Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Clinical Sciences

The use of artificial insemination in dairy farms in urban/peri-urban Kampala, Uganda – a study of knowledge, attitude and practices

Camilla Eklundh

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The use of artificial insemination in dairy farms in urban/peri-urban Kampala, Uganda – a study of knowledge, attitude and practices

Användningen av artificiell insemination på mjölkgårdar i urbana/periurbana områden av Kampala, Uganda - en studie av kunskaper, attityder och tillämpning

Camilla Eklundh

Main supervisor: Lennart Söderquist, Professor
Co-advisor: Renée Båge, Associate Professor
Swedish University of Agricultural Sciences, Faculty of Veterinary Medicine and Animal Science,
Department of Clinical Sciences, Division of Reproduction
Swedish University of Agricultural Siences, Uppsala, Sweden
Co-advisor: Dr. Benon Kanyima, Lecturer
Department of Pharmacology, Clinical and Comparative Veterinary Medicine
School of Veterinary Medicine and Animal Resources
College of Veterinary Medicine, Animal Resources and Biosecurity
Makerere University, Kampala, Uganda
Examiner: Hans Gustafsson, Professor, Swedish Dairy Association/Department of Clinical Sciences

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ABSTRACT

Uganda is one country with fastest growing populations in the world and with more than 25 % of the population living in poverty. There is a rapid rural urban migration with increasing demands for food for low income earners especially in these areas. One way to mitigate food insecurity is to increase milk and meat production efficiency, and thus reproductive performance of cows is crucial for good production. A well-documented strategy for improving dairy cow productivity through faster genetic improvement is to breed dairy cows using proven semen via artificial insemination (AI). AI has been used in Uganda for over 60 years but only less than 10 %, a small population of the country's herd has been bred that way.

The aims were to study knowledge, attitude and practices factors influencing cow fertility results on dairy farms around Kampala using AI and to propose ways of promoting increased use of AI in Uganda. The study was conducted in urban and peri-urban areas of Kampala, Uganda. Data was collected through interviews of farmers breeding cows using AI (n=10) or natural mating (n=10); AI technicians (n=10) and semen vendor units (n=3). The results indicated many reasons limiting the use of AI. The outstanding reason for not using AI was said to be the poor pregnancy result from AI. Poor herd management and heat detection on farms as well as incorrect handling of semen by AI technicians indicated how knowledge gaps and improper practices jeopardize the outcome of AI and thereby also the extent of the use of AI. Furthermore, poor administration of AI activity at national level such as lack of central records database and reporting format as well as lack of breeding regulation authority to register and manage technicians were evident shortfalls.

In order to improve AI-services in Uganda and mitigate reproductive failures from AI, the study proposes further farmer education and sensitization, refresher courses for AI technicians, identification and promotion of cattle breeds better adapted for conditions prevailing in Uganda in addition to operationalizing herd recording would be necessary to guarantee quality of insemination service delivery by authorized and registered AI technicians and semen vendor units.

SAMMANFATTNING

Uganda är ett land med en av världens snabbast växande befolkningar och mer än 25 % av befolkningen lever i fattigdom. Fastän den största delen av befolkningen bor på landsbygden, sker en snabb inflyttning till städerna, vilket leder till att de grundläggande behoven som mat för låginkomsttagare inte räcker till, särskilt för de som bor i de urbana och peri-urbana områdena. Ett sätt att trygga livsmedelsförsörjningen är att öka effektiviteten i mjölk- och köttproduktionen där god reproduktionsförmåga hos kor är avgörande för god produktion. Ett väldokumenterat sätt för att förbättra produktiviteten hos mjölkkor genom snabbare genetisk förbättring är att föda upp mjölkkor med hjälp av avkommebedömd sperma via artificiell insemination (AI). AI har använts i Uganda i över 60 år men endast en liten del av besättningarna i landet (> 10 %) använder sig av denna teknik.

Syftet var att studera faktorer baserade på kunskap, attityd och tillämpning som påverkar fertiliteten hos kor på mjölkgårdar som använder AI runt Kampala och att ge förslag som främjar en ökad användning av AI i Uganda. Studien genomfördes i urbana och periurbana områden i Kampala, Uganda. Data samlades in genom intervjuer med lantbrukare som använde sig av AI (n=10) eller naturlig betäckning (n=10), AI-tekniker (n=10) och spermadistributörer (n=3). Resultaten visade på många orsaker som begränsar användningen av AI i Uganda. Det vanligaste skälet till att inte använda AI sades vara dåliga dräktighetsresultat med AI. Dålig skötsel och brunstpassning på besättningsnivå liksom felaktig hantering av sperma av AI-tekniker indikerade hur kunskapsbrister och felaktig tillämpning äventyrar resultatet med AI och därigenom även i vilken omfattning som AI används. Vidare var dålig organisation av AI-verksamheten på nationell nivå, som t.ex. avsaknad av en central databas och ett rapporteringssystem, liksom brist på reglering av behörighet och organisation av AI-tekniker uppenbara brister.

För att förbättra AI-servicen i Uganda och få bättre dräktighetsresultat med AI föreslår studien fortsatt utbildning av djurägare, fortbildningskurser för AI-tekniker, identifiering och främjande av mjölkkoraser som är bättre anpassade till rådande förhållanden i Uganda. Det är även nödvändigt med en fungerande rapportering på besättningsnivå för att garantera kvaliteten på det inseminationsarbete som utförs av godkända och registrerade AI-tekniker och spermadistributörer.

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LIST OF ABBREVIATIONS

ABS – American Breeders Service

AI – Artificial Insemination

DDA – Dairy Development Authority

EADDP – East African Dairy Development Project

EPRC – Economic Policy Research Centre

FAO – Food and Agricultural Organization

GPS – Global Positioning System

ICAR - International Committee for Animal Recording

IFPRI – The International Food Policy Research Institute

LN_2 – Liquid Nitrogen

MAAIF – Ministry of Agriculture Animal Industry and Fisheries

MFPED – Ministry of Finance, Planning and Economic Development

NAGRC-DB – National Animal Genetic Resources Centre and Data Bank

NGO – Non-Governmental Organization

NM – Natural mating

PG – Prostaglandin

SLU – Sveriges lantbruksuniversitet (Swedish University of Agricultural Sciences)

SMI – Smittskyddsinstitutet (Swedish Institute for Communicable Disease Control)

SVA – Statens veterinärmedicinska anstalt (National Veterinary Institute)

SVU – Semen vendor unit

UBOS – Uganda Bureau of Statistics

UGX – Uganda Shilling

USD – US dollar

UTM – Universal Transverse Mercator

WWS – World Wide Sires

INTRODUCTION

Uganda has one of the fastest growing populations in the world and a large part of the population live in poverty. An efficient way to reduce poverty is to increase the agricultural production since the majority of the poor are living in rural areas. An effective way to increase milk production is to breed dairy cattle using artificial insemination (AI). The use of AI in Uganda is still not very widespread and well adopted by the farmers because of poor pregnancy results and low quality of the service provided. The objectives were to study 1) knowledge, attitude and practices factors influencing cow fertility results on dairy farms around Kampala using AI and 2) to propose ways of promoting increased use of AI in Uganda. The use of AI to a larger extent and in an improved way could contribute to a better food security and alleviation of rural poverty by increasing the productivity of the cattle.

BACKGROUND

Uganda

The land area of Uganda is 241 551 square km and about 15 % is open water and swamps (Uganda Bureau of Statistics (UBOS) 2012a). A large part of it is occupied by Lake Victoria in the southern part of the country (Figure 1). Uganda lies on the equator, boarded by Kenya in the east, Sudan in the north, Democratic Republic of the Congo in the west, Rwanda in the southwest and Tanzania in the south. Despite the equatorial site of the country the climate is not very hot or dry because of the high altitude, on average 1,100 meters above sea level. The temperature varies between 16-31°C, with the highest temperatures in the beginning of the year (UBOS 2012a). There are two rainy seasons, the short rains in April-May and the long rains in September-November. The altitude and the predominant warm and wet climate make excellent conditions for farming. A great part of the 34 million people living in Uganda today are involved in the agricultural sector. The population is one of the fastest growing in the world, with an annual growth rate at 3.5 % (UBOS 2012b). Kampala is the capital city with 1.72 million citizens.

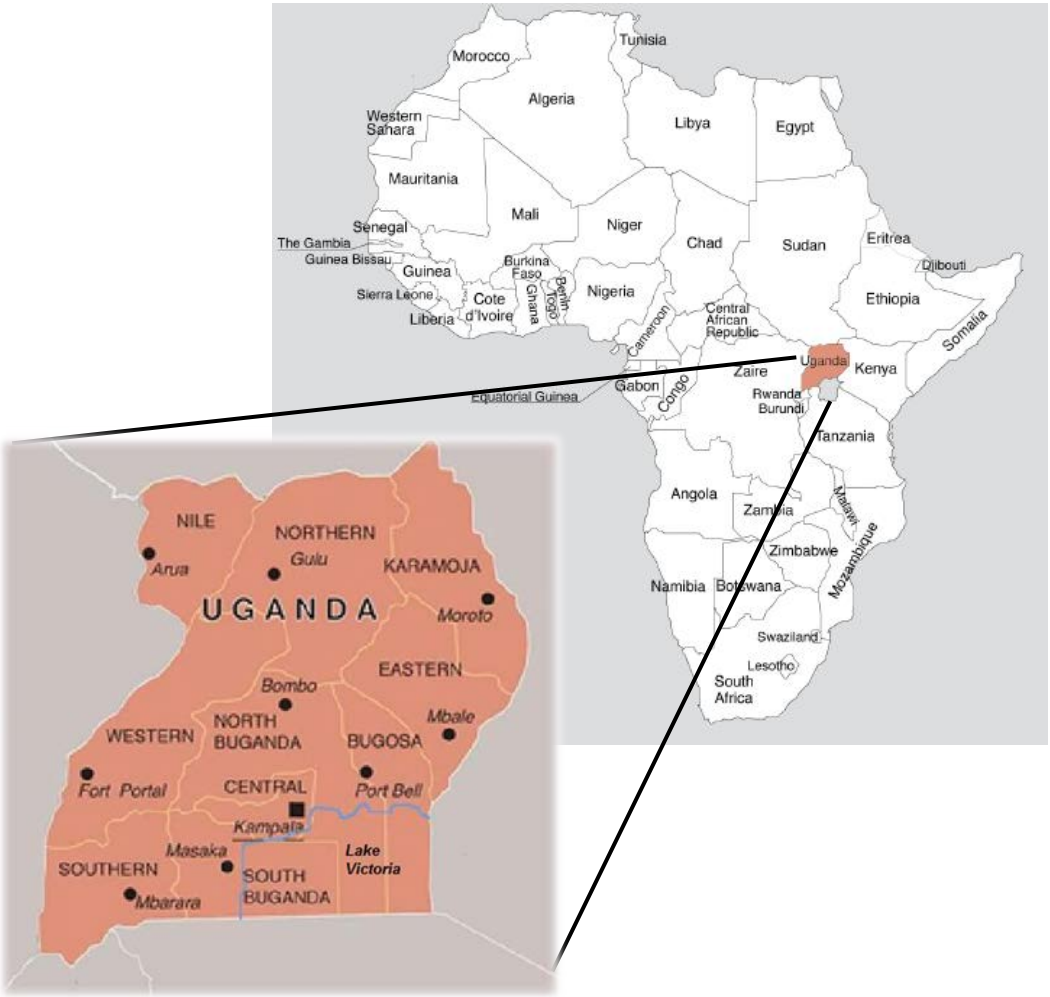

Figure 1. Map of Africa and Uganda (modified from http://www.freemaps.no/).

