Discussion Paper

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BASELINE SURVEY REPORT

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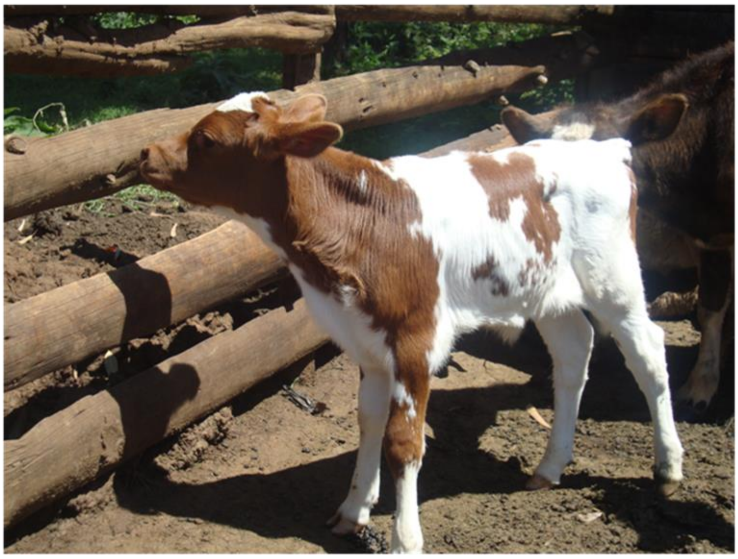
Constraints to use of artificial insemination service and possible solutions



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Constraints to use of artificial insemination service and possible solutions

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Abbreviations

AI	Artificial Insemination
CAIS	Central Artificial Insemination Station
EADD	East Africa Development Project
FAO	Food and Agriculture Organization
KNAIS	Kenya National Artificial Insemination Services
NGO	Non-Governmental Organizations
PRA	Participatory Rural Appraisal
RARDA	Rwanda Animal Resources Development Authority
SOW	State of the World

Acknowledgements

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Executive summary

Artificial Insemination (AI) technology has, over the years, been the single most important tool in transforming dairy cattle populations around the world, including in the EADD project countries. The greatest value of AI lies in the ability and potential for many farmers who adopt the technology to benefit from selections carried out in other regions of the world at a low cost, so long as the selection goals are consistent with farmer production goals and conditions.

This report analyzes the level of preference for, and use of, AI in EADD project hubs, and identifies constraints or problems hindering optimal use of the service as well as possible solutions. The report relies on data collected at the community level using participatory rural appraisal (PRA) and a questionnaire conducted at household level with 450 randomly selected respondents in Uganda, 525 in Kenya, and 302 in Rwanda.

The populations sampled across the EADD hubs and countries were a heterogeneous group, evident in the diverse human capacity, wealth, and milk market access characteristics of farmers. In general, it was evident that the preference for, and use of, AI in most of the hubs was low. The lowest rate of adoption of AI among the countries was found in Rwanda, where no sampled hub had more than 30% of farmers prefer and/or use AI over traditional breeding practices (natural service).

Several constraints were noted that hinder utilization of AI, including the unavailability of the service, high costs relative to natural bull services, limited technical capacity to use the technology at farm level, and difficult calvings when cows were served using AI. It was noted that AI is cheapest in Rwanda where 69% of the market share belongs to the government, which offers the service at a highly subsidized price. Therefore, the cost of AI is not a constraint to the use of the service in some hubs within Rwanda.

Farmers' suggestions of possible solutions to these problems included the need to develop infrastructure within the different regions to increase access to, and availability of, AI. Creation of service centres within hubs would not only bring AI closer to farmers, but would also lower the cost of delivery and therefore reduce the price of the service. Other suggested solutions were improvement of farmer capacity to use AI through increased farmer awareness campaigns on benefits of the technology, good dairy breeds and training on heat detection and timely reporting to inseminators; improvement of technician capacity through re-training

of inseminators and training of community health workers as inseminators; and provision of high quality semen that is obtained from animals that are most suitable for the targeted environment and meet the needs of the farmers. The relevance of these solutions offered differed from one hub to another. However, the need to improve delivery of AI through improved infrastructure was cited by more than 80% of the survey hubs.

Key providers of AI within each country were identified, and the proportion of farmers receiving AI from each of the providers determined. In Uganda and Rwanda, a substantial proportion of AI was provided by the government, while in Kenya, 90% of the AI was provided through the private sector. As the EADD project aims to enhance sustainable improvement in livestock productivity with greater involvement of the private sector, a challenge for the project in Rwanda and Uganda will be how to increase participation of the private sector in providing AI.

This report also identifies factors that influence farmers' decision to use AI by comparing characteristics of farmers preferring and using AI and those who do not. Results suggest that increased rearing of more exotic types of cattle and intensification of livestock production results in a greater demand for and use of AI.

1 Introduction

Artificial Insemination (AI) technology has, over the years, been the single most important tool in transforming dairy cattle populations around the world, including in the East African Dairy Development (EADD) project countries. This stems from the fact that with AI, a mature dairy bull is capable of producing well over 100,000 straws of semen per year, leading to well over 10,000 offspring in a year, hugely influencing the genetic composition and average herd performance for given traits of economic interest. The greatest value of AI lies in the ability and potential for many farmers to benefit from selection that has occurred across animals from other regions, at a relatively low cost, providing that the selection goals are consistent with farmer production goals and conditions.

For AI to be sustainable as a tool for enhancing livestock genetic improvement in productivity, various measures need to be put in place; these include: a) stable organizational structures for delivery and utilization of breeding services, b) reliable supportive infrastructure, c) well organized input-output (particularly milk) marketing systems, d) producer incentives to adopt the technology, and e) an adequate technical support system (Kaaya et al. 2005). This report will partly contribute to the assessment of whether these measures or conditions already exist in the EADD project countries and suggest possible interventions. Its objective is to analyze the level of preference for and use of AI in project hubs and identify constraints or problems hindering optimal use of the service as well as suggest solutions.

This report is based on empirical data collected using both participatory rural appraisal (PRA) approaches and household surveys. It starts by providing the background of AI in Kenya, Uganda and Rwanda in Section 2, followed by a brief literature review to generate hypotheses of the factors expected to influence use of AI, along with methods used to collect data in Section 3. The results are presented in Section 4 while conclusions are drawn in Section 5.

2 Background

Uganda, Rwanda and Kenya, host an estimated dairy cattle population of 8,538,000 head, with the highest proportion of these located in Kenya (6,200,000, 72.6%), followed by Uganda (2,100,000, 24.6%), then Rwanda (238,000, 2.8%) (FAOSTAT, 2007). The high number of dairy cattle found in Kenya can be attributed to several factors, including the implementation of the Swynnerton Plan of 1954 supporting local farmers to take up commercial agriculture, followed by the introduction of highly subsidized AI services where semen from exotic animals was provided for use in upgrading local animals by the government in the 1960's and 1970's.

In Uganda, AI of indigenous cattle with exotic semen started in 1959. The service was heavily supported by the government, using semen from both external sources and bulls bred within the country. Progress in the dairy sector in Uganda was however hampered by the civil strife experienced in the late 1970's and early 80's. Since 1987, several policies, strategic plans and laws have been enacted by the government to effect positive changes in all sectors, including the livestock sector, but these have not yet seen the anticipated results. Uganda has a national bull station at the National Animal Genetics Resources Centre and Data Base (NAGRC & DB) headquarters in Entebbe that provides semen for AI in the country. However, this only reaches a small number of dairy farmers within the country (2-15%) (SOW Report Uganda, 2006). A National Rehabilitation and Development Plan for the period 1987-1990 identified the revival of the dairy industry as a priority programme. This was followed by a review of the dairy sector policy, and the development of a national policy for livestock breeding. Implementation of dairy improvement activities however remains limited, and the provision of AI is greatly restricted.

The dairy sector in Rwanda was significantly affected by civil strife in the 1990s. Subsequently, the country needed to urgently develop institutions to provide services to support livestock improvement. AI within the country is carried out and supported by the Rwanda Animal Resources Development Authority (RARDA). RARDA provides free mandatory training for AI providers, supplies then with all equipment free of charge, and sells semen at a subsidized cost and on credit. The country depends heavily on semen from other countries, mainly within the region, but also from international sources. The capacity to deliver AI within the country is also limited by the few trained inseminators, each of whom must cover very large areas.

