the household herd, purchased from elsewhere or obtained from a neighbour, respectively. In Morogoro, the reported main sources of the breeding bulls (n=58) were raised within the herd (26.8%), obtained from a neighbour (42.9%), bought from SUA farm (17.9%) or purchased from elsewhere (12.5%).

For the 24 farmers with self-owned breeding bulls in Tanga, 62.5, 29.2, 4.2 and 4.2% of them indicated that they needed only one, two, three or four NS breeding sessions per conception/pregnancy respectively. For farmers using NS in Morogoro, about 50% of the responding 129 HH heads indicated that they needed to send out cows/heifers in heat only once per conception/pregnancy. Otherwise it was reported that cows and heifers were sent out twice, thrice, four or five times for bulling sessions in 42.6, 5.4, 1.6 and 0.8% respectively before they became pregnant.

(i) Persons responsible for heat detection and reporting to inseminator

In both Tanga and Morogoro, it is mainly the HH head who was responsible for both heat detection and reporting to the inseminator as shown in Table 11. Within Tanga Urban, Pongwe and Morogoro municipality, the hired worker was responsible for heat detection in 45.2, 40.5 and 27% of the cases respectively. On the other hand, in a relatively rural based area like Mzizima in Tanga, the hired worker was only responsible for heat detection in 14.3 % of cases. Overall, the HH head was again mostly responsible for reporting to the inseminator (Table 11).

(j) Suggestions for improving AI service

Suggestions put forward by respondents for improving AI services in the study areas were as shown in Table 12.

Table 9. Reported number of inseminations (AI) needed per conception/pregnancy in smallholder dairy herds in Tanga and Morogoro, Tanzania

Average number of AI per conception/ pregnancy	Tanga (N=72)					Morogoro N=96)	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	% (n/N)	Total (n)	% (n/N)
One	4	14	17	35	48.6	22	22.9
Two	3	8	12	23	31.9	48	50.0
Three	1	2	8	11	15.3	23	24.0
Four	1	0	1	2	2.8	3	3.1
More than four	0	0	1	1	1.4	0	0.0

Percentages and totals are based on respondents; for Tanga n= $n_1+n_2+n_3$

Table 10. Mean number of bull visits by cow per conception/pregnancy and mean age (years) of self-owned breeding bulls, Tanga, Tanzania

Area	n	Mean	S.D.
(a) Bull visits by cow per conception/pregnancy			
Mzizima	33	1.85	1.39466
Pongwe	47	1.54	0.71346
Tanga Urban	19	1.42	0.60698
(b) Age (years) of self-owned breeding bulls			
Mzizima	11	2.57	1.4
Pongwe	15	2.22	0.78
Tanga Urban	11	2.65	1.25

SD; Standard deviation

Table 11. Persons responsible for heat detection and reporting to the inseminator

Person responsible for	Tanga					Morogoro	
	Mzizima (n_1)	Pongwe (n_2)	Urban (n_3)	Total (n)	% (n/N)	Total (n)	% (n/N)
(a) Heat detection					(N=178)		(N=174)
HH Head	20	22	13	55	30.9	48	27.6
Spouse	7	5	8	20	11.2	23	13.2
All HH members	22	17	8	47	26.4	36	20.7
HH head's father	3	3	2	8	4.5	8	4.6
HH head's mother	6	5	4	15	8.4	6	3.4
Son	1	1	1	3	1.7	6	3.4
Hired worker	6	17	19	42	23.6	47	27.0
(b) Reporting cows/heifers in heat to inseminator					(N=100)		(N=131)
HH Head	13	13	16	42	42.0	69	52.7
Spouse	4	2	6	12	12.0	23	17.6
All HH members	5	7	1	10	10.0	20	15.3
HH head's father	4	3	3	10	10.0	4	3.1
HH head's mother	3	2	5	10	10.0	6	4.6
Son	1	2	1	4	4.0	5	3.8
Hired worker	2	9	3	14	14.0	4	3.1

Percentages and totals are based on respondents; for Tanga n= $n_1+n_2+n_3$

Table 12. Respondents' suggestions on improving AI service to smallholder dairy farmers in Tanga and Morogoro, Tanzania

Suggestion for Improvement	Tanga (N=82)					Morogoro (N=85)	
	Mzizima (n_1)	Pongwe (n_2)	Tanga Urban (n_3)	Total (n)	% (n/N)	n	% (n/N)
Reduce cost	11	19	16	46	56.1	21	24.7
More inseminators	3	10	1	14	17.1	33	38.8
Have service centre nearby	6	12	8	25	30.5	31	36.5
Provide quality service	5	7	16	28	34.1	0	0.0
Use professional inseminators	3	1	3	7	8.5	0	0.0
Increase farmer awareness through education/ seminars	1	16	5	22	26.8	0	0.0