Agriculture situation in Uganda

Uganda has had a strong economic growth during the last two decades but still almost 25 % of the people in the country are living in poverty [Ministry of Agriculture Animal Industry and Fisheries (MAAIF) & Ministry of Finance, Planning and Economic Development (MFPED) 2000; UBOS 2010]. In recent years the agricultural sector has not progressed as well as the rest of the economy. Thus, the incidence of poverty is considerably higher in rural areas than in the cities (IFPRI 2008). Rural areas hold 96 % of Uganda's poor (Garcia *et al.* 2008). Agriculture is the biggest source of income for the people in Uganda. Of Uganda's 34 million people 80 % get their income through agriculture (MAAIF & MFPED 2000; Population secretariat 2012). Improving the production and agriculture efficiency is one of the most important ways to reduce poverty (MAAIF & MFPED 2000).

In 2006 there were approximately 6.5 million cattle in Uganda and the number had almost doubled by the year 2010, to 12.1 million cattle (UBOS 2011). The biggest part (90 %) of the farmers is smallholders, having 1-40 animals, and in rural areas about 60 % of the households have cattle (Garcia *et al.* 2008). A majority of these farmers have their only regular income

through milk selling (Masembe *et al.* 2003). Most of the cattle (93.6 %) in Uganda are indigenous breed (Ankole longhorn (Figure 2), Zebu, Nganda) and exotic dairy breeds or crossbred (Figure 3) constitutes only about 6 % of the total livestock. This number is somehow higher in the region around Kampala with about 24 % exotic or crossbreeds. Kampala district have approximately 32,000 cattle (MAAIF 2009). It is only a small part of the exotic/crossbreeds that are pure exotic breeds. The vast majority are crosses (exotic/indigenous) with varying percentage of exotic blood (The World Bank 2011).

Figure 2. Ankole longhorn cattle near Lake Mburo National Park, Uganda. Photo: Camilla Eklundh, 2012

Figure 3. Exotic cross breeds outside Kampala, Uganda. Photo: Camilla Eklundh, 2012

The estimated number of milked cows in Uganda is 1.52 million which gives 1.85 million liters of milk/day (MAAIF 2009). The average milk production per cow/day differs between the different cattle breeds. An indigenous cow produces on average 2-3 liter/day, a crossbreed 5-6 liter/day and a pure exotic (Holstein-Fresian) about 10-12 liter/day (The World Bank 2011).

The milk production systems in Uganda can be divided into two categories: 1) subsistence farming and 2) commercial farming. The subsistence farming is characterized of milk production mostly for family use and milk is sold if it exceeds what is needed for family consumption. This category of farmers traditionally keeps indigenous cattle that are looked at as a live capital as well as draught animals. The animals are typically free-range grazing or communal grazing.

In the second category, commercial farming, farmers keep animals for maximizing profit through dairy production. This type of farming holds pure bred exotic dairy cows (Holstein-Friesian-, Ayrshire, Guernsey, and Jersey) or crossbreds. The farming systems are zero-grazing or semi-intense with animals in perimeter fenced areas. This type of dairying is often located in urban or peri-urban areas (Masembe Kasirye 2003). Common fodders in this type of farms are: local pasture, elephant grass and crop by-products such as; banana peels, sweet potato vines and potato peels. Some farmers supplement their cows with concentrate feeds e.g. Dairy meal, maize bran, wheat bran.

Between these two managing systems there is a number of varying farming strategies. It is also common that cattle are herded, tethered or grazed on roadsides, valley bottoms, and hillsides (Masembe Kasirye 2003).

Artificial insemination

Artificial insemination (AI) is the technique of transferring semen collected from a male animal and manually (artificially) placing the spermatozoa in the reproductive tract of a female animal (insemination) in order to get the female impregnated. Artificial insemination is widely used for livestock breeding around the world, and a necessary tool in sustainable farm animal breeding (Gamborg 2005). Sub-optimal fertility leads to aggravating productivity losses which can be directly translated into economic loss of great magnitude, and it is also the major reason for involuntary culling of dairy cows.

AI in cattle developed in the 1940’s and has since then come to be used and developed by the dairy industry in great parts of the world. Every year about 100 million cattle are inseminated, which are about one fifth of the female reproductive cattle population (Thibier 2005).

AI being simple, economic and successful is the most important assisted reproductive technology in developing countries (Rodriguez-Martinez 2012).

Advantages with AI

There are many advantages of using AI instead of using a bull for breeding; one example is faster genetical improvement. There are reports of up to four times faster genetic progress

with AI compared to natural mating (NM) (van Vleck 1981). Other advantages with AI are: lessens the risk of spreading disease between animals, makes it possible to overcome the geographical and temporal distances between males and females, lessens the risk for injuries on the male and female, safer working environment for staff, more effective use of good males when one ejaculate can be used to many females and allows progeny testing of AI-bulls (Swensson 1987). It is economically advantageous not to have to pay for feed and management for a bull. Also increased production and decreased spread of diseases result in healthy animals that produce more which is economically good for the farmers.

Disadvantages with AI

AI has many advantages but also some disadvantages. A well functional AI-breeding system requires a thorough and well-functioning heat detection of females. To accomplish this, education, training and breeding management is needed. Artificial insemination can, if not managed in a correct way, cause wide spreading of diseases and genetic defects (Althouse 2007). Before insemination, the female animal has to be separated from the herd and restrained which requires some kind of crush. The insemination process also requires well trained and technically skilled personnel, using relevant equipment. Essential for a well operated AI-breeding is a thorough recording system. This is to avoid inbreeding, to calculate birth dates, know when to expect repeat breeders (Parkinson 2009). Recommended minimum data recorded are, according to Galloway and Perera (2003): Farmer, Farm and address, Identification of female, Breed of female and breed of its sire and dam, Last calving date, Date of AI, Interval from heat to AI, Time of AI (AM/PM), Site of semen deposition, Whether milking only; if not, the type of suckling, Semen used (bull, breed and batch/freezing operation number), Milk sampling dates, Progesterone values in milk samples, Date of pregnancy diagnosis and result, Remarks.

Factors affecting reproduction and pregnancy results at AI

Some general factors that can influence reproduction negatively in dairy cows are: heat stress (Zwart & de Jong 1996) location of the farm (urban or rural) (Msangi 2005; Woldu, Giorgis & Haile 2011) heard size, increased incidence of clinical mastitis and other diseases (Gustafsson & Emanuelson 2002), season at calving, high production (Coleman, Thayne & Oailey 1985), no dietary supplementation (Woldu, Giorgis & Haile 2011), loss of body condition, lameness, subclinical mastitis (Peake, Biggs, Argo, Smith, Christley, Routly & Dobson 2011) and intensive suckling (Nordin, Zaini & Zahari 2007; Zwart & de Jong 1996).

Farmers must be skilled in heat detection and keep proper records of fertility and reproduction in the herd. Farmers should look for heat in their herd for at least three times per day, in times other than during milking and feeding (Galloway & Perera 2003). Standing to be mounted is the primary sign of estrus, other signs of heat can be: swelling of vulva, mucus discharge, mounts other animals and frequent vocalization (Althouse 2007).

For a well functioning AI-breeding program some basic requirements have to be fulfilled. Genetic success is based on using the best bulls for the best cows. To achieve this goal a

reliable AI-recording system and progeny testing are essential. To gain genetic improvement it is necessary with record phenotypic traits regarding health, fertility and production in excess of recording insemination and their results (Philipsson & Jorjani, 2009). Without phenotypic recording it is impossible to select the best animals for breeding or making the right combinations of dam and sire.

Some diseases can be transmitted via semen and a hygienic and safe semen handling including control of the semen for contagious diseases is important. The fresh semen is also evaluated in terms of motility and quality. The spermatozoa in the collected semen are sensitive and must be handled with care. After collection the semen is cooled, frozen, and stored in liquid nitrogen (LN_2) in -196°C until it is time for thawing and insemination. It is important to avoid sudden temperature changes and cooling and thawing of the semen shall be made according to certain recommended approved regimes. Post thaw motility should be at least 40 %. It is important to regularly check levels of LN_2 in storage containers (Galloway & Perera 2003).

The AI-technicians must be well trained and have fresh knowledge in AI-technique, hygiene routines, reproduction, heat detection, pregnancy checking, dairy cow nutrition and herd management. Correct AI-work includes some minimum of equipment: a small portable LN_2 container, insemination gun, water thermos with hot water for thawing, thermometer, scissors, tweezers, disposable gloves, disposable plastic sheets for the insemination gun, paper/paper towels, lubricant, recording files or record books, protective clothing, easily cleaned foot were and soap (Galloway & Perera 2003). AI semen doses are sensitive to temperature changes and must be kept in adequate levels of LN_2 during storing to prevent damages on the spermatozoa (DeJarnette 1999; Galloway & Perera 2003). It is therefore essential that the AI-technicians always have easy access to LN_2 so they can store the straws in LN_2 in a correct way. An organization responsible for the AI-work performed and supervision and control of the AI-technicians in their work facilitates the goal to provide a good AI-service. Hence, there is a guarantee of quality of the service of the AI-technicians and the farmers know what to expect of the AI-service. Many factors can affect the conception results when using AI for breeding. As mentioned earlier right insemination time is of great significance. Other factors that affect the outcome are sperm quality and number of sperms in the insemination dose and handling of semen (Nadir, Saacke, Bame, Mullins & Degelos 1993). The preferable place to deposit the semen is in the body of uterus (Nordin, Zaini & Zahari 2007). Some propounds deeper intra corneal insemination as a better place for semen deposition but according to Hunter (2003) the insemination technique potentially could cause damage to the endometrium and in the worst cases cause perforation of the uterine wall. Furthermore, palpation and manipulation of the ovaries, to determine where ovulation is expected to occur in the deep insemination, increase the risk of premature ovulation and a poor fertility result.

AI in Uganda

Artificial insemination is an important technique that offers several advantages over natural mating in developing countries for breeding dairy cows. A major benefit of the technique is

that it offers excellent possibilities to improve the livestock genetically especially for the small-scale farmers so that their production and productivity are enhanced (Rodriguez-Martinez 2012)

In urban and peri-urban farming environment in Uganda, dairy farmers are faced with hardship of feeding their cattle and cannot afford the luxury of keeping a bull simply to breed one or two cows they keep for milk production. For these farmers it would be advantageous to use a well functioning AI-service to avoid the costs of feeding and management for a bull. Import of exotic milking cattle breeds and artificial insemination service started in the 1960s in Uganda (Nakimbugwe, Sölkner & Willam 2004). At first the AI-service in Uganda was a public sector service, now AI-technicians have a variety of employments other than government e.g. co-operative, AI-organizations, NGOs and self-employed. There are two institutions that give courses for AI-technicians in Uganda namely the Veterinary Faculty at Makarere University and the National Animal Genetic Resources Centre and Data Bank (NAGRC-DB) in Entebbe.