In Kenya, AI was adopted as a key priority government activity to improve livestock productivity among indigenous farmers in 1968 (Philipsson et al. 1988; Israelsson and Oscarsson 1994). AI was provided at a highly subsidized rate through the Kenya National AI Services (KNAIS) supported by a central bull station (Central Artificial Insemination Station [CAIS]) that was established in the country in 1946 to ensure a regular supply of semen to farmers. Both the CAIS and the KNAIS relied heavily on donor support until 1992, when structural adjustment programmes were implemented by the government and all subsidies to the livestock sector were withdrawn. A greater proportion of the costs of producing and distributing semen was thus to be borne henceforth by farmers, a change that the industry was not adequately prepared for. The reduced financial resources available to maintain the CAIS and the KNAIS resulted in a rapid decline in AI availability, against an increasing unmet demand for the service by farmers (Okeyo et al. 2000). The private sector then stepped in and supplied semen from both the CAIS and international bull breeding companies to farmers who could afford the services. However, many farmers were not adequately prepared to pay the additional costs for private services since they had been accustomed for many years to highly subsidized AI services. Delivery of AI within the country through the private sector was also skewed to areas where financial capital was abundant and farmers were able to pay the rates. Less advantaged communities thus lost out on the service, and with the unreliable government provision of AI, resorted to using local bulls for natural service.

It should be noted that among the project countries, Kenya is ahead of the others in terms of having established institutions to support AI provision such as the CAIS and the KNAIS. A review of the institutions and organizations involved in the provision of breeding services in Kenya is presented by Kosgey et al., 2011.

3 Key factors expected to affect the delivery of AI and methodological aspects

Past studies (e.g. Baltenweck et al. 2004 and Kaaya et al. 2005) indicate that provision, availability and use of AI services are generally affected by the external environment in which farmers operate as well as factors within the action domain of farmers and other local actors in the dairy industry. Key factors that have been previously documented to influence AI delivery in the EADD project countries are presented in Table 1.

Table 1. *Key factors affecting availability of AI in East Africa*

External factors	Factors within farmers' control / action domain
• Policies on and related to AI delivery	• Farm characteristics
• Infrastructure (road, access to cold chains, etc.)	• Household characteristics
• Extension services	• Demographic characteristics
• Veterinary services	• Inter-household relations
• Training or capacity building	• Animal husbandry aspects
• Advocacy on improvement of breeds	• Intra-household decisions

It is important to note that some of the individual factors within farmers' control may influence the level of impact the external factors will have on the farmers. To assess the importance of all factors in influencing AI provision and availability, empirical data were collected from select EADD project sites (hubs) which represent the overall project intervention areas. Hubs selected were determined using statistical sampling techniques described in EADD Report No 1. Two approaches detailed in EADD Baseline Report No.1 (EADD 2009) were used to obtain the baseline information:

(a) Participatory Rural Appraisal (PRA) conducted in stratified (by development domain), randomly selected project hubs (5 in Uganda, 3 in Rwanda and 3 in Kenya); and

(b) Household surveys conducted with 1,277 randomly selected households (450 in Uganda, 302 in Rwanda and 525 in Kenya) in the hubs covered during the PRA, plus non project sites which served as control sites. In Kenya, the household survey was carried out in two phases, one set of hubs in 2009 and another in 2010.

During the PRAs, a variety of matrix ranking and scoring tools were used to investigate the breeding preferences and strategies used by the farmers. Important traits of dairy cattle preferred were identified at the community level, and breeding services with their associated problems were assessed and mapped. This information was used in assessing the availability and use of breeding services within the targeted areas. The information from the PRAs was also used to estimate the level of demand for AI versus natural mating in the project areas.

The farmers participating in the PRAs suggested some interventions or solutions they would like to see implemented in their respective areas to improve the delivery and use of AI.

Household level information was collected using a structured household questionnaire containing specific sections targeting issues concerning the availability, accessibility and utilization of AI and natural bull services. Details were obtained on the source of last service, different providers of AI over the last 5 years, number of visits by service providers, expenditures on bull and AI services, and problems experienced with these services. As much as possible, efforts were made during data analysis to link data on breeding services to household data on other aspects of dairy enterprises, e.g. feeding, watering, landholding size, livestock inventory and market conditions. This facilitated identification of factors or conditions that may enhance the preference and utilization of AI.

For this report, only households with cattle were considered since they are the immediate beneficiaries of breeding services. Their numbers were 230, 169 and 458 in Uganda, Rwanda and Kenya, respectively. The information presented is from an analysis of the data obtained from the hubs within a country.

4 Results and discussion

In this section, results generated from the household and community-level (PRA) baseline data are related to the use of AI in each hub. The control sites in each country are included in the household summaries and are always placed last in the tables and figures. These sites are, however, not included in the analyses and discussions of the community-level results since they were not among the sites selected for the PRAs. General characteristics of the hubs are presented in Table 2Table 1, while their locations are presented in Figure 1. A more detailed description of each hub is presented in EADD Report 1 (EADD 2009).

Table 2. *General characteristics of hubs and control sites surveyed at baseline*

Country	Site	Characteristics of Site	
		Market Access	Length of growing period for pastures
Uganda			
	Bbaale	Low	Low
	Kakooge	High	Low
	Luwero T.C.	High	Good
	Masaka Municipality	High	Low
	Mukono/Buikwe	High	Good
	Bumanya *(Control)*	Average	Average
Rwanda			
	Bwisanga/Gasi	High	Good
	Kabarore	High	Low
	Mbare	Low	Low
	Nyagihanga *(Control)*	Average	Average
Kenya			
	Kabiyet and Kaptumo	High	Good
	Metkei	Low	Low
	Siongiroi	Low	Good
	Soy	High	Low
	Siaya and Kandara *(Control)*	Average	Average

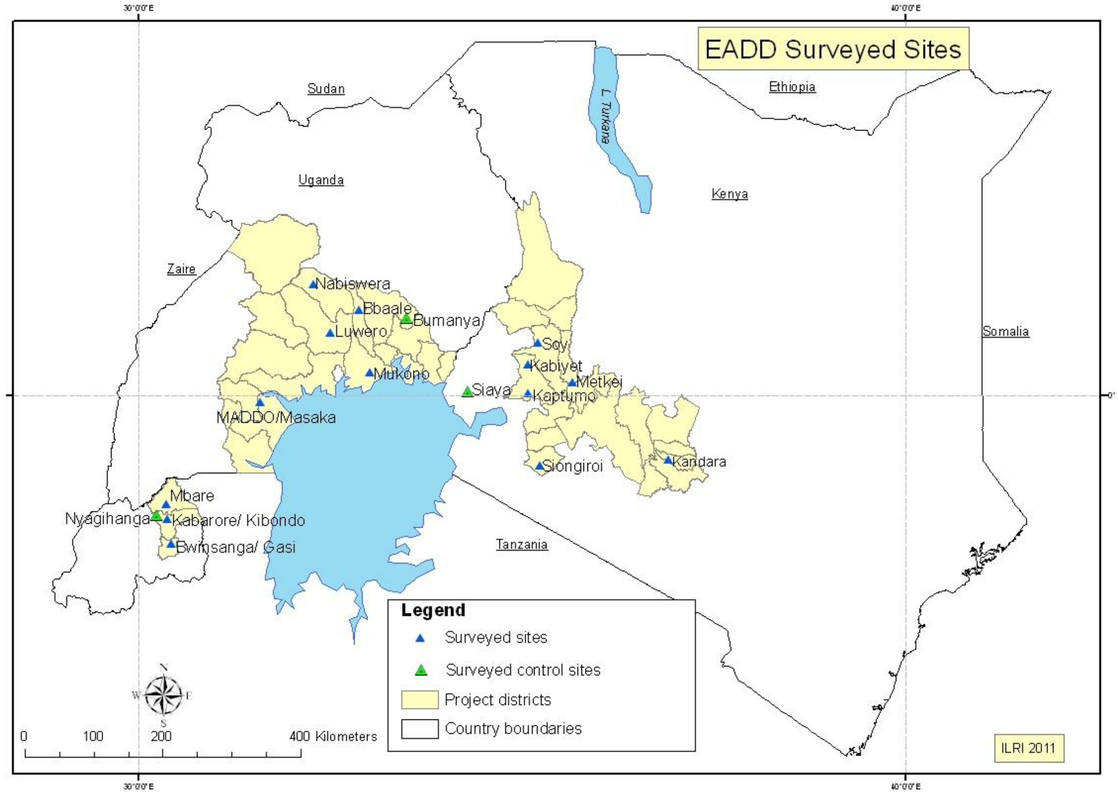


Figure 1. *Map showing sites surveyed for the project*

4.1 Characteristics of farmers and their choice of breeding services

Uganda

An overview of the human capital, wealth and milk market access characteristics of Ugandan cattle keepers in different sites, proxied by years of schooling of the household head, landholding size, number of cattle kept (local and exotic), and distance to milk market centre is presented in Table 3. Differences observed for characteristics between sites and between cattle types were tested for significance using standard analyses of variance (ANOVA) procedures.