Percentages and totals are based on respondents; for Tanga n= $n_1+n_2+n_3$

DISCUSSION

A higher proportion of HHs in Tanga preferred to use NS (67.3%) when compared to Morogoro (45.0%) although the AI service generally was reported to be almost equally available to dairy farmers in Tanga (63.0%) and Morogoro (66.7%). In the course of focus group discussions (as part of the wider diagnostic survey) and based on direct observation it was noted that there was no AI service provider stationed at Mzizima (Tanga) and therefore they depended on inseminators coming from either Tanga Urban or Pongwe. It is interesting that despite differences in availability of, and/or preference for AI service between the three localities in Tanga, overall about 50% of all respondents in both Tanga and Morogoro had not used the service for the past five years. Perhaps this has much to do with limitations of the methodolody of data collection which mainly depended on memory recollection of respondents. This study shows that in Tanga private practitioners (38.0%) are the major service providers of AI whereas in Morogoro it is the government agents (52.3%) who provide the service. However, this finding need to be qualified because in Tanzania some of the inseminators are actually government employed livestock extension staff engaged in other livestock related activities but they offer AI service on a private basis. In Tanga, the mean annual expenditure for breeding purposes and mean charges per service were higher for HHs using AI than for those using NS (Tables 2 & 5). The current high cost associated with use of AI is partly a result of the poor technical results attained as the farmer pays for every insemination when the animal returns to heat after the first insemination. In addition, in Tanga, there is a lot of variability in charges per insemination for the three areas of study and these results point to the possibility of price discrimination being in operation in the areas as mean charge per service was highest in Tanga Urban. Probably this is also an indication of a higher disposable income for the urban based smallholder dairy farmers compared to their rural based counterparts in Mzizima and Pongwe.

In both Tanga and Morogoro, closely associated with service charges is the decision to use either AI or NS in the HH, responsibility for heat detection and reporting of cows/heifers in heat to the inseminator which in most cases rested with the HH heads. Most likely this is so because of cost implications associated with these activities. The limited role accorded to the hired worker in all these three activities particularly in regard to oestrus detection could actually undermine attaining of optimal results for both AI and NS by hand mating. This is because the hired worker is the person in the HH handling animals most of the time particularly if the HH head is engaged/employed elsewhere for the greater part of the day. AI results in smallholder herds could therefore be improved by greater involvement of the hired animal attendants in heat detection and reporting to the inseminator.

Reproductive efficiency in a dairy herd improves when the percentage of pregnancies resulting from AI increases. In this study, a major reported constraint that is common in both Tanga and Morogoro is low success rates after AI leading to many repeat inseminations although this seems to contradict other findings elsewhere (Table 9) where 48.6% of respondents in Tanga indicated that they needed only one AI service per conception. Four factors that determine the percent of resulting pregnancies from AI are; cows detected in heat and inseminated, fertility level of the herd, semen fertility level and inseminator efficiency (American Breeders Service, 1986). The percentage of pregnancies resulting from AI is the product of these four factors and not their average. Of the factors included in the equation of reproduction, the inability to detect oestrus efficiently and accurately is the major impediment in attaining an optimal percentage of pregnant cows from AI. Therefore, training and retraining of farmers, animal attendants and inseminators on the true and reliable signs of heat as well as proper semen handling along the chain of activities from collection, examination and evaluation, processing to insemination would contribute immensely towards improving conception/pregnancy rates.

Previous studies on adoption of AI show that infrastructure, managerial and financial constraints, problems associated with reproductive management of cattle, such as poor heat detection, improper timing of inseminations and embryonic deaths are factors that limit the efficiency contributing to farmers resorting back to natural service (Pandey and Kumar, 2003). Similarly, studies on AI show that technical inefficiency encourages farmers to resort back to natural service and may hinder development or destroy the dairy industry all together (Galloway and Perera, 2003).

It would be interesting to find out why NS was associated with too many repeat services as for AI in both Tanga (42.6%) as well as in Morogoro (42.9%). One possible explanation is that the majority of the farmers did not keep their own breeding bull and therefore had to first detect heat in their cows/heifers and send out those in heat for breeding. Therefore, problems of heat detection could play a role in the observed repeat natural services. However, this finding should be interpreted in light of realistic expectations of achievable herd reproductive efficiency. That is, irrespective of reproduction method used (AI or NS) even under ideal conditions (absence of specific fertility problems) a calving rate of 55-60% is to be expected for any single insemination or an average of 1.65 inseminations are required per calf born (Peters and Ball, 1987; Chenoweth and Larsen, 1992; Risco, 2000) It is also

worth noting that a high proportion (67.3%) of farmers in Tanga preferred use of NS to AI despite the fact that they also realized using unselected bulls for NS resulted in inferior calves. With 34% of farmers associating low calf quality with the use of NS, it is probably true that they only continue using bulls for breeding purposes because of unavailability or poor AI service results and not because they do not know or appreciate the value of improved breeding/reproduction method.

There are several factors which influence AI technology adoption and utilization including availability and reliability of service provision, cost effectiveness, price of AI offspring (heifers and bulls), milk production from AI dam, price of milk, sexually transmitted disease control, flexibility of the technology, control of inbreeding and genetic improvement (Roberts, 1986).

It is concluded that attainment of high pregnancy rates at low service costs would positively contribute towards adoption of AI by smallholder dairy farmers because they attach a higher value to an AI-born calf compared to one from NS. In both study sites, for successful intervention in addressing identified constraints, further studies are needed to find out underlying causes of low conception/pregnancy rates following AI.

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