There are a few different semen vendor units (SVUs) in Uganda that provides semen doses to the AI-technicians; the governmental agencies, but also NGOs and private actors. There is only one SVU that produces semen doses locally in Uganda why imported semen (from e.g. USA and Europe) constitutes a large part of the market.

The use of AI in Uganda has increased from approximately 5 % in 2004 to 7 % in 2008 but is still rather low relatively to many other countries. There are also big variations within the country with the highest adoption in the central parts and only 2 % use in the northern parts of the country (Mbowa, Shinyekwa & Lwanga 2011). In one study by Kaaya in 2005 the adoption rate of AI was 36 % in three districts in central Uganda. Reasons for not adopting AI-technique was due to high costs and off-springs to inseminated cows considering being fragile and too big for cows to deliver (Mbowa, Shinyekwa & Lwanga 2011).

The mean milk production per cow in Uganda is only 8.5 liter/week (MAAIF 2011). This is attributed to several causes such as low genetic potential, high level of diseases with poor animal health, periods of drought that makes shortage of fodder during dry periods and inadequate access to veterinary and AI-services. One of the main goals in the National Dairy Strategy (2011-2015) is to increase milk production and thereby contribute to eradicate poverty. One important way to achieve increased productivity is trough increased use of improved cattle and modern breeding techniques such as AI (MAAIF 2011).

AIMS OF THE STUDY

The objectives were to study 1) knowledge, attitude and practices factors influencing cow fertility results on dairy farms around Kampala using AI and 2) to propose ways of promoting increased use of AI in Uganda.

MATERIALS AND METHODS

To collect data concerning the use of AI in dairy herds in and around Kampala in Uganda, four different questionnaires were designed for four different target groups: 1) dairy farmers using AI, 2) dairy farmers using natural mating, 3) AI-technicians and 4) semen vendor units (see enclosure 1-4).

Interviews were conducted in accordance with the questionnaires with farmers and AI-technicians chosen by the local supervisor at Makerere University in Kampala and with representatives of the different semen vendor units in the area.

A few of the interviews with dairy farmers were made using an interpreter. The farms visited were zero-grazing (Figure 4), open grazing (Figure 5) or a mixture of these two farm types. The cattle on the farms were exotic breeds or exotic crosses.

Figure 4. Zero grazing production system with exotic cross breeds. Photo: Camilla Eklundh, 2012

Figure 5. Open grazing production system with exotic cross breeds. Photo: Camilla Eklundh, 2012

Altogether ten farmers from each category 1 and 2, ten AI-technicians, all around Kampala, and three semen vendor units, in Kampala and Entebbe, were interviewed in our study (see Figure 6).

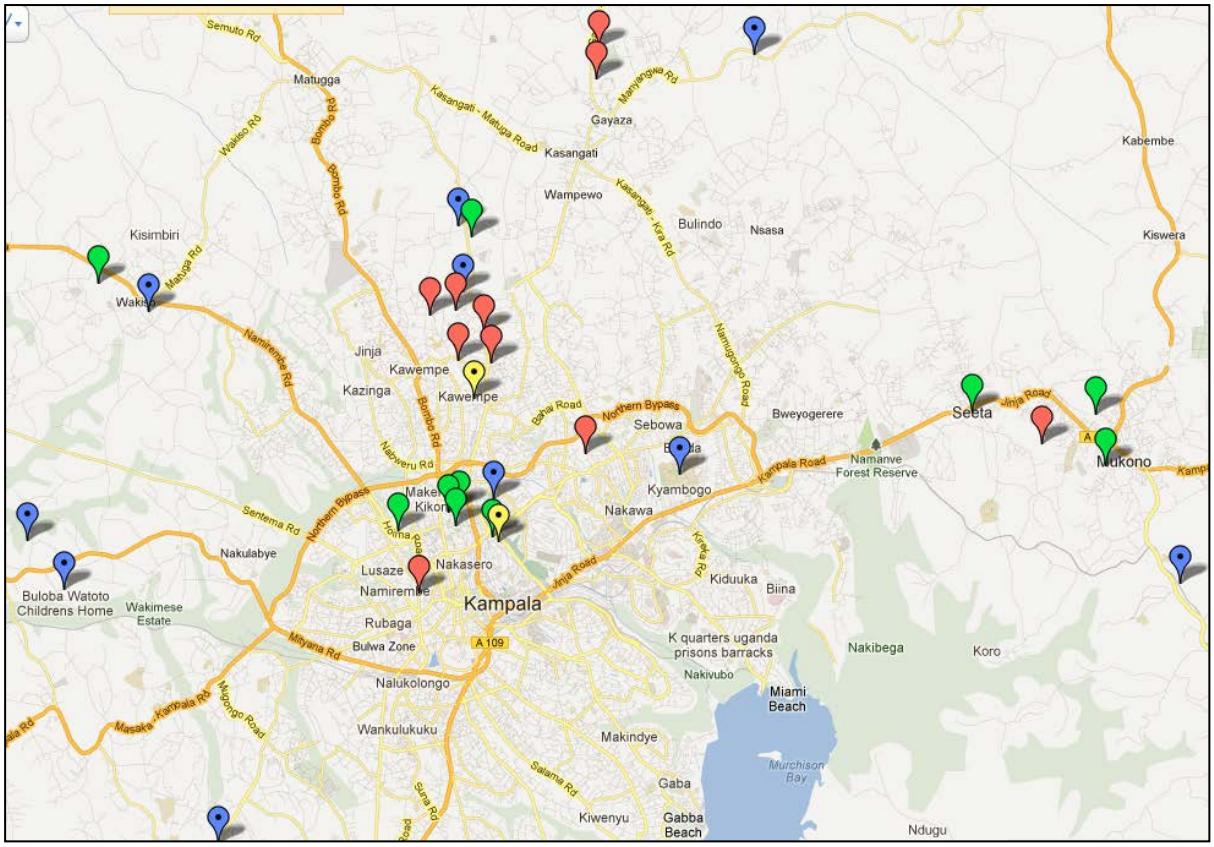

Figure 6. Map over Kampala, Uganda. Locations of farms, AI-technicians and semen vendor units were interviews were conducted. Red: Farmers using artificial insemination (AI). Blue: Farmers using natural mating (NM). Green: AI-technicians. Yellow: Semen vendor units (SVU), one SVU was in Entebbe 30 km from Kampala. (Modified from © https://maps.google.se)

RESULTS

The results from the different questionnaires are summarized and presented below. Numbers to the left indicates the number of the question in the different questionnaires (enclosure 1-4).

1. Farmers using AI

1.1 Six of the ten farmers using AI had a zero grazing farming system, two had open grazing and two used a combination of these two farming systems.

1.2 All cows were kept outdoors around the clock. In one farm the cows were tied up, but the remaining nine farms had loose housing all the time. Three of the farms with loose housing had their cows on pasture in big paddocks, two farms kept their animals in small paddocks with some grass and two farms kept their animals in small paddocks without grass.

1.3 The number of animals kept on the farms varied between 2 and 99 with a mean value of 38.5 and a median of 7.5 animals. The number of milking cows varied between 0 and 41 with a mean value of 15.5 and a median of 2.5. Two of the ten farmers using AI also kept a bull for mating.

Table 1. Number of animals in the different categories kept on the ten different farms using AI

Farm	Calves	Yearling heifers	Milking cows	Dry cows	Bull for mating	Other
1	2		12	2		1 young bull
2	4		2			
3	8	2	10	2		
4	33	14	41	11		
5	3		3			
6	5	1	1	2		
7		2				
8	13	8	13	6	1	
9	1	1	1		1	
10	2		2	2		

1.4 The major breed in the farms using AI were Holstein-Fresian (10/10), but Guernsey (3/10), Jersey (4/10) and some local breed (1/10) were also seen. Most (6/10) of the farmers said that the cattle on their farm were cross-breeds.

1.5 In three of the farms the cattle were grazing, but the cows were also fed silage (1/10), banana peel (4/10), and elephant grass (5/10). Furthermore, the cows were fed concentrate (5/10) (i.e. Dairy meal) and maize bran (1/10). One farmer fed his cows

with wheat bran and two gave potato peel. Four out of ten said that they gave minerals to their animals.

1.6 Six of the interviewees said that they had been farming dairy cows for < 5 years (1), for 5-9 years (1), for 10-14 years (2) and for 20-30 years (2). Four of the ten farmers were not asked the question.

1.7 Eight of the ten farmers used AI as their only breeding method, while the remaining two used both AI and natural mating. Four out of nine farmers had used AI for > 10 years, 3/9 had used it for 5-9 years and 2/9 had used AI for < 5 years. One did not answer the question.

1.8 To detect animals in heat the majority (8/10) of the farmers were looking for animals mounting other animals. Four out of ten also scored nervousness and restlessness as heat signs. Bellowing animals were a sign of heat according to the majority of the farmers (7/10) as well as loss of appetite (2/10). Physical heat signs such as mucus discharge were commonly used (7/10), while only two were looking for swelling of the vulva. None of the farmers answered that they scored standing heat or lordosis at heat check.

1.9 In most (6/10) farms it was the stockman who checked heat. In three farms it could be anyone at the farm and in one farm it was the farm owner himself checking heat.

1.10 In the ten farms studied heat was checked once/day (3/10), twice/day (1/10) or three times/day (3/10). Three out of ten farms answered that they didn't check heat at a particular time of the day. None of the farms checked heat more than 3 times a day. Most of the farmers checked heat in the morning (6/10), and some checked in the afternoon (2/10) and/or in the evening (4/10) (see Table 2).

Table 2. Number of times and time of the day devoted for checking heat daily in the ten farms using AI

Farm	Number of times/ day used for heat check				No particular time	Morning	Midday	Afternoon	Evening	Other	Amount of time devoted for heat check/day
	1	2	3	4							
1					X						No particular
2					X						Don´t know
3	X					X					Don´t know
4			X			X		X	X		30 min
5	X									Anytime	2 h
6	X					X					No particular
7					X						Check when the cow starts bellowing
8			X			X		X	X		3x20 min
9			X			X			X		5-10 min
10		X				X			X		20 min

1.11 Only visual observations were used among the interviewed farmers for heat detection.

1.12 Three out of ten used a heat calendar, and among those that did not use a heat calendar two farmers said that they kept that kind of information in a record book.

1.13 All the farm owners contacted the AI-technician by cell phone. One of them also traveled to the AI-technician some times to notify him.

1.14 Most farmers (6/10) contacted the AI-technician as soon as possible after they had detected heat. One waited 24 hours and for two of the farmers it differed depending on when they detected the heat. One answered that he called the same day.

1.15 Most of the farmers (6/10) answered that the AI- technician came to the farm in the afternoon or evening if they called in the morning. Two said that the AI-technician came the same day and one that he/she came on the morning after if they contacted him/her in the evening. Two farmers said that the AI-technicians sometimes were on time and sometimes they were too late.