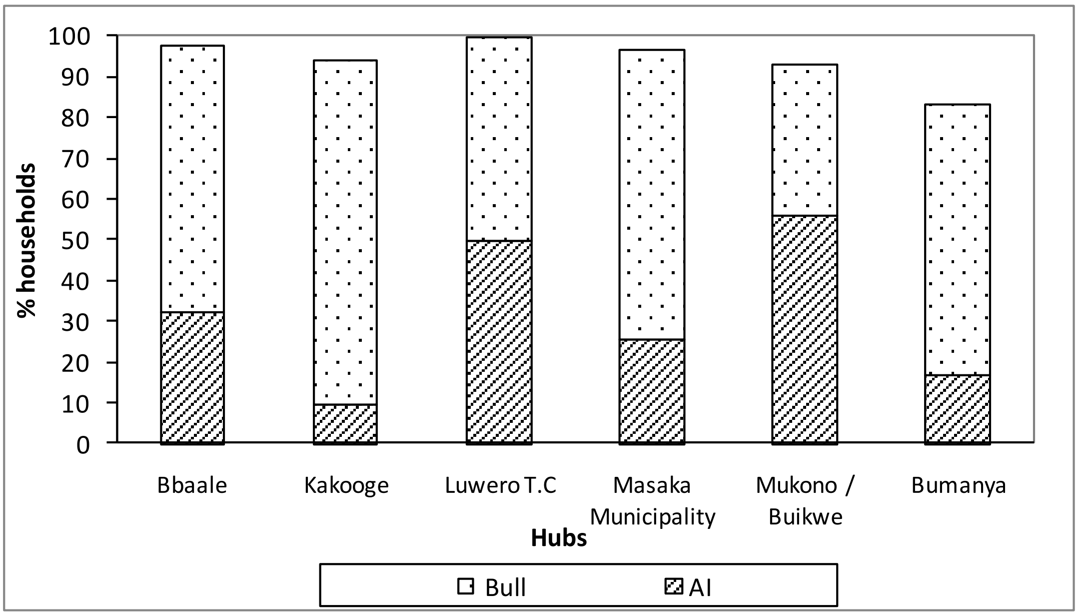
Table 3. *Major characteristics of livestock farmers in project hubs in Uganda*

Characteristic (average)	Bbaale (n=40)	Kakooge (n=52)	Luwero T.C (n=28)	Masaka Municipality (n=31)	Mukono / Buikwe (n=43)	Bumanya (control) (n=36)	Between site variation[1]
Number of years of schooling	5.2	3.5	4.8	6.0	5.1	4.2	***
Total farm size (acres)	292.0	680.0	9.9	3.5	7.8	8.6	***
Number of exotic cattle kept	15	2	1	1	1	0	***
Number of local cattle kept	20	55	8	4	3	6	***
Total number of cattle kept	35	57	9	5	4	6	***
Distance (km) to milk selling point	4.6	8.6	5.0	0.8	3.4	5.2	ns

[1] ns = not significant, *** = significant at p<0.001

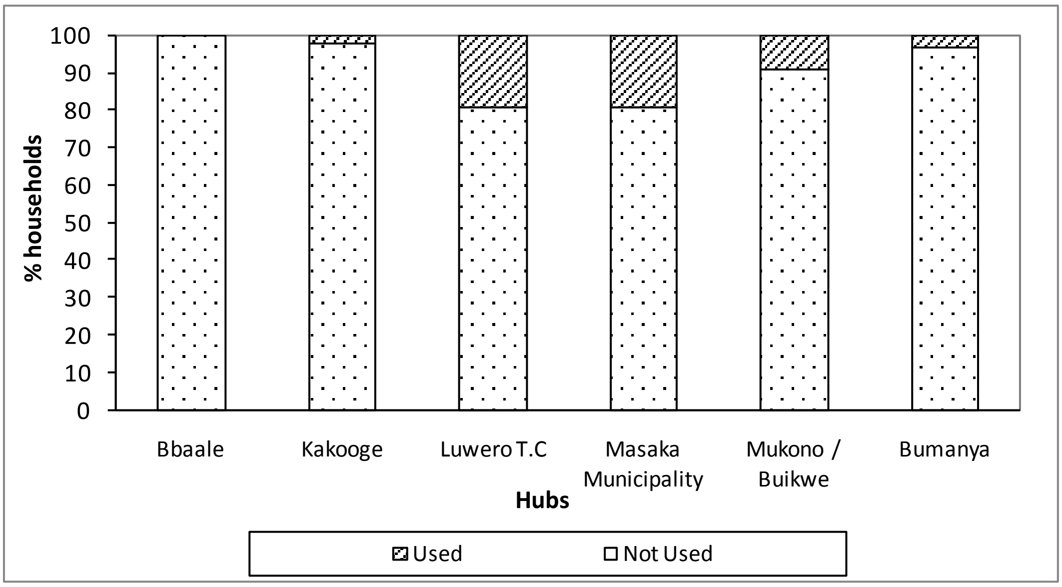
The results indicate that Masaka farmers had the highest level of formal schooling, while those from Kakooge were the wealthiest in terms of landholding and cattle ownership. Differences due to the distance to milk selling points were not significant, although farmers from Masaka farmers are likely to have lower costs of transporting milk since they are closest to the existing milk selling point (0.8 km). In all hubs there are significantly ($p<0.01$) more local than exotic cattle. In Bbaale and Kakooge hubs where the total farm size was large (highlighted in yellow), the number of local cattle kept was also much larger.

Preference for and use of mating using either AI or bull services by households within each hub is illustrated in Figure 2 and Figure 3 respectively. Only 94% of the households provided information on the preference of the mating method. In Bbaale, Masaka, Kakooge and Bumanya hubs, more farmers preferred bulls for breeding than AI, unlike in Luwero and Mukono/Buikwe, where more farmers preferred AI over bulls (Figure 2). These results correspond well to those in Figure 3, which shows that three of the hubs with higher preference for bull service (i.e., Bbaale, Kakooge and Bumanya) had very few farmers using AI in the five years prior to the survey.



Note: Total number of respondents in each hub are presented in Table 3; not all respondents provided information on preference for a mating method in the different hubs.

Figure 2. *Farmer preference of mating services in Uganda*



Note: Total number of respondents in each hub are presented in Table 3.

Figure 3. *Farmer use of AI in the last five years in Uganda*

It is clear from Figure 2 that although a larger proportion of farmers in Luwero (50%) and Mukono/Buikwe (55.8%) hubs would prefer to use AI, very few of them have actually been using AI over the last five years (19.2% in Luwero, 9.4% in Mukono Buikwe, Figure 3) indicating a lack of availability and / or accessibility to the technology. It is important to note that the data on Masaka produced an unexpected result; it was the hub with the highest percentage of farmers using AI (19.2%), yet it was among the hubs where bull service was preferred (71%) over AI. The link between preferences and actual use is therefore not always directly proportional, as other factors are at play and will be explored in subsequent sections.