1.16 The most common reason given for using AI instead of a bull was to avoid getting diseases (6/10), for genetic improvement (5/10) and because it was considered cheaper than using natural service (2/10). Other reasons to use AI were according to the farmers: “easier to choose breed, get more heifers when using AI, it is hard to find a bull in the city, it is easier to get semen doses from a good bull and you don’t have to

transport the cow to the bull". One farmer said that they only used AI while they waited for the bull to be old enough to be able to breed naturally.

1.17 The major disadvantages using AI, according to the interviewees, were: cows do not conceive (6/10), too expensive (4/10), AI-technician doesn't come on time (5/10) and difficulties to detect heat (2/10). One of the farmers didn't think there were any disadvantages and one thought that it was bad that the cows didn't get sexually satisfied.

1.18 In nine out of ten farms the farmer decided which bulls and breeds that should be used for AI and in one farm it was the livestock manager who made the decisions. Three of the farm owners got help from the veterinarian and one asked the AI-technician for advice.

1.19 Eight out of ten farmers had their cows pregnancy checked after insemination. Those who didn't thought that the cows had conceived if they didn't show any further heat.

1.20 The cost for a single AI-service including all expenses (semen dose, transportation and labor) varied according to the farmers between 12.000 and 60.000 UGX (4.5-22 USD). The costs of the AI-dose *per se* varied according to farmers: < 20.000 UGX (1/10), 20-30.000 UGX (1/10), 41- 50.000 UGX (4/10), and 51-60.000 UGX (4/10). Most (7/10) farmers considered the cost for the AI-service to be reasonable, but 3/10 thought it was too expensive. Two of those (7) who considered the cost to be reasonable thought so only if the cow conceived after AI.

1.21 Most (7/10) interviewees said that they kept records of AI and for the reproductive parameters, one didn't and two gave no answer. Date of AI-service, cow identification, bull information, pregnancy confirmation, expected delivery date and date of last calving were some of the information recorded according to the AI-technicians.

1.22 Prostaglandin (PG) injections to induce heat or to synchronize the cows had been used by most (9/10) farmers. After the PG-injection the farmers looked for heat after 3-6 days (5/10), after 14 days (2/10) and two couldn't answer the question.

1.23 Six of the farmers answered that cows in their farms had suffered from retained placentas, while 4/10 farms hadn't had any. Most (4/10) farmers considered a placenta to be retained after 12-18 hours, 2/10 after 24 hours and one considered it retained after 2-3 days

1.24 Most farmers (6/10) answered that they had had problems with mastitis. East coast fever (2/10) and Lumpy skin disease (2/10) were other diseases reported. Parasites were known as a problem according to one farmer, 2/10 had had problems with Trypanosomiasis and 2/10 had had eye problems in their herd.

1.25 The majority (7/10) of the farm owners didn't belong to any farm association.

2. Farmers using natural mating

2.1 Half of the farmers (5/10) using natural mating had an open grazing farming system, 2/10 had zero grazing system and 4/10 had mixed systems.

2.2 All farmers had their cattle outdoors day and night and 7/10 had their cattle in large paddocks with grass. One had the cows in a small paddock with grass and two in small paddocks without grass. Tree of the farmers had some of the animals tied up sometimes.

2.3 The number of animals kept on the farms varied between 9 and 474 with an average of 157 and a median of 43 animals. The number of milking cows varied between 0 and 67 with a mean value of 35 and a median of 16 cows (see Table 3).

Table 3. Number of animals in different categories on the ten farms using natural mating

Farm	Calves	Yearling heifers	Milking cows	Dry cows	Bull for mating	Other
1	18	6	12	1	1	30 bulls not for mating
2	40	7	20	4	1	1 young bull
3	17	5		9	1	1 steer, 4 young bulls
4	245	90	67	70	2	
5	2	2	3	1	1	
6	14	10	24		1	
7	6	26	28	8	1	1 steer
8	3	5	20	7	1	
9	3	7	9	4	1	2 bulls for sale
10	5	4	8	4	1	

2.4 All of the farmers had Holstein-Fresian cattle, some (4/10) also had some animals of the Guernsey or Jersey breed (4/10) and two farmers had a few local breeds. In all cases, they said that their cattle were crosses and not purebred breeds.

2.5 Most (7/10) of the farmers kept their cattle grazing. The cows were also supplemented with silage (3/10), banana peel (3/10), or elephant grass (3/10). Furthermore, the cows were fed concentrate (5/10) (i.e. Dairy meal) and maize bran (5/10) and one farmer fed with wheat bran. Four out of ten farmers said that they gave minerals to their animals.

2.6 Some (2/10) of the farmers had been farming dairy cows for 10-14 years, but the majority (5/10) had been farming dairy cows for 20-30 years and three of them for more than 30 years.

2.7 The absolute majority (8/10) of the farm owners solely used a bull for breeding, whereas two of them used both a bull and AI. All the farmers had their own bull, and one of the farmers also offered other farmers in the surroundings to use his/her bull for breeding. The cost for using the bull was 30 000 UGX (11 USD) and if the animal bred came in heat again within a month the farmer could have the female mated once again for free.

2.8 The most common reasons (6/10) stated by the interviewees why they didn't use AI instead of breeding was because of poor pregnancy results and an increased risk of getting repeat breeders. Some (2/10) thought AI was too expensive, two said that the service was not available or had a poor availability and two said that they had difficulties performing the heat detection. One farmer said that he/she only got bull calves when using AI and another said that AI resulted in problems with too big calves. One farmer had stopped using AI when the government banned the import of semen to Uganda and hasn't started using AI again after the ban was taken away.

2.9 The majority (8/10) of the farm owners had used AI in their herd before starting to use a bull, only two had never used AI.

2.10 The disadvantages of using a bull for breeding instead of AI according to the interviewees were: poor genetic development (3/10), dangerous working environment (1/10), problems with inbreeding (1/10) and that some bulls only gave calves of one sex (1/10). Half of the interviewed farmers could not think of any disadvantages at all using a bull.

2.11 Two of the farmers had their animals pregnancy checked regularly, one did it sometimes and one never checked for pregnancy. Only some farmers (4/10) were asked this question.

2.12 Two of the farmers had used prostaglandin injections to induce heat and they looked for heat 2-3 days after the injection. The remaining farmers (8/10) had never used it.

2.13 Six of the farmers answered that cows had suffered from retained placentas in the herd, but 4/10 did not think it was a problem. Most (5/10) farmers considered a placenta to be retained after 1 day, after 2 days (2/10), after 3-6 days (1/10), and one considered it to be retained after one week. One farmer didn't answer the question.

2.14 Diseases that they had experienced in their herds were: mastitis (7/10), East coast fever (6/10), foot problems (3/10), parasites (2/10), lumpy skin disease (2/10) and eye problems (3/10). One farmer said that he had had rabies and anaplasmosis in his herd and one had had problems with cows eating plastic bags in the field.

2.15 Few (2/10) farmers belonged to a farm association.

3. AI-technicians

3.1 Most (6/10) of the AI-technicians had been educated at NAGRC-DB in Entebbe, the rest at the veterinary faculty at Makerere University in Kampala and the length of their education as well as which year they attended the AI-course varied (see Table 4).

Table 4. Duration, place and year of the AI-course for the ten AI-technicians

	Length of course						
AI-technician	**2 weeks**	**3 weeks**	**4 weeks**	**6 weeks**	**12 weeks**	**Place**	**Year**
1		X				Makerere	1986
2	X					Makerere	2001
3		X				Makerere	2000
4				X		Makerere	1998
5					X	NAGRC	1982
6					X	NAGRC	2008
7			X			NAGRC	2006
8		X				NAGRC	2004
9	X					NAGRC	1994
10				X		NAGRC	2000

3.2 The AI-technicians had worked for 1-5 years (1), 6 -10 years (2), 11-15 years (4), 16-20 years (1) and for > 20 years (2).

3.3 Five of the ten AI-technicians worked in a private practice, three in a co-operative and three worked for the government. Two of the technicians had established contracts with certain farmers, while the other eight technicians provided service to any farmer that called them. One AI-technician said he was working both privately and at a co-operative.

3.4 The AI-technicians said that they inseminated <10 animals/month (3/10), 11-25 animals/month (5/10), 51 -100 animals/month (1) and >100/month (1). Most (8/10) technicians thought that the number of services varied between seasons. Four said that more services were performed during dry season and four that it was more inseminations during the rainy season.

3.5 For transportation to the farms most technicians (7/10) said they used a motor cycle or a car (4/10). Of the four using car two had their own car and two went by taxi. The average distance to the farm varied for the different AI-technicians ≤ 10 km (3/10), 11-50 km (3/10) and 51-100 km (4/10).

3.6 The majority (6/7) of the technicians said that it was difficult to get hold of LN_2. Most (7/10) bought the LN_2 at ABS/EADDP in Kampala, one bought from World Wide Sires (WWS) in Kampala and two bought the LN_2 in Entebbe at NAGRC-DB. The cost for the LN_2 varied between 1500 and 10.000 UGX/liter (0.5-3.7 USD/liter) and the majority (7/10) paid 5000 UGX/liter (1.85 USD/liter) for the LN_2.

3.7 The storage places and the number of doses stored varied between the AI-technicians (see Table 5).

Table 5. Storage place and number of AI-doses stored by the different AI-technicians (n=10)

AI-technician	Storage place for the AI-doses	Number of stored AI-doses
1	Store at Makerere university	
2	Tank at Makerere university	Buy and then distribute
3	LN_2	
4	Tank at home	Have 20 AI-doses or more at home
5		Do not store, only buy what is needed
6	3 L tank	Buy and use the AI-doses in two weeks
7	Small LN_2 tank	Buy every other week
8	27 L tank at ABS, don't have own tank	Buy what is needed
9	5 L tank, fill 1/week	20 AI-doses /week, buy when needed
10	3 L tank	Buy 100 AI-doses/month

3.8 Most (7/10) AI-technicians said that the farmers or at least some of the farmers were the ones who decided from which bull and of which breed the AI-dose should be. The majority (7/10) of the technicians said that they selected the bull and breed of the bull to be used and some (3/10) said they only gave the farmer advice on what bull and breed to choose for AI. One AI-technician said that it also was the semen wending unit who decided what bull and breed to be used, because as a technician it was only possible to buy what semen the semen vendor unit had in their stock.

3.9 The cost for a single AI-service including transport and semen dose varied according to the different AI-technicians (see Table 6).

Table 6. Price for one AI-service (including all expenses) according to the ten AI-technicians interviewed

AI-technician	Price for one AI-service including all expenses
1	No information
2	No information
3	No information
4	ca 40.000 UGX (15 USD)
5	40-60.000 UGX (15-22.5 USD)
6	30-35.000 UGX (11-13 USD)
7	35-40.000 UGX (13-15 USD)
8	35-50.000 UGX (13-19 USD)
9	50-180.000 UGX (19-67.5 USD)
10	40-70.0 UGX (15-26 USD)

3.10 All (10/10) of the technicians used medium straws (0.5ml). Some (4/10) also used mini straws (0.25ml), but not very frequently. One technician used an equal number of medium and mini straws.

3.11 The temperature of the water used for thawing the semen doses varied between the technicians: ambient temperature (4/10), 27°C (1/10), 32°C (1/10), 35°C (2/10), 37°C (2/10).

3.12 Less than half of the AI-technicians (4/10) said they used a thermometer to check the temperature of the thawing water, two used their fingers and four didn't check the thawing temperature at all.

3.13 Few (2/10) technicians used a separate thermos for the thawing water; four said that the farmer provided them with a water container.

3.14 The thawing time varied between 2 seconds and 5 minutes. Some (3/10) thawed the medium straw for <30 s, for 30-60 s (4/10) and for >60 s (3/10). One technician said that sometimes they didn't thaw the straws in water at all, they just let the straws stay in the ambient temperature for awhile before inseminating.

3.15 Two of the technicians used a stop watch to check the thawing time, the rest (8/10) of the technicians didn't check the time at all - they only estimated the thawing time.

3.16 Most AI-technicians (7/10) answered that they arrived at the farm in the afternoon or evening if they got the call from the farmer in the morning and 5/10 answered that if they got a call in the evening they arrived in the morning the day after. Four out of ten said that that the time they arrived differed from time to time.

3.17 The absolute majority (9/10) of the technicians said that they checked for heat before they inseminated, and 5/10 also checked for pregnancy. All of the technicians said that they wouldn't perform the insemination if the cow didn't show any signs of heat.

3.18 Half (5/10) of the AI-technicians said that they deposited all the semen in the body of the uterus, but some (2/10) also put some semen in the cervix. One technician put some semen in each of the horns of the uterus and the rest in the body of the uterus. One technician answered that he deposited the semen in the body of uterus, but sometimes put some in the "pregnant horn". One technician deposited all the semen in one horn.

3.19 Almost all (9/10) technicians said that they inserted the insemination gun after they have emptied the rectum. One said that he didn't always empty the rectum before performing the insemination.

3.20 The majority (8/10) of the technicians said that they used a protective coat when they worked and all of them said that they used disposable gloves. Someone said that they reused the disposable gloves sometimes after washing them. Four out of ten technicians used footwear that they cleaned between farms. One of them cleaned the boots because he didn't want the smell and dirt in his car. One technician cleaned the boots every other day. Four out of ten cleaned their equipment with soap and water, 2/10 with hot water, and one put the gun in boiling water. One technician said he didn't clean or disinfect the equipment at all and one did it every weekend.

3.21 The majority (9/10) of the AI-technicians said that they kept AI-records. Data that was commonly said to be recorded were: date of service, cow identification, bull information, when to check for heat next time, expected calving date. All (10/10) of the technicians said that they left a copy to the farmer or wrote notes in the farmers recording book.

3.22 Where the AI-technicians reported their records, if they reported at all, varied widely as can be seen from Table 7.

Table 7. To whom the 10 AI-technicians said that they reported their AI-records

AI-technician	Leave a copy to the farmer	To NAGRC-DB	To ABS/EADDP	To the Co-operative	To WWS	Do not report
1	X	X				
2	X					X
3	X	X				
4	X					X
5	X					X
6	X			X		
7	X		X	X		
8	X	X	X			
9	X	X				
10	X		X		X	

3.24 Different reasons for a poor pregnancy result were according to the AI-technicians: lack of LN_2, the farmers want to inseminate too young animals, poor semen from the semen vendor units, cows are in poor condition, poor heat detection, some AI-technicians use an unsatisfactory technique and hygiene, farmers do not treat sick cows, reproduction diseases, poor feeding, some AI-technicians inseminate when it is too late in estrus, poor record keeping by farmers, poisonous weeds, Trypanosomiasis and endoparasites.

3.25 Factors, according to the AI-technicians interviewed, that ought to be improved for increased use of AI were: more education for farmers about AI, improved heat detection, management, feeding and nutrition, better infrastructure, easier access of LN_2, better education for AI-technicians, marketing for farmers about AI, lower prices for the service, AI-technicians must choose doses from good bulls and breeds, and an organization of the market so farmers can sell the milk they produce.

4. Semen vendor units

4.1 Two of the three semen vendor units (SVUs) provided semen produced in Uganda. One of them produced all the bull semen doses themselves and the other one answered that approximately 5 % of the semen doses that they sold were produced in Uganda, the rest of the doses were imported semen. The companies from which the semen vendors imported the semen doses were: ABS global (USA), Transworld genetics (USA), Taurus (USA), World Wide Sires (USA), Dansires (Denmark), UK cogent (UK), Taurus (South Africa), World Wide Sires (Kenya/South Africa). Some of the imported semen also came from Canada and Australia.

4.2 The criteria used by the semen vendor units when buying semen were for example: the price of the dose, the milk yield (not less than 30 liters/day), good legs and feet, longevity, coat color (preferably black, not so much white), good udder shape/health, size (not too big cows), relationship (try to avoid inbreeding). One of the SVU imported semen from Australia because they had the same production system as in Uganda and from USA because they had high milk yields.

4.3 The Holstein-Fresian breed was the most popular breed. According to the SVUs the farmers think that animals that are black and white are the best animals but breeds like Jersey and Guernsey having a smaller body size are getting more popular.

4.4 Only frozen semen was provided by the SVUs. All units sold medium straws in readiness, but two also sold mini straws used for sexed semen and for semen doses that were produced locally in Uganda.

4.5 The semen extenders used were Bioexcell® or Triladyl® in the SVU that produced their own straws. The two SVUs that exclusively imported semen didn't know what kind of extender had been used for their doses.

4.6 The total sperm concentration in the straws in one SVU was said to be 30 millions in mini straws and 5-9 millions in medium straws. The other two SVUs didn't know the sperm concentration in the straws they provided.

4.7 The minimum sperm motility accepted after thawing of the semen they sold was 65%, 50% and 68%, respectively, for the different semen vendor units.

4.8 Two of the SVUs had their own power plant for production of LN_2. One of the units bought the LN_2 for 3200 UGX/liter (1.2 USD/liter) in Entebbe at NAGRC-DB. Two of the units filled their LN_2 tanks every second week and the third SVU filled their tanks every week.

4.9 One SVU usually didn't store the semen more than 2 months but sometimes up to two years. One said maybe one year and the third said that they produced more than they sold to have the surplus in stock but usually they did not store them for long.

4.10 All of the SVUs gave recommendations to the AI-technicians regarding the thawing time and temperature. One of the SVUs recommended the straws to be thawed at 37°C for 30 seconds. One recommended thawing at 37°C for 5 minutes and the third SVU recommended the doses to be thawed at 37-38°C but couldn't answered for how long time the semen should be thawed.

4.11 The average cost for one semen dose was according to one SVU 7000 UGX (2.6 USD), 4000 UGX (1.5 USD) according to another SVU and 12000 UGX (4.5 USD) for the third SVU. For sexed semen the price was 100 000 UGX (37.3 USD) for one SVU and about 70 000-85 000 UGX (26-32 USD) for another SUV.

4.12 Factors that influences the price on the straws according to the SVUs were: some bulls are more expensive than others e.g. if they are known for inheriting a high milk yield, imported straws are more expensive than straws produced within Uganda and high protein- and low fat producers are more expensive. One semen vendor unit said that the price of the straws was halved if he imported more than 1000 straws from the same bull.

4.13 One SVU recommended the AI-technicians to use, disposable gloves, protective clothes, wash their hands etc. Another said that they used to give out sheets for the insemination guns for free and recommended them to clean their equipment etc but didn't think the AI-technicians followed their advice. The last SVU misunderstood the question.

4.14 The SVU who produced semen locally in Uganda used an extender containing four different kinds of antibiotics namely: Gentamycin, Tylocin, Spectinomysin and Lincomycin.

4.15 How the SVUs ensured a hygienic procedure in the AI-process, via the technicians to the farm, and if they saw any problems in this chain of events are shown in Table 8.

Table 8. How the semen vendor units (SVU) ensured a hygienic AI-procedure and what problems they could see in this chain of events

SVU	How they ensured a hygienic procedure in the AI-process	Problems the SVUs could see in this chain
1		Shortage of LN_2, some AI-technicians store the straws in water instead of LN_2 or use empty/already used straws. The AI-technicians can fool the farmers and sell cheap straws to a higher price.
2	Educate the technicians in hygienic handling during the AI-course. There is an association who handle this type of questions, but it isn't very active.	There was one AI-technician who sold straws that he had stored in water instead of LN_2.
3	Provides the AI-technicians with protection sheets for the insemination gun: one for each straw.	Some technicians do not clean the vulva before insemination and some in some farms the conditions are unhygienic and some farms don't have access to water.

4.16 To market their semen and reach out to the farmers one SVU had set up AI centers in different places and to supply AI-technicians with straws. The second SVU was governmental so they didn't market their semen, but they were the only SVU who locally produced semen doses in Uganda and therefore were cheaper than the ones selling imported semen. The last SVU said that no AI-technician was tied up to him but that he lent LN_2 tanks to some AI-technicians for a small fee and then they were supposed to come and by semen doses from him.

4.17 To communicate the advantages of using AI to the farmers the SVUs arranged training groups for farmers about AI, made farm visits and participated in agricultural shows.

4.18 To inform AI-technicians and farmers about the different bulls the SVUs had catalogues with bull information for the imported semen. The SVU who produced semen locally didn't have a bull catalogue with information of the bulls they had in the unit but was at present producing one. One SVU said that they taught the AI-technicians to read the catalogues so they could help the farmers. Another SVU said that the farmers and the AI-technicians did not understand what were in the catalogues so they instead provided an information sheet of one page for each bull with some understandable information on. According to that SVU the farmers mostly looked at the pictures when they chose bulls.

4.19 All of the semen vendor units said that they arranged information meetings regarding the use of AI for farmers.

4.20 All of the SVUs collaborated with veterinarians regarding reproductive health such as corrective mating, management of repeat breeders and reproductive pathology.

4.21 The competitive and financial advantages of using AI instead of a bull were according to the SVUs: reduced risk of transmitting diseases, better genetic improvement, no costs for keeping a bull, reduced risk for inbreeding. None of the SVUs had any figures on the financial advantages of using AI in Uganda compared to using a bull.

4.22 One of the SVU admitted that the record keeping from the AI-technicians did not work at all. There are forms to be filled in but the AI-technicians did not forward them to the SVU, why there was no statistics available regarding AI according to the SVU. They said that the only information the SVU got from the AI-technicians was the oral information.

DISCUSSION

Artificial insemination has been used in Uganda for over 60 years but still to a limited extent. However, use of AI, a reproduction biotechnology, could really have a great potential in helping to develop the dairy sector in Uganda, which would have a great impact on the goal to reduce poverty (MAAIF 2011). The use of AI can be seen as a chain of events - from the collection of semen from a bull to the birth of a calf. And to be successful in the AI work no failures can be tolerated anywhere since each link of this chain of events is of equal importance.