Rwanda

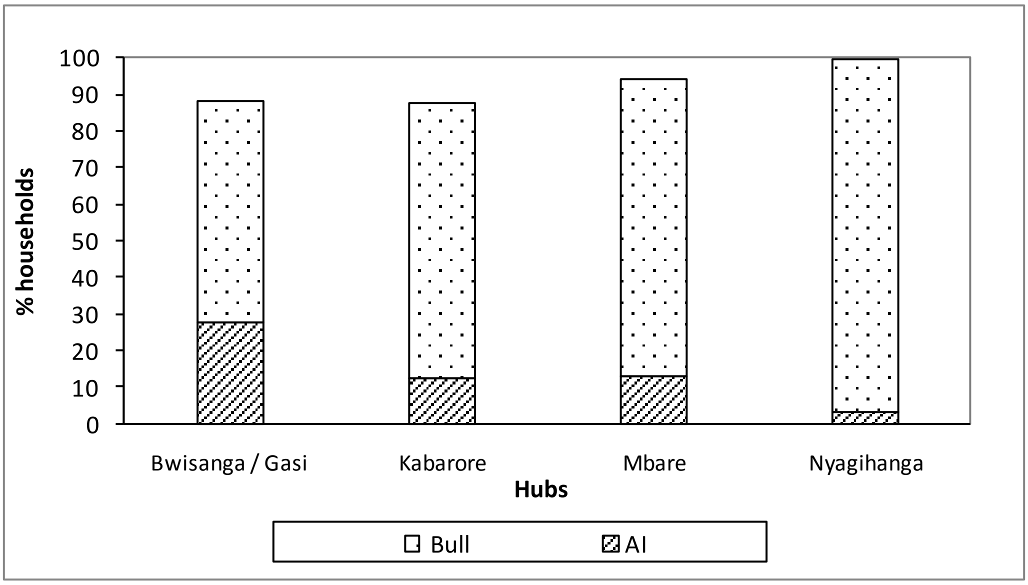
An overview of the human capital, wealth and milk market access characteristics of farmers in Rwanda is presented in Table 4. Differences in the number of years of schooling, farm size and number of exotic cattle kept were not significant between hubs. Kabarore and Mbare hubs had significantly more cattle per household, on average, than the other hubs (Table 4)Table 1.

Table 4. *Major characteristics of livestock farmers in Rwanda*

Characteristic (average)	Bwisanga / Gasi (n=43)	Kabarore (n=40)	Mbare (n=53)	Nyagihanga (control) (n=33)	Between site variation[1]
Number of years of schooling	3.7	3.9	3.4	3.2	ns
Total farm size (acres)	23.4	26.3	26.3	5.3	ns
Number of exotic cattle kept	5	9	6	0	ns
Number of local cattle kept	2	13	14	3	***
Total number of cattle kept	7	22	20	3	***
Distance (km) to milk selling point	7.5	5.9	5.8	1.5	ns

[1] Differences observed for characteristics between sites were tested for significance using standard analyses of variance (ANOVA) procedures: ns = not significant, *** = significant at p<0.001

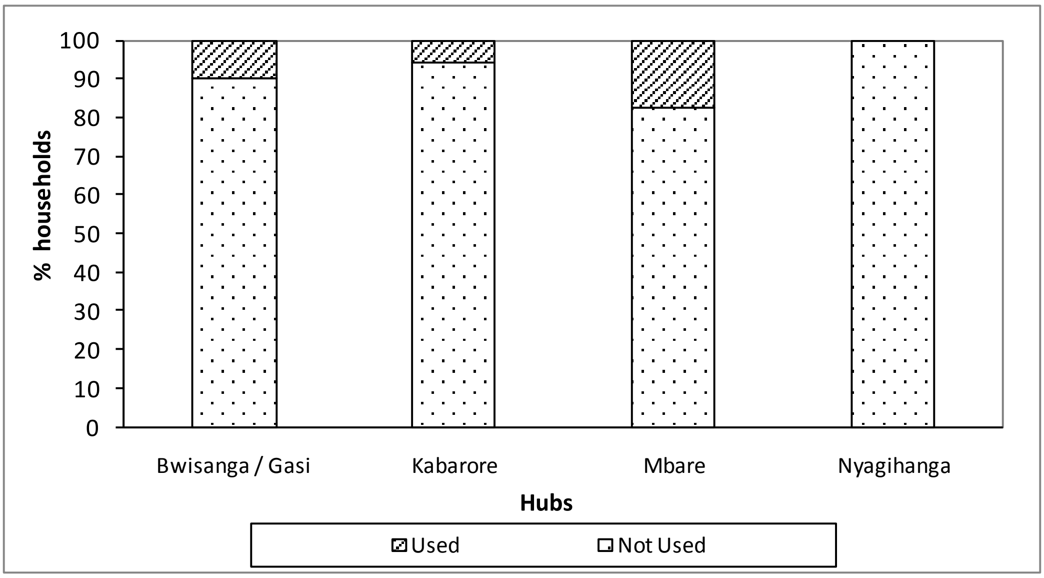
92.3% of the farmers provided information on their preference for breeding services. Bull services were preferred to AI in all the hubs in Rwanda (Figure 4). Bwisanga/Gasi hub had the highest preference for AI (27.9%), while Kabarore and Mbare had roughly the same level of AI preference (12.5% and 13.2).



Note: Total number of respondents in each hub are presented in Table 4; not all respondents provided information on preference for a mating method in the different hubs.

Figure 4 -*Farmer preference of breeding services in Rwanda*

Mbare hub led the others in terms of using AI over the last five years (Figure 5) although the use of AI here was still low (17.4%). Bwisanga/Gwasi hub had a higher preference for AI (27.9%) though its use was low (9.8%). No surveyed farmer in Nyagihanga hub, which had the lowest preference for AI (3%), had used AI in the 5 years preceding the survey (Figure 5).



Note: Total number of respondents in each hub are presented in Table 4

Figure 5 - *Farmer use of AI for the last five years in Rwanda*

Kenya

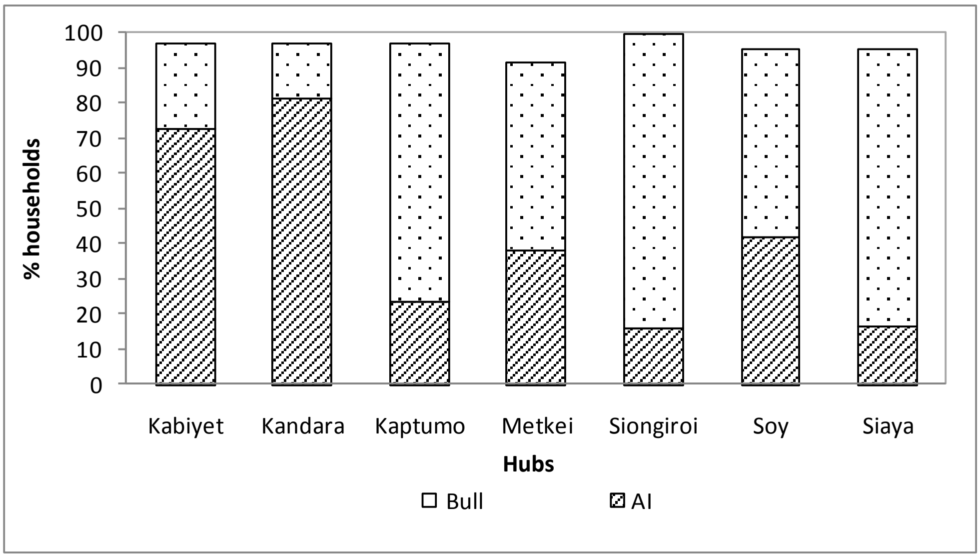
In Kenya, farmers in Kabiyet hub had the highest average number of years of schooling and total number of cattle kept, while farmers in Soy were the wealthiest farmers in terms of average landholding size (Table 5). These two hubs also had good access to markets (Table 2). Farmers within Siongiroi hub had the shortest distance to the existing milk selling point (0.5 km). Differences observed for cattle types within Kabiyet, Kandara, Soy and Siaya hubs were tested for significance using a paired T-Test. Kabiyet, Soy and Kandara hubs had significantly more exotic cattle per household ($p < 0.01$), while Siaya had significantly more local cattle types. Siaya hub is located in a warmer agro-ecological area (Table 2) tends to be prone to higher incidences of diseases.