In our study, the most common reason why farmers stated that they didn't use AI or were not fully satisfied with the AI-services provided at present was, according to the questionnaires, poor pregnancy results and the great risk for getting so-called repeat breeders, non-pregnant cows returning to estrus. Some farmers, however, said that they would have used AI if the pregnancy results had been better. But to achieve a good pregnancy result when using AI all

factors that influence the pregnancy results must be optimally controlled and correctly performed.

Herd management and nutrition can influence the pregnancy results and according to our findings only some of the farmers fed their animals with concentrate. According to Woldu, Giorgis and Haile (2011) complementary feeding with concentrate is positively correlated with good reproduction. Some AI-technicians blamed the poor pregnancy results on what they considered poor farm management. Any breeding regime is dependent of well managed animals for achieving good results. Factors as mastitis, lameness and other diseases have a negative impact on reproduction (Gustafsson & Emanuelson 2002; Peake *et al.* 2011). A better education of farmers is needed so they can improve management and feeding as well as the reproduction and production in their herd.

All farmers interviewed had exotic cattle or exotic crossbreeds in their farms. Most of the farmers used Holstein-Fresian cattle. Exotic cattle breeds, as the Holstein-Fresian, have the genetic capacity to produce a higher milk yield than the indigenous breeds and are therefore preferred by the farmers. The exotic cattle are originally bred in temperate climate zones and are not fully adapted to tropical zones as the indigenous breeds are (Nakimbugwe, Sölkner & Willam 2004). Exposure to a hot climate, poor feeding, poor management and suffering from sickness from tropical diseases and parasites results in animals that shows poor heat, low pregnancy rates and produce low milk yields - despite their genetic potential to produce more. With accurate recordings of individual animals' traits, production and management it is possible to find individuals who function well in different environments and production systems. A breeding program comprising indigenous cattle ought to make a sustainable and more robust female that is more disease and parasite resistant compared to Holstein-Fresian cattle. A healthy cow produces more than a sick cow and is therefore more profitable and leaves a smaller carbon footprint. Girolando cattle in Brazil are an example of a breed bred for tropical climate. This breed is a cross between Gir, a *Bos indicus* breed, and Holstein cattle and has high resistance against diseases, good ability to self regulate body temperature, strong legs and a suitable grazing habitat which makes it well adapted to the environment. Developing a breeding program like that in Uganda could give cattle with potential to meet with the conditions of the country and in the end a higher production.

A thorough heat detection and insemination at an optimal time are factors known to influence the pregnancy result. However, none of the interviewees devoted a separate time for heat detection and only a few of the farmers said that they used a heat calendar. Thus, it is a great risk that they fail to detect heat, and there is a risk that the insemination will be done too late in estrus. To reach a good pregnancy result using AI it is essential to inseminate at an optimal time in estrus. To achieve this goal the farmer must be well educated in heat detection and check for heat regularly in the herd (Galloway & Perera 2003). The most common signs of heat**,** according to the interviewees, were: "mounting other animals", "bellowing animals" and "mucus discharge". None of the farmers mentioned "standing to be mounted" as a sign, which is the primary sign of heat according to Althouse (2007). One study by Kanuya, Kessy, Bittegeko, Mdoe & Aboud (2000) in Tanzania showed a lower pregnancy rate for the first

service in a group of animals being artificially inseminated compared to the group subjected to natural mating, which led to a suspicion of a lack of accuracy and efficiency in the heat detection, semen handling and semen-deposition techniques. Another study by Msangi, Bryant & Thorne (2005) in Tanzania also found that the pregnancy rates were higher when using natural mating than with AI. They also suspected difficulties with estrus detection as the cause. Hence, a better education of farmers focusing on heat detection would result in animals being reported and inseminated at an optimal time.

Furthermore, only six of the farmers contacted the AI-technician as soon as they could after having detected a female in heat, which probably could result in some animals being inseminated too late. However, half of the interviewees also said that the fact that the AI-technician didn't come on time was one of the problems with using AI. The optimal time for insemination is reported to be ca 12 hours after onset of estrus (Dalton, Nasir, Bame, Noftsinger, Nebel & Saacke 2001) and a decreased pregnancy result has been reported when inseminating >32 h after estrus begins (Pursley, Silcox & Wiltbank 1998). Because of the relatively narrow time span available for insemination it is important that the farmer gets in contact with the AI-technician directly after having detecting standing heat, but also that the AI-technician must arrive on time to avoid inseminations at a suboptimal time. Hence, a better education of farmers as well as of AI-technicians is needed to be able to improve the pregnancy results using AI.

A consequence of a poor pregnancy result when using AI, and the high costs involved according to many farmers, was that the farmers used a bull and natural mating instead. In two studies performed in Tanzania (Kanuya *et al.* 2000; Msangi, Bryant & Thorne 2005) they found that the pregnancy rate was higher when using natural mating than using AI. In another study (Landivar, Galina, Duchateau & Navarro-Fierro 1984), however they saw no difference in conception rate between natural mating and AI, which indicates that AI, when performed correctly, results in as good fertility results as natural mating. And since many farmers were familiar with the advantages of using AI compared to natural mating some of them would be prepared to use AI if the pregnancy rates were higher, which is in line with the results from the Economic Policy Research Centre (EPRC) (Mbowa, Shinyekwa & Lwanga 2011).

Several of the interviewees said that the costs for AI were too high. There is no consistency in the price for a single AI-service. The costs varied largely among AI-technicians and it was difficult for the farmers to know exactly what they were paying for since no specified bill was presented. One SVU mentioned the problems he had experienced with AI-technicians selling cheap straws to the farmers for a high price and even AI-technicians inseminating with empty or defect straws. High costs and poor quality of the AI-service makes the farmer use natural mating for breeding their cattle instead of AI (Kaaya, Bashaasha & Mutetikka 2005).

To achieve an improved and high quality of the AI-services some kind of authorization of the AI-technicians based on a national framework (a quality document with fixed standard procedures) for the AI-work, and controlled by the authorities or some organization, ought to be discussed in Uganda. The AI-technicians who refuse to work in line with the quality

document could lose their authorization as an approved AI-technician. Hence, the farmers would know that they would receive AI-service by a certified technician. A high quality of the AI-service would most likely improve the conception rate as well the reputation of AI resulting in a larger number of farmers using AI in Uganda.

Many of the interviewees said that they used AI because the technique prevented transmission of diseases. But if AI is not performed in a proper way it can instead help spreading diseases and it is therefore very important that the AI-technicians work in a careful and hygienic way (Althouse 2007). However, many of the interviewed AI-technicians didn't obviously follow the standard operations and recommendations given during their basic AI-training course. For instance, they did not procure what they considered unnecessary AI-equipment (like forceps, thermometer and water thermos), neither did they use the thawing recommendations (in case such recommendations were given by the SVU) and they did not work according to strict hygienic rules when performing the AI. In general, the cleaning routines for themselves or their equipment between farms were according to the interviewees not satisfactory. And one AI-technician said that the disposable gloves were sometimes reused after having washed them and turned them inside out and sometimes they did not even use gloves at all. To neglect hygienic rules like that would most likely increase the risk of spreading different diseases, especially Brucellosis which is a zoonosis. Brucellosis can thus be transmitted to humans via direct contact with infected animals or persons working in close contact with animals, like veterinarians or AI-technicians who often get infected. Hence, it is essential to adopt the right attitude and a hygienic way of working to prevent the spread of infections between animals as well as to humans (Smittskyddsinstitutet (Swedish Institute for Communicable Disease Control, SMI) 2010; Sveriges veterinärmedicinska anstalt (National Veterinary Institute, SVA) 2011). It is obvious that a national document regarding standard operations to be used for the AI-work in Uganda as a guarantee of quality needs to be prepared to improve the procedures and quality of the AI-work services given today.

Two of the SVUs recommended thawing protocols (although different) to the AI-technicians buying semen doses from them, but the third SVU couldn't answer which thawing protocol to recommend. As a consequence we also found that all of the AI-technicians thawed the semen doses in many different ways both regarding the time and the thawing temperature and some AI-technicians didn't even thaw the straws in water. Semen doses should be thawed according to specific recommendations from the semen doses manufacturer to achieve good semen quality after thawing. Mistreatment of semen leads to poor semen quality and reduces the pregnancy results (DeJarnette, Barnes & Marshall 2000; Galloway & Perera 2003). Hence, a better education of AI-technicians with compulsory refreshment courses is needed to stress and improve the importance of a correct handling of the semen doses at AI.

Many AI-technicians said that it was hard to get access to LN_2 - especially in weekends and during holidays. This could be one of the reasons why, according to some interviewees, there have been AI-technicians who have stored semen doses in just water instead of in LN_2. Varying or very low levels of LN_2 in the storing container probably leads to fluctuations in the temperature, which could be deleterious to the spermatozoa fertilizing capacity and lead to

insemination of semen of poor quality followed by reduced pregnancy rates (DeJarnette 1999; Galloway & Perera 2003). In conformity with what Kaaya, Bashaasha and Mutetikka (2005) stated there is a need for further training of AI-technicians and control and regulation of the AI-service by the government to ensure a high quality of the AI-services.

An AI-recording system is essential and a must to be able to utilize AI in a proper way. However, many of the AI-technicians and one of the SVU said that the recording system and the feedback information regarding the use of AI did not work properly in Uganda. One SVU, the one producing semen doses locally, said that there are forms available to be filled in but the AI-technicians do not use them. The only breeding information the SVU had was the one they got sporadically and only orally from the AI-technicians. Even some of the AI-technicians said that an AI-recording system was non-existing. The AI-technicians that did report to an organization, reported to many different ones and they didn't know if and what the records were used for, indicating a lack of feedback. The insufficient AI-recording in Uganda makes it impossible to conduct a satisfactory AI-work and a good management of the herd reproduction (Zwart & de Jong 1996). Without a careful and accurate registration of important breeding parameters it is completely impossible to use semen from the best bulls to the best cows and make use of the breeding progress that comes with the use of AI in a proper way (Philipsson & Jorjani 2009). Developing a well functioning AI-recording system is a real challenge but an absolute prerequisite for the AI-work and one of the most important things to prepare - if the authorities really wish to improve and further develop and increase AI-work in Uganda.

To select semen doses for AI from the most suitable bull for a certain cow aiming at adjusting some less favorable traits of the cow for the next generation is an important part of the breeding progress. According to the farmers they are the ones that choose the bulls to be used for AI, some of them said that they did it together with the AI-technicians. However, when asked the same question to the AI-technicians they said that they are the ones that choose the bulls and what breeds to be used at insemination. As the matter of fact, in many cases we were told by one of the interviewees that the farmers selected the bull semen primarily according to color (black and white were considered better than brown), then according to the price of the semen dose and lastly they asked for the plus-traits of the bull. On the other hand, when the SVU purchased their semen doses they selected the bulls for sale according to their price, production and traits of the bull - in that order. It is essential that the farmer choose semen doses after traits of the bull that can compensate for the inferior traits of the cow that they want to improve in the next generation. Hence, an increased knowledge and therefore a better education of farmers, AI-technicians and SVUs are needed regarding strategies for breeding. Preparing a simple one page guide for farmers concerning breeding strategies and how and what to think of when selecting bulls for AI could be one small step forward.

Sources of error

The selection of the interviewed AI-technicians and particularly the farmers were made exclusively by the local supervisor and were therefore not randomized. Some of the interviews were done together with an interpreter and there might also be some elements in

the data collected that could be incorrect due to misunderstanding. Furthermore, we have reasons to believe that some of the interviewed persons, due to the situation, may have answered what they once were taught or what they know is the right procedure or answer and not how they really go about in real life. These answers might be unreliable since the interviewees often gave the impression of trying to please the interviewer and the accompanying local vet, instead of answering truly.

CONCLUSIONS

Based on our study of knowledge, attitude and practices factors influencing cow fertility results on dairy farms around Kampala using AI there are many things that need to be improved if the national goal is to improve AI-services in Uganda and mitigate reproductive failures from AI. A further education of farmers (and AI-technicians) of heat detection, management, nutrition and breeding is needed and would result in more animals being inseminated at an optimal time and a higher pregnancy result.

Authorization of AI-technicians attending refresher courses following a national document regarding standard operations for the AI-work (a guarantee of quality) in Uganda would not only improve the quality of AI-services in Uganda and mitigate reproductive failures from AI but also minimize the risk of spreading diseases to both humans and animals.

A prerequisite and absolutely essential for a successful use of AI is, however, a functioning AI-recording system used by the farmers, AI-technicians and semen vendor units on a national basis. Without a proper recording AI becomes like a “shot in the dark”.

FUTURE PERSPECTIVES

Based on the factors identified in our study regarding knowledge, attitude and practices influencing cow fertility results on dairy farms around Kampala using AI we would like to suggest the following improvements:

- Develop courses for farmers focusing on heat detection, herd management, nutrition and breeding.
- Prepare a simplified breeding guide for farmers on how and what traits to think of - when selecting bulls for AI.
- Develop a breeding program or breeding recommendations that has the potential to meet with the prevailing conditions in Uganda.
- Develop compulsory further training and refresher courses for AI-technicians.
- Prepare a national document regarding standard operations for AI-work (a guarantee of quality) in Uganda to improve the procedures and quality of the AI-service performed today.

- Issue authorization for AI-technicians that meet with the national regulations and work according to the standard operations for AI-work.
- Develop a functioning national AI-recording system.

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REFERENCES

Althouse, G. (2007) Artificial Insemination, In: Schatten, H. and Constantinescu, G.M. (Eds.) *Comperative Reproduction Biology*. 159-169. Oxford: Blackwell Publishing Ltd

Coleman, D.A., Thayne, W.V. & Oailey R.A. (1985) Factors Affecting Reproductive Performance of Dairy Cows. *Journal of Dairy Science* 68,1793-1803.

Dalton, J. C., Nasir, S., Bame, J. H., Noftsinger, M., Nebel, R. L. & Saacke, R. G. (2001) Effect of Time of Insemination on Number of Accessory Sperm, Fertilization Rate, and Embryo Quality in Nonlactating Dairy Cattle. *Journal of Dairy Science* 84, Issue 11, 2413-2418.

DeJarnette, J. M. (1999) Factors affecting the quality of frozen semen after thawing. In: *Proc. Soc. Theriogenology, Semen Cryopreservation Artificial Insemination Symposia*, 267-276. Nashville, USA. 21-22 September 1999.

DeJarnette J.M., Barnes D.A. & Marshall C.E. (2000) Effects of pre- and post-thaw thermal insults on viability characteristics of cryopreserved bovine semen. *Theriogenology* 53. 1225-1238.

Galloway, D. & Perera, O. (2003) Guidelines and recommendations for improving artificial breeding of cattle in Africa. A working document of the AFRA Project III-2(RAF/5/046).

Gamborg, C. & Sandoe, P. (2005) Sustainability in farm animal breeding. A review. Livestock Production Sci. 92, 221-231.

Garcia, O., Balikowa, D., Kiconco, D., Ndambi, A. & Hemme, T. (2008) Milk Production in Uganda: Dairy Farming Economics and Development Policy Impacts, IGAD LPI Working Paper No. 09 - 08 [online]. Available from: http://www.igad-lpi.org/publication/docs/IGADLPI_WP09_08_MK.pdf [2012-12-04]

Gustafsson, H. & Emanuelson, U. (2002) Characterisation of the Repeat Breeding Syndrome in Swedish Dairy Cattle. *Acta Veterinaria Scandinavica* 43, 115-125.

Hunter, R.H.F. (2003) Advances in Deep Intrauterin Insemination: A Fruitful Way Forward to Exploit New Sperm Technologies in Cattle. *Animal Reproduction Science* 79, 157-170.

IFPRI- International Food Policy Research Institute (2008) Agricultural Growth and Investment Options for Poverty Reduction in Uganda. IFPRI Discussion Paper 00790 08 [online]. Available from: http://www.ifpri.org/sites/default/files/publications/ifpridp00790.pdf [2012-12-18]

Kaaya, H., Bashaasha, B. & Mutetikka, D. (2005) Determinants of utilisation of artificial insemination (AI) services among Ugandan dairy farmers. African Crop Science Conference Proceedings, Vol. 7, 561-567

Kanuya, N.L., Kessy, B.M., Bittegeko, S.B.P., Mdoe, N.S.Y. & Aboud, A.A.O. (2000) Suboptimal reproductive performance of dairy cattle kept in smallholder herds in a rural highland area of northern Tanzania. *Preventive veterinary medicine* 45, 183-192.

Landivar, C., Galina, C.S., Duchateau, A. & Navarro-Fierro, R. (1985) Fertility trial in zebu cattle after a natural or controlled estrus with prostaglandin F2 alpha, comparing natural mating with artificial insemination. *Theriogenology* 23, 421-429.

MAAIF - Ministry of Agriculture, Animal Industry & Fisheries and MFPED- Ministry of Finance, Planning and Economic Development (2000) Plan for Modernisation of Agriculture: Eradicating Poverty in Uganda.

MAAIF -Ministry of Agriculture, Animal Industry & Fisheries and UBOS- Uganda Bureau of Statistics (2009) The National Livestock Census Report 2008.

MAAIF - Ministry of Agriculture, Animal Industry & Fisheries, FAO- Food and Agriculture Organization of the United Nations and DDA- Dairy Development Authority (2011) National Dairy Strategy 2011-2015.

Masembe Kasirye, F.N. (2003) FAO- A Review of The Small Scale Dairy Sector – Uganda. FAO Prevention of Food Losses Programme.

Mbowa, S., Shinyekwa, I. & Lwanga, M.M. (2011) Dairy Sector Reforms and Transformation in Uganda since the 1990s. Economic Policy Research Centre (EPRC) in Collaboration with Africa Growth Initiative (AGI), Brookings

Msangi, B.S.J., Bryant, M.J. & Thorne, P.J. (2005) Some factors affecting reproductive success in crossbred dairy cows on smallholder farms in coastal north-east Tanzania. Tropical animal health and production 37, 413-426.

Nadir, S., Saacke, R.G., Bame, J., Mullins, J. & Degelos, S. (1993) Effect of freezing semen and dosage of sperm on number of accessory sperm, fertility, and embryo quality in artificially inseminated cattle. *Journal of animal Science* 71, 199-204.

Nakimbugwe, H., Sölkner, J. & Willam, A. (2004) Open Nucleus Cattle Breeding Programme in the Lake Victoria Crescent Region of Uganda. Deutscher Tropentag 2004, Berlin, October 5-7, 2004, Conference on International Agricultural Research for Development. [online] Available from: http://www.tropentag.de/2004/abstracts/full/80.pdf [2013-01-02]

Nordin, Y., Zaini , N. & WAN Zahari, W.M. (2007) Reproductive status following artificial insemination and factors affecting conception rate in dairy cows in smallholder production systems 79-91. In: *Improving the Reproductive Management of Dairy Cattle Subjected to Artificial Insemination.* International Atomic Energy Agency, IAEA-TECDOC-1533.

Parkinson, T. (2009) Artificial insemination. In: Noakes. D.E., Parkinsson, T.J. & England, G.C.V. (Eds.) *Veterinary Reproduction and Obstetrics*. Ninth edition, 765-806. Elsevier Ltd.

Peake, K.A., Biggs, A.M., Argo, C.M., Smith, R.F., Christley, R.M., Routly, J.E. & Dobson. H. (2011) Effects of lameness, subclinical mastitis and loss of body condition on the reproductive performance of dairy cows. *Veterinary Record* 168, 301.

Pursley, J.R., Silcox, R.W. & Wiltbank M.C. (1998) Effect of Time of Artificial Insemination on Pregnancy Rates, Calving Rates, Pregnancy Loss, and Gender Ratio After Synchronization of Ovulation in Lactating Dairy Cows. *Journal of Dairy Science* 81, Issue 8, 2139-2144.

Philipsson, J. & Jorjani, H. (2009) The importance of recording of AI data for the genetic systems. The context of AI from service to genetic progress. In: Sattler, J.D. (Ed.) *ICAR Technical Series - No. 13. Identification, breeding, production, health and recording of farm animals*. Proceeding ICAR 36th Session Biennial, Niagara Falls, USA 16-20 June 2008. 11-18. Rome, ICAR.

Population secretariat – Ministry of Finance, Planning and Economic Development, The Republic of Uganda. Home page. [online] (2012) Available from http://www.popsec.org/key_facts.php [2013-01-04]

Rodriguez-Martinez, H. (2012) Assisted reproductive techniques for cattle breeding in developing countries: a critical appraisal of their value and limitations. *Reproduction in Domestic Animals* 47, 21-26.

SMI – Smittskyddsinstitutet (Swedish Institute for Communicable Disease Control). Homepage. [online] (2010-12-30) http://www.smittskyddsinstitutet.se/sjukdomar/brucellos/ [2013-01-16]

SVA – Statens veterinärmedicinska anstalt (National Veterinary Institute). Homepage. [online] (2011-09-15) http://www.sva.se/sv/Djurhalsa1/Zoonoser/Brucellos-som-zoonos1/ [2013-01-16]

Swedish government. Home page. [online] (2012-11-12) Available from: http://www.regeringen.se/sb/d/2574/a/75614 [2012-11-28]

Swensson, T. (1987) AI-teknikens för- och nackdelar (Advantages and disadvantages with AI-technology). In: *Artificiell insemination och reproduktion (Artificial insemination and reproduction*). 23-24. Eskilstuna. Swedish Association for Livestock, Cooperative Society.

The world bank (2011) *Uganda Dairy Supply Chain Risk Assessment February 2011*. Report. Agricultural Risk Management Team of the Agricultural and Rural Development department of the World Bank.

Thibier, M. (2005) The zootechnical applications of biotechnology in animal reproduction: current methods and perspectives -a review. *Reproduction Nutrition Development* 45, 235-242.