Table 5. *Major characteristics of livestock farmers in Kenya*

Characteristic (average)	Kabiyet (n=70)	Kaptumo (n=73)	Metkei (n=71)	Siongiroi (n=69)	Soy (n=67)	Siaya (control) (n=43)	Kandara (control) (n=65)	Between site variation[1]
Number of years of schooling	7.6	6.0	6.0	5.2	6.6	6.0	6.6	ns
Total farm size (acres)	16.9	7.4	8.9	13.9	19.5	4.5	2.3	**
Number of exotic cattle kept	11	3	4	4	7	1	2	***
Number of local cattle kept	0	2	4	4	1	4	0	***
Total number of cattle kept	11	6	8	8	8	5	2	***
Distance (km) to milk selling point	3.8	1.0	1.0	0.5	2.1	1.7	0.9	**

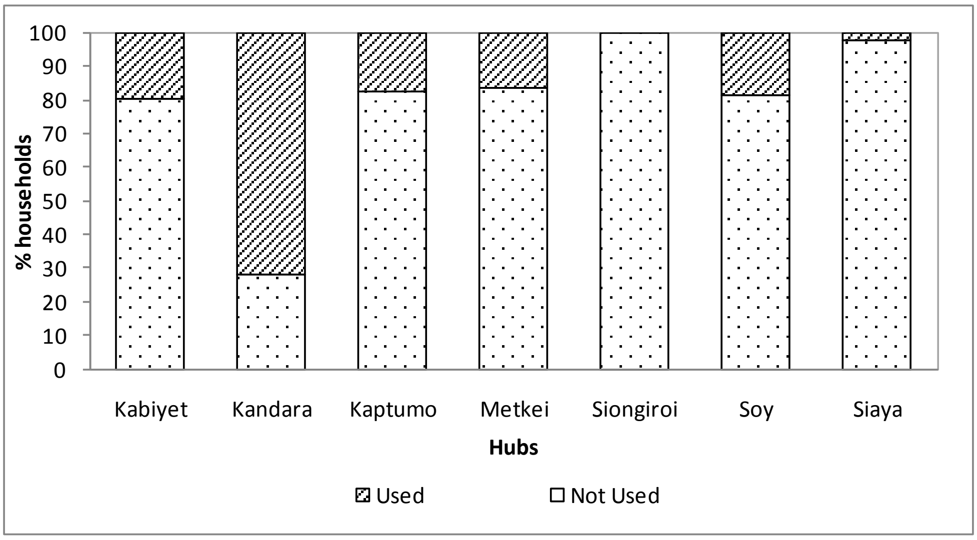
[1] Differences observed for characteristics between sites were tested for significance using standard analyses of variance (ANOVA) procedures: ns = not significant, *** = significant at p<0.001

Observations on preference and use of AI within the hubs in Kenya are presented in Figure 6 and Figure 7 respectively. Farmers within Kandara hub had the highest preference (82%) for AI, and used the service more than 70% of the time. In all the other hubs, use of AI tended to be low (< 20 %, Figure 6). Although farmers in Kabiyet preferred the use of AI relative to bulls (72.9%, Figure 6), 80% of the farmers indicated that they had not used AI in the last five years (Figure 7). In Siongiroi and Siaya, less than 17% of the farmers indicated they would prefer to use AI rather than bulls (Figure 6), and indeed the use of AI in these hubs over the last five years was negligible (0% in Siongiroi and 2.5% in Siaya, Figure 7).



Note: Total number of respondents in each hub are presented in Table 5; not all respondents provided information on preference for a mating method in the different hubs.

Figure 6. *Farmer preference of breeding services in Kenya*



Note: Total number of respondents in each hub are presented in Table 5

Figure 7. *Farmer use of AI in the last five years in Kenya*

4.2 Farmer preferences for bull mating (natural) services

From the PRA results, several reasons were given by farmers for their preference for using bulls rather than AI in the project hubs. These reasons have been synthesised in Table 6. Bumanya, Nyagihanga and Siaya in Uganda, Rwanda and Kenya, respectively, are not included in this analysis since they are control hubs and did not have a PRA survey. Soy and Kaptumo hubs from Kenya were also not included in the PRA as they were added to the project in a second phase of implementing household surveys a year after the PRA.

Unavailability of AI was mentioned by farmers in all hubs to be a problem contributing to its low adoption. High costs associated with AI and the lack of farmer and technician capacity to use the technology were also identified as major problems in most of the hubs for the three countries. It was only in Bbaale hub in Uganda where costs of AI and the capacity to use AI by the farmers and technicians were not cited as problems (Table 6).

The less frequently cited reasons for preferring bull to AI service were availability of cash to pay for AI and constraints in the quality and sex of offspring resulting from AI experienced by farmers (see Table 6). Lack of cash to pay for AI when required was reported in Mukono/Buikwe and Masaka in Uganda and in Kabiyet and Metkei in Kenya. The quality and sex of offspring resulting from AI were noted as a constraint by farmers in Mukono/Buikwe, Bbaale and Masaka hubs in Uganda only.

Table 6. *Reasons given by farmers who participated in the PRA for their preference for bull rather than AI services*

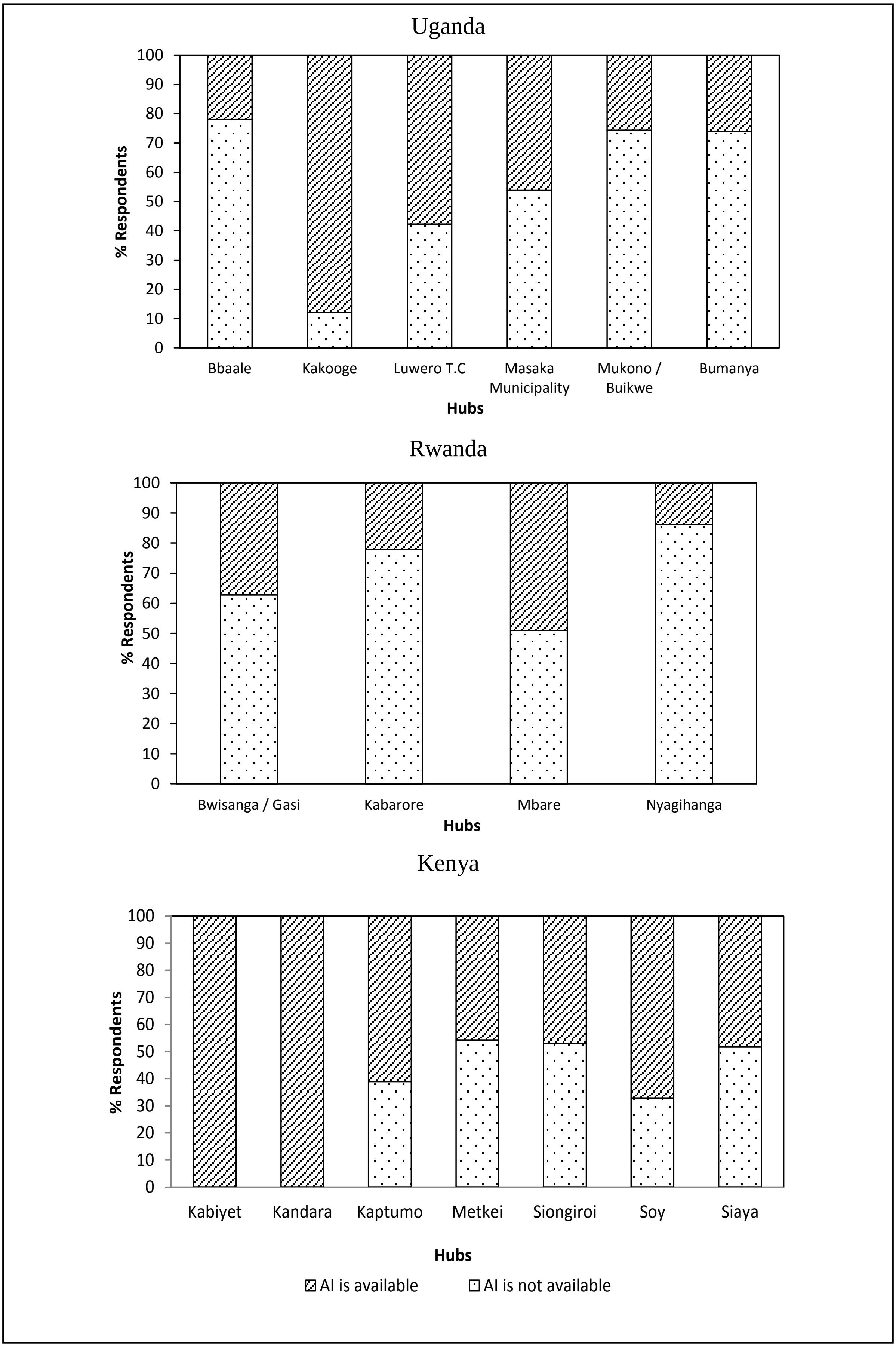
	Uganda					Rwanda			Kenya		
Reason	Bbaale	Kakooge	Luwero	Masaka	Mukono	Bwisanga	Kabarore	Mbare	Kabiyet	Metkei	Siongiroi
Availability of AI: Bulls are more readily available and in some areas there are no AI Services	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost: Bull service is cheaper than AI, AI repeats are charged, but bull service repeats are free			✓	✓	✓	✓	✓	✓	✓	✓	✓
Cash constraints: Lack of cash to pay for AI when animal is on heat				✓	✓				✓	✓	
Low farmer and technician capacity to effectively use AI: success rate of the AI services is very low, more repeat services in AI; AI technicians are few and are unable to respond on time when their services are required, AI technicians are poorly equipped		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Offspring characteristics: Poor quality of AI offspring, difficult deliveries in AI calves, more bull calves born through AI	✓			✓	✓						
Lack of support services: Veterinary services are inaccessible particularly at times of difficult deliveries	✓		✓		✓		✓		✓	✓	✓

In all the countries, the farmers noted that bulls are more readily available than AI services. Where AI was available, the costs tended to be high as each individual service was charged, whereas bulls used for repeat matings were only charged once. Farmers thus opted for bull services due to their comparatively lower cost (see discussion in Section 4.3). In Rwanda, cash constraints were not cited as a reason for preferring bulls since AI is provided by the government at a highly subsidized rate (see Section 4.3), while in Kenya and Uganda, the unavailability of cash in hand at the time of insemination was a key constraint to using AI.

4.3 Availability and cost of AI

The lack of availability of AI, as perceived by the farmers, within the various hubs noted during the PRA was investigated further during the household survey. Results from this for the three countries are presented in Figure 8. Although farmers were aware of AI, the availability of AI services was noted to be a serious constraint in all the surveyed hubs except in Kakooge in Uganda where only 12% of farmers stated that AI was not available, and Kabiyet and Kandara in Kenya where all farmers indicated that AI was available in their area.

In Uganda, AI was reported to be unavailable in Bbaale, Mukono/Buikwe and Bumanya (Figure 8) by more than 70% of the interviewed households. Furthermore, 42-54% of households in Luwero and Masaka said they had no access to AI services. Measures thus need to be put in place to increase the availability of AI in Uganda.



Note: Total number of respondents in each hub are presented in Table 3 (Uganda), 4 (Rwanda) and 5 (Kenya)

Figure 8. *Availability of AI in different hubs in the three countries*

In all the hubs in Rwanda more than 50% of the households indicated that AI was not available. The hub with highest access to AI was Mbare, where 49% of the households indicated that AI was available in their area (Figure 8).

In Kenya, AI was reported to be more available than what was reported in Uganda and Rwanda (except Kakooge in Uganda). It was only in Siongiroi, Metkei and Siaya hubs where slightly more than 50% of the farmers stated that AI was not available (Figure 8). Kabiyet and Kandara, in Kenya, were the only surveyed hubs in the EADD project countries where all farmers stated that AI was available in their area. This is in contrast to the findings from the PRA in Kabiyet where it was mentioned that bulls were more readily available than AI (Table 6).

Results from an evaluation of costs of AI to households relative to costs of bull services as reported by farmers in various hubs are presented in Figure 9. From the analysis of variance in AI and bull service costs in the project countries, AI was significantly more expensive ($p<0.001$). There were also significantly high price disparities for AI across the project countries ($p<0.1$). The highest cost of AI ($18.64 per service) was reported in Soy (Kenya), where 67% of the farmers had mentioned that AI was available (Figure 8). This may be because Soy farmers, being predominantly keepers of high yielding exotic dairy breeds, were able to pay for the higher priced service. However, only 20% of the farmers in this hub were using AI (Figure 7). The lowest costs of AI to the farmer were recorded in Rwandese hubs where AI services are highly subsidized by the government (Figure 9); Kabarore had the lowest price ($3.20). It should be noted that in Uganda, Kakooge and Bbaale hubs reported 0-2% use of AI (Figure 3) hence either very low or no costs were indicated for AI in the two hubs (Figure 9).

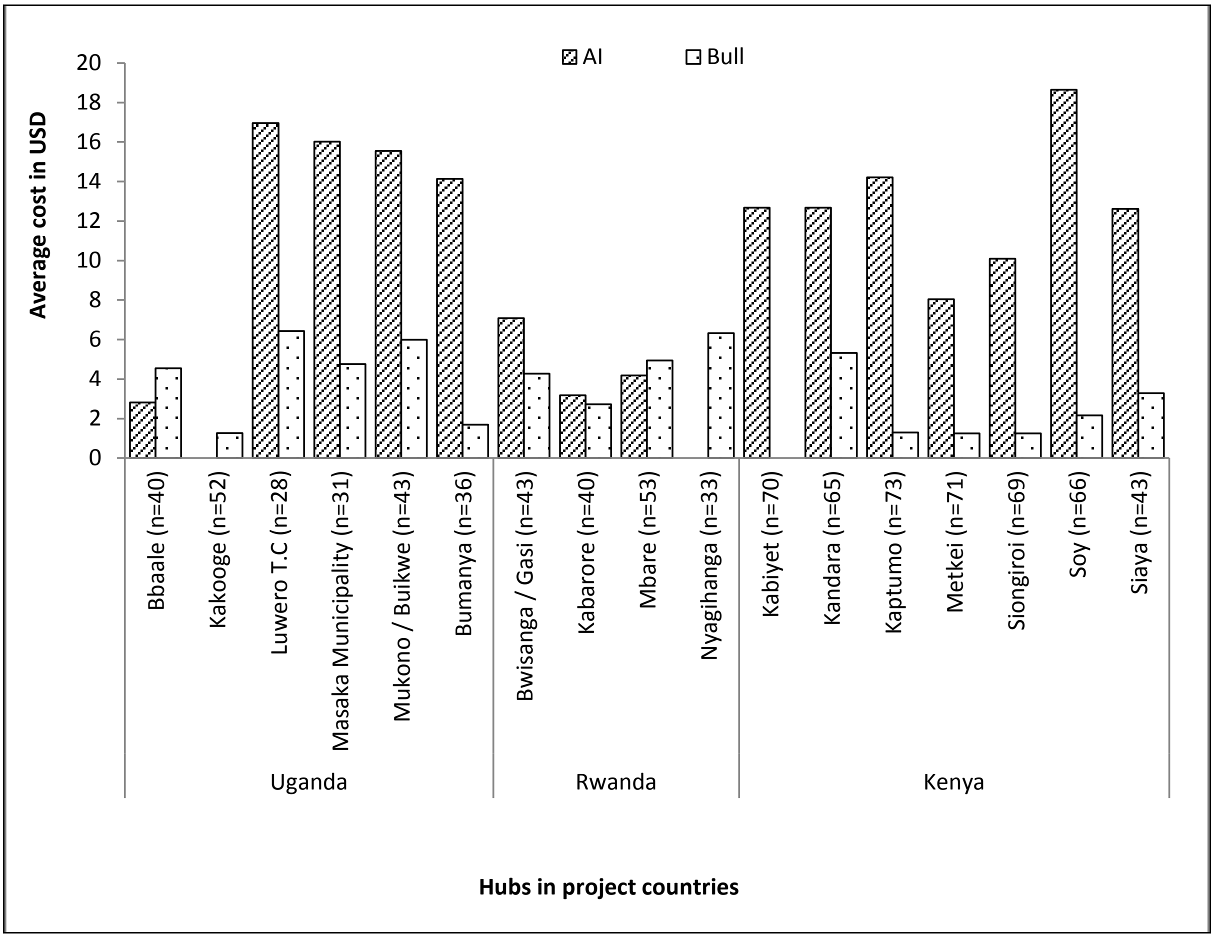


Figure 9. *Average cost (per service) of AI and bull services in project hubs*

Generally, in Kenya and Uganda, the costs of servicing an animal using AI were more than double the cost of using bulls for service (Figure 9). The high cost of service using AI is one challenge to improving livestock productivity that is to be addressed through the EADD project.

4.4 Problems associated with AI utilization

During the household interviews, farmers ranked the most important problem associated with AI use in their area (Table 7). Only hubs/farmers that had used AI in the previous 6 months were requested to rank the problems.

Table 7. *Major problems associated with AI and the proportion of households citing the problem as the most important within the different hubs*

Country / Hub	Percentage of farmers citing problem					
	Too expensive	Long distance to inseminator	Too many repeats	Low quality semen offered	No variety of breeds	*Other
Uganda						
Bbaale (N=0)	-	-	-	-	-	-
Kakooge (N=0)	-	-	-	-	-	-
Luwero (N=28)	33.3	33.3	-	-	33.3	-
Masaka Municipality (N=31)	25.0	25.0	50.0	-	-	-
Mukono / Buikwe (N=43)	100.0	-	-	-	-	-
Bumanya (N=36)	-	100.0	-	-	-	-
Rwanda						
Bwisanga / Gasi (N=43)	-	66.7	33.3	0.0	-	-
Kabarore (N=40)	-	50.0	25.0	25.0	-	-
Mbare (N=53)	14.3	14.3	57.1	14.3	-	-
Nyagihanga (N=33)	-	-	100.0	-	-	-
Kenya						
Kabiyet (N=70)	25.0	12.5	62.5	-	-	-
Kandara (N=65)	-	21.1	63.2	15.8	-	-
Kaptumo (N=73)	-	0.0	100.0	-	-	-
Metkei (N=71)	-	50.0	25.0	25.0	-	-
Siongiroi (N=0)	-	-	-	-	-	-
Soy (N=66)	25.0	-	50.0	-	12.5	12.5
Siaya (N=43)	50.0	-	50.0	-	-	-

*Other includes lack of knowledge, beliefs and perceptions regarding the services

There were differences in the relative importance of problems based on household level information between the three countries (Table 7). More problems tended to be identified in areas where AI was heavily used than in areas where its use was sparse as presented in Figure 3, Figure 5 and Figure 7. In Uganda, costs of AI and long distance to inseminator were the problems identified by the highest percentage of farmers as hindering the use of AI. Since AI was rarely used in Bbaale and Kakooge hubs (Figure 3), farmers in these areas did not rank problems experienced with AI.

In Rwanda, the most common problems experienced were long distance to inseminators and a large number of repeat services required to achieve a conception (Table 7). The quality of semen available was also a concern within two of the hubs, Kabarore and Mbare, while it was only in Mbare that costs of AI were an issue.

In Kenya, the greatest concern in the provision of AI was the large number of repeat services required in order to achieve a conception (Table 7). This was particularly notable in Kaptumo hub where all the farmers stated that this was their most important problem. In this hub, more than 80% of the households had not used AI in the previous 5 years (Figure 7). The cost of AI was noted as a key limitation in three hubs, Kabiyet, Soy and Siaya, which is not surprising given that all three sites indicated high costs of AI (Figure 9). Distance to inseminators and low quality of semen were also of concern in some Kenyan hubs. Knowledge of the breeds desired by farmers would be important to help improve the adoption of AI within these areas.

4.5 Main providers of AI services

The main providers of AI in the project countries and their relative market share, based on information from the household surveys, are presented in Figure 10. The key providers identified were the government and private sector in all three countries, and additionally non-governmental organizations (NGOs) in Uganda.

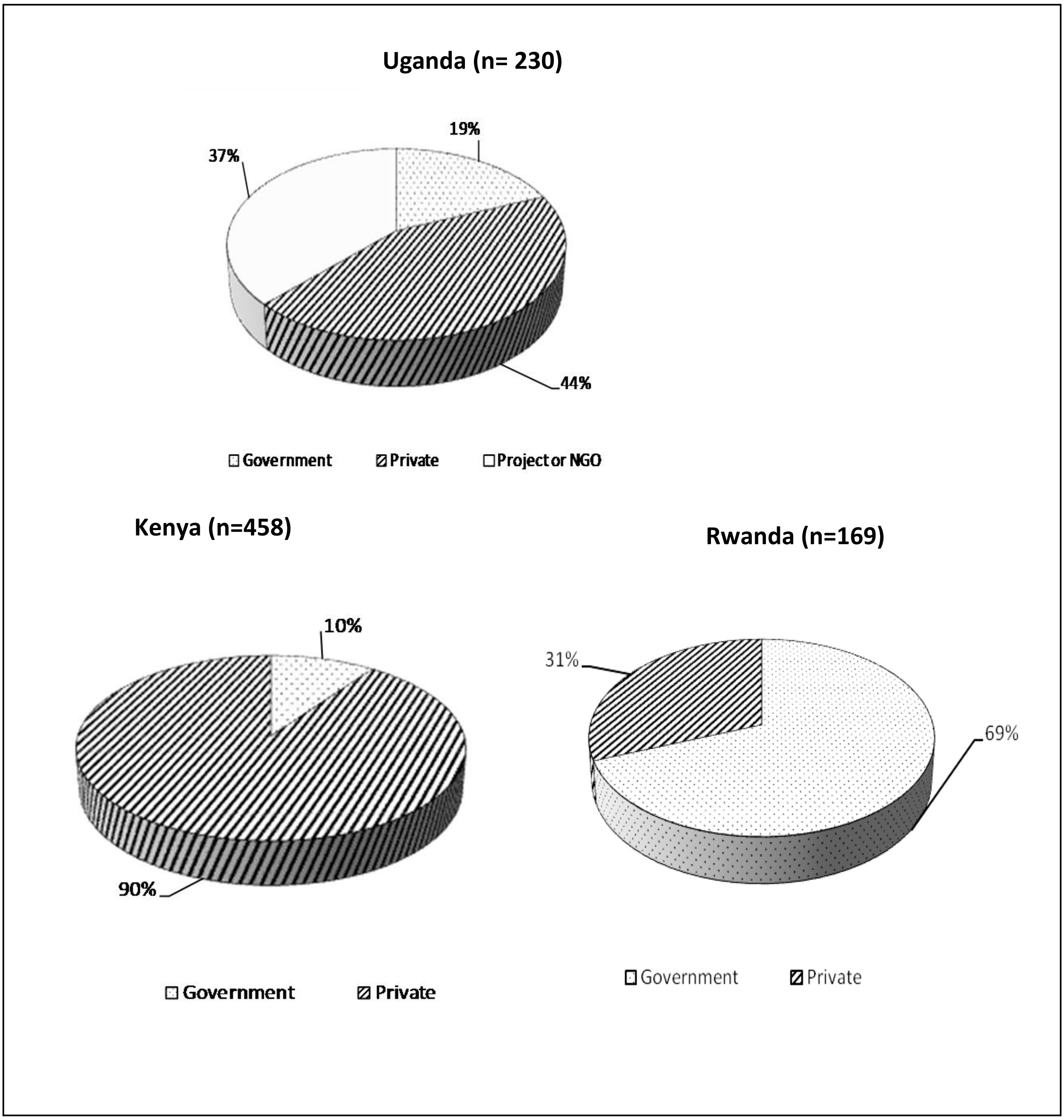


Figure 10- *Percentage of farmers receiving AI by type of provider*

Whereas in Rwanda the government provides most of the AI services (69%, Figure 10), the opposite is the case in Kenya and Uganda where 90% and 44%, respectively, of AI service is provided by private firms. It is worth noting that in Uganda, projects and NGO's provide a substantial proportion (37%) of AI services to farmers. With different AI service providers between and within project countries, prices of AI are likely to continue to vary across the countries and hubs.

4.6 Linking preference and usage of AI to farmers' characteristics

The bivariate relationship between various factors and the preference for, and use of, AI is presented in Table 8Table 1. For the continuous variable factors, a positive (+) correlation implied that the greater the level of the factor, the higher the preference for, or use of, AI while a negative (-) correlation implied that the greater the level of the factor, the lower the preference for, or use of, AI. The directions of correlation and significance levels were generated using a combination of 2-sample t-tests for the continuous variables and chi-square tests for the categorical factors, comparing farmers who prefer and use AI to those who do not. Data from Kenya were analyzed by phases of data collection (Year 1 versus Year 2) to avoid confounding due to differential timing of the surveys.

In both Uganda and Kenya, the level of farmer education was highly significant and positively associated with the preference for, and use of, AI (except 'AI use' in Kenya year 2), while in Rwanda, the correlation was not significant. Education level is important in enhancing human capital, making it easier for farmers to understand the usefulness of the AI service.

Farm size showed varying types of association with preference for, and use of, AI. The relationship was positive with the use of AI in Rwanda and preference for AI in Kenya year 1. Conversely, in Kenya year 2, farm size showed a mild negative association with use of AI and in Uganda a significant negative association was observed with preference for, and use of AI. These results suggest that small farm size may not be a constraint to the use of AI in Uganda and Kenya, and small-scale farmers who are EADD primary beneficiaries, are able to adopt this technology.

Farmers preferring and using AI in Uganda and Kenya tended to have fewer cattle (total herd size) and more exotic breed animals than indigenous; this result was expected, as AI technology is associated with more intensified systems, which means smaller herds and animals with a higher milk production potential. Conversely, in Rwanda, farmers with larger herd sizes were more likely to be using AI, perhaps reflecting a wealth relationship. Farmers with more exotic cattle were more likely to prefer and use AI in all three countries (except in Rwanda and Kenya year 2, for preference).

Table 8. *Relationships between selected factors and 'preference for' and 'use of' AI*

Factors	Uganda N=197		Rwanda N=154		Kenya (year 1, N=235)		Kenya (year 2, N=202)	
	Prefer	Use	Prefer	Use	Prefer	Use	Prefer	Use
Number of years of schooling	*** +	*** +	ns	ns	*** +	*** +	*** +	ns
Total farm size (acres) !	** –	** –	ns	** +	*** +	ns	ns	* –
Total number of cattle kept &	*** –	* –	ns	*** +	ns	ns	*** –	* –
Number of local cattle kept &	*** –	*** –	ns	ns	*** –	*** –	*** –	*** –
Number of exotic cattle kept &	* +	*** +	ns	** +	*** +	*** +	ns	** +
Currently having fodder? (Yes=1, No= 0) $	*** +	*** +	ns	ns	ns	* +	*** +	*** +
Fodder conservation in the farm? (Yes=1, No=0) $	ns	ns	ns	*** +	*** +	** +	** +	*** +
Zero-grazing only? (Yes=1, No=0) $	** +	*** +	ns	ns	X	X	*** +	*** +
Distance (km) to milk selling points !	ns	ns	ns	ns	ns	ns	ns	ns
Farmer's income levels (levels1 – 6) $	ns	ns	ns	*** +	*** +	*** +	** +	ns

$ – compared using chi-square test on 2 x 2 contingency table (2 x 6 for income), all other factors compared using 2-sample (unpaired) t-test
! / & – data natural log / cube root transformed to equalise variances and approx. normal distribution for test
X – no Kenyan dairy farmers used zero-grazing only
ns – non-significant ($p > 0.10$), * - significant at 10% level ($p \leq 0.10$),
** - significant at 5% level ($p \leq 0.05$), *** - significant at 1% level ($p \leq 0.01$)
Significant *negative* correlations in the table are presented in a highlighted box

N.B. Relationships between factors and AI use should be interpreted with caution as the proportion of dairy farmers reporting use of AI in the previous 5 years was very low (Uganda Figure 3, Rwanda – Figure 5, Kenya Yr 1 and Yr 2 Figure 7.

SIGNIFICANCE OF DIRECTION FOR T-TESTS:

+ = positive relationship, e.g. farmers who prefer/use AI have, on average, larger farms, more years of schooling, more cattle

– = negative relationship, e.g. farmers who prefer/use AI have, on average, smaller farms, fewer years of schooling, fewer cattle

INTERPRETATION OF SIGNIFICANT CHI-SQUARE TESTS:

+ = more observations than expected where factor use matches preference and AI use, e.g. more fodder keeping farmers DO prefer/use AI than expected if no relationship, more non-fodder keeping farmers DO NOT prefer/use AI than expected if no relationship.

– = more observations than expected where the factor use does not match preference and AI use, e.g. more fodder keeping farmers DO NOT prefer/use AI than expected, more non-fodder keeping farmers DO prefer/use AI than expected.

Growing fodder and practising fodder conservation are animal husbandry practices associated with livestock intensification or high-input livestock systems. As expected, these practises were generally positively correlated with the use of, and in some countries, preference for, the AI technology. Farmers practicing only zero-grazing, a more intensive form of dairy production, tended to have more exotic cattle, and showed a positive correlation with preference for, and use of AI in Uganda and Kenya in year 2.

Income levels for farmers who used AI in Rwanda and in Kenya year 1 were significantly higher than those who did not use AI, mirroring the association between total farm size and use of AI.

It should be noted that the use of, and preference for, AI services were not correlated with access to milk selling point (in terms of distance) in any of the three countries.

4.7 Possible solutions to enhance the use of AI

During the PRAs, farmers suggested measures that could be taken to enhance the use of AI in their areas. These measures or solutions are described in more detail in Table 9. They include: infrastructural development, farmer capacity building on utilization of AI, technological support to enhance quality of AI, and technician capacity development to serve farmers better.

Farmers in every hub had at least one suggestion as to what kind of external help they would like to receive in order to improve delivery and utilization of AI in their areas. From Table 9, it is clear that the main solution suggested regarding improved provision of AI by PRA farmer groups is infrastructural development. This is related to the fact that the main challenge for the utilization of AI is unavailability of the service (see Table 6 and Figure 8). This problem could be tackled by availing or setting up AI service centres nearer to farmers, a measure that is also likely to lower the costs of delivery and therefore the price of AI.

Delivery of the solutions presented in Table 9 would require a multi-sectoral and multi-stakeholder approach as proposed through the project as no single partner or actor can address them all. For instance, EADD partners may have the resources to improve farmer and trainer capacity to use AI. However, infrastructural development and technological interventions require larger capital investments with active participation of the government, the private sector and other development partners.

Table 9. *Suggested solutions to enhance delivery and use of AI by PRA participants*

Country	Hub	Infrastructural Development	Farmers Capacity Development	Technicians' Capacity Development	Technological Support
Uganda	**Bbaale**	Setting up of more "agro-vet" shops			
	Kakoge	Setting up more milk collecting centres in order to bring AI and other services nearer to farmers	Training farmers to increase awareness about good dairy breeds and AI services		
	Luwero	Inputs, including AI services, to be brought closer			Provision of semen of high quality and/or heifers of good quality
	Masaka	Bring semen storage facilities/equipments nearer to farmers	Train farmers on heat detection and good reporting time		
	Buikwe	Need for setting up of an information center for breeding services Setting up of "agro-vet" shops		Train community based health workers	
Rwanda	**Bwisanga/ Gasi**	Setting up of "agro-vet" shops		Training more AI technicians and community health workers	Need for exotic dairy breeds
	Kabarore	Need for AI technicians to be brought near to the community			Need for improved bulls
	Mbare	Inputs, including AI services, to be brought closer			
Kenya	**Kabiyet**				Provision of semen of high quality and/or heifers of good quality
	Metkei	Need for AI technicians to be brought near to the community			
	Siongiroi			Re-training of inseminators	Provision of semen of high quality and/or heifers of good quality

5 Conclusions

The results of this report indicate:

- Use of AI in most of the project hubs is generally low, with the majority of livestock farmers preferring and using natural service.
- The main constraints to adoption of AI include limited access to the service, high cost of AI, low farmer and technician capacity to effectively use the technology, inappropriateness of the technology in meeting farmer needs, lack of cash to pay for AI and lack of support services such as veterinary and extension services.
- The cost of AI in the project areas varies depending on the level of support given by the respective governments, among other factors. In Rwanda, for example, the government subsidizes over two-thirds of all costs related to AI services, thus dairy farmers here enjoy the lowest AI prices in the region.

Key solutions suggested by farmers to increase the use of AI were:

- Infrastructural development and improved supply of external inputs such as setting up of AI and "agro-vet" shops, provision of semen storage facilities and equipment, and setting up of technician bases.
- Capacity development of farmers and technicians: this includes re-training of AI technicians, training of community-health workers and training farmers to increase their awareness on the benefits of AI and the use of good dairy breeds and breeding practices.

It is most likely that private inseminators will continue finding it difficult to penetrate hubs in Rwanda where government support is still relatively high. Similarly, the participation of NGO's as AI providers may be a hindrance to the emergence of a strong AI private sector in some project sites in Uganda.

It is expected that adequate provision of services depends on how EADD partners will work together with other stakeholders including donors and government ministries to address the issues raised.

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