UBOS -Uganda bureau of statistics (2010) The Uganda National Household Survey 2009/10 [online] Available from: http://www.ubos.org/UNHS0910/unhs200910.pdf [2013-01-04]

UBOS -Uganda bureau of statistics (2011) Livestock numbers [online] Available from: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/Agric_T1_2011.pdf [2012-11-28]

UBOS –Uganda bureau of statistics (2012a) 2012 Statistical Abstract. [online] Available from: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2012StatisticalAbstract.pdf [2012-12-11]

UBOS –Uganda bureau of statistics (2012b) Annual Growth Rate. [online] Available from: http://www.ubos.org/index.php?st=pagerelations2&id=17&p=related%20pages%202:Population [2012-12-14]

Van Vleck, L.D. (1981) Potential genetic impact of artificial insemination, sex selection, embryo transfer, cloning and selfing in dairy cattle. In: Brackett BG, Seidel GE, Siedel SM (eds), New Technologies in Animal Breeding. 221-242. New York, USA, Academic Press.

Woldu, T., Giorgis, Y.T. & Haile, A. (2011) Factors affecting conception rate in artificially inseminated cattle under farmers condition in Ethiopia. *Journal of Cell and Animal Biology* 5 (16), 334-338.

Zwart, D. & de Jong, R. (1996) Animal health and dairy production in developing contries. In: Brand, A., Noordhhuizen, J.P.T.M. & Schukken, Y.H. (eds), *Herd Health and Production Management in Dairy Practice.* 511-543. Wageningen, The Netherlands: Wageningen Pers.

ENCLOSURE 1

Questionnaire 1: Farmers using artificial insemination.

A QUESTIONNAIRE FOR FARMERS using AI

Section A.

BACKGROUND INFORMATION

Farm ID & location

Name of farm/er

Village (LC) parish

District GPS UTM

Section B.

1.1 FARMING SYSTEM: (*Tick appropriate*) ***Open grazing/ Zero gazing/ Mixed/ Other specified***

1.2 HOUSING: (description)

1.3 NUMBER OF ANIMALS

Calves	Yearling heifers	Milking cow	Dry cows	Bull	Other

1.4 BREED

Breed	Fresian	Guernsey	Jersey	Cross breed	Local breed
Numbers					

1.5 What are the animals fed?

1.6 For how many years have you been farming dairy cows?

1.7 Which method used to breed the cows in the herd (***AI/ NS/both)***
For how long have you used AI in this herd?

1.8 Signs used to confirm heat/ estrus checklist

Swollen vulva …… ☐
Mucus discharge …… ☐
Nervousness and restlessness……. ☐
Standing to be mounted…… ☐
Mount other animals…… ☐
Lordosis …… ☐
Chin resting …… ☐
Licking vulva…… ☐
Other

1.9 Who detects estrus in this herd?
(Stockman/ family members/, farm owner/ anybody/ other)

1.10 Number of times devoted to detecting estrus in the herd?
(Once/ Twice/ Thrice/ Four x per day?)
TIME OF DAY FOR DETECTING ESTRUS
(Morning, midday, afternoon, evening, other)
How much time do you devote to detecting estrus/day?
(<10min/ 10min/20min/30min/>30min)

1.11 Do you use other estrus detection AIDS other than visual observation? ***(YES/NO)***

1.12 Do you know/use heat detection calendar ***(YES/NO)***

1.13 If a cow goes on heat, what by means do you notify the AI technician?
(Mobile phone call / landline call/ travel to office/ text message/ Fax/ other)

1.14 After how long do you contact technician for service?
(As soon as possible/ other)

1.15 How long after being contacted, does the technician arrive for the service?
(Same day/ next day/ other)

1.16 Which of the following is the most important reason for you to use AI instead of a bull?
☐***Costs***
☐***Genetic improvement***
☐***Hygiene/ avoid venereal diseases***
☐***Safer working environment***
☐***Safer for cows***
☐***other***

1.17 State 3 disadvantages you suffer as result of using AI instead of a bull?

1.18 Who decides which bulls, breeds and doses should be used?
(***The farmer /AI-tech /Semen vendor units***)

1.19 Do you normally request for your cows to be examined to confirm pregnancy after AI?
(YES/NO)
If you do not, then, which of the signs do use or depend on to confirm the outcome of AI?

1.20 How much does a single AI-service cost?
What do you think of the cost? Reasonable, too expensive?

1.21 Do you keep any records for AI? ***(YES/NO)*** What?

1.22 Have you ever used prostaglandin injections to induce heat or to synchronize the females? ***(YES /NO)***
If yes, when do you check for heat?

1.23 Do you have any problems with retained placentas? ***(YES /NO)***
After how long (hours) would you consider a placenta to be a retained? ***hours.***
How many cow of this herd have suffered retained placenta so far this year?
How many retained placenta last year?

1.24 Which other problems/ diseases disturb you in this herd?

1.25 Do you belong to an association? ***(YES/NO)***
If yes, name of association

ENCLOSURE 2

Questionaire 2: Farmers using natural mating

A QUESTIONNAIRE FOR FARMERS not using AI

Section A.

BACKGROUND INFORMATION

Farm ID & location

Name of farm/er

Village (LC) parish

District GPS UTM

Section B.

2.1 FARMING SYSTEM: (*Tick appropriate*) ***Open grazing/ Zero gazing/ Mixed/ Other specified***

2.2 HOUSING (description)

2.3 NUMBER OF ANIMALS

Calves	Yearling heifers	Milking cow	Dry cows	Bull	Other

2.4 BREED

Breed	Fresian	Guernsey	Jersey	Cross breed	Local breed
Numbers					

2.5 What are the animals fed?

2.6 For how many years have you been farming dairy cows?

2.7 BREEDING METHOD CHECK LIST
Which method used to breed the cows in the herd (***AI/ NM/both)***

If, natural breeding: ***Have own bull ❑ Use bull who comes to farm ❑ Take cows to bull ❑***
If not use own bull, how much does it cost to get the cow mounted?
If it requires more than one mating to get the cow pregnant, does that cost extra?

2.8 Why are you not using AI-service?
To expensive ☐
No availability ☐
Not reliable ☐
Not god pregnancy results ☐
Don´t know about it ☐
The service is not available here ☐
Other ☐

2.9 Have you been using AI before? ***(YES /NO)***
If yes, why did you stop using AI?
To expensive ☐
No availability ☐
Not reliable ☐
Not god pregnancy results ☐
Don´t know about it ☐
The service is not available here ☐
Other ☐

2.10 Is there something negative about using natural breeding?
Poor genetic development ☐
Dangerous working environment ☐
Risk for transmitting veneric diseases ☐
Food and maintenance for the bull is expansive ☐
Other ☐

2.11 Do you normally request for your cows to be examined to confirm pregnancy? ***(YES/NO)***

2.12 Have you ever used prostaglandin injections to induce heat or to synchronize the females?
If yes, when do you check for heat?

2.13 Do you have any problems with retained placentas? ***(YES /NO)***
After how long (hours) would you consider a placenta to be a retained? ***hours***
How many cow of this herd have suffered retained placenta so far this year?
How many retained placenta last year?

2.14 Which other problems/ diseases disturb you in this herd?

2.15 Do you belong to an association? ***(YES/NO)***
If yes, name of association

ENCLOSURE 3

Questionnaire 3: AI-technicians

A QUESTIONNAIRE FOR SERVICE PROVIDERS/ AI-TECHNICIANS

Section A.

BACKGROUND INFORMATION

AI tech ID & location

Name

Village (LC) Parish

District GPS UTM

Gender: ***Male*** ☐ ***Female*** ☐

Section B.

3.1 In which institution did you study AI?
Duration of the AI course?

3.2 Which year did you undertake the course?
For how long have you worked as an AI-technician?
<1 year ☐ ***1-2*** ☐ ***3-5*** ☐ ***6-10*** ☐ ***>10 years*** ☐

3.3 Are you working privately or do you belong to an AI-co-operative?
Privately ☐ ***Co-operative*** ☐ ***Other*** ☐
Do you have contracts to give service to certain farms or you service any?
Certain farms ☐ ***any*** ☐

3.4 How many animals/year do you inseminate? /month
<10 ☐ ***10-50*** ☐ ***50-100*** ☐ ***100-500*** ☐ ***500-1000*** ☐ ***>1000*** ☐ ***Don't know*** ☐
Do numbers you serve change with season of the year***? (YES/NO)***

3.5 How do you transport the semen to the farm? What type of transport vehicle do you use?
By foot ☐ ***Bicycle*** ☐ ***Motor cycle*** ☐ ***Car*** ☐ ***Other***
What is the average distance from your place to the different farms? Km

3.6 Where do you buy liquid nitrogen from and at what price? Is it hard to supply LN2?

3.7 How do you store the semen? Do you have a stock of AI-doses yourself or do you buy the doses according to what is ordered when you need them for AI?

3.8 Who determines the bulls, breeds and doses to be used to inseminate a cow?
The farmer ☐ ***AI-tech*** ☐ ***Semen vendor units*** ☐

3.9 Who much does a single AI-service cost?

3.10 What type of straw do you use?
Mini ☐ ***Medium*** ☐ ***Both*** ☐ ***Other*** ☐

3.11 At what temperature do you thaw semen? ***°C***

3.12 How do you check the temperature before thawing?
Thermometer ❑ Finger ❑ Not at all ❑ Other ❑

3.13 For how many seconds do you thaw the semen? ***Seconds***

3.14 How do you check the thawing time?
Stop watch ❑ Counting ❑ Not at all ❑

3.15 Do you use a separate water thermos for thawing?
(YES/NO) If no, use

3.16 How long time after the farmer has contacted you and ordered AI-service do you come to the farm normally?
After hours The same day ❑ Next day ❑ Differs ❑

3.17 Do you check for heat before insemination?
(YES/NO)
What do you do if the female that you are going to inseminate is not in heat at the time you arrive at the farm for AI?
Inseminate ❑ Do not inseminate ❑ Other ❑

3.18 Where do you deposit the semen at AI?
In the cervix ❑ Body of uterus ❑ One uterine horn of uterus ❑
Both uterine❑ other ❑

3.19 When do you insert the insemination gun?
Before empting the rectum ❑ After empting the rectum ❑

3.20 Checklist for hygiene routines?
Use of protective coat ❑ Disposable gloves ❑ Cleaning and disinfection of the equipment ❑ Cleaning and disinfection of footwear between farms ❑
Other ❑

3.21 Do you make any records at AI? ***(YES/NO)***
Which records do you put down at AI?
Do your farmers keep notes by themselves? ***(YES/NO)***
Concerning the notes/records made, if any, which other organization do you report to?
Of the records made at AI, do you leave a copy to farm owner ***(YES/NO)***

3.22 What do you think can be some reasons for bad pregnancy results?

3.23 What factors must improve so more farmers will use IA?

ENCLOSURE 4

Questionnaire 4: Semen vendor units

A QUESTIONNAIRE FOR SEMEN VENDOR UNITS

Section A.

BACKGROUND INFORMATION

ID & location

Name of semen vendor unit

Village (LC) Parish

District GPS UTM

Section B.

4.1 Do you sell any **semen**, produced within Uganda?
Indicate how much of what you sell is **Imported ❑ produced In Uganda ❑ Other ❑**

Which company (ies) and country export semen for your business?

- USA ❑
  company
- Europe ❑
  Country
  Company
- Africa ❑
  Country
  Company
- Other country ❑
  Company

4.2 What criteria guide you to decide which bulls, breeds and doses to be imported or buy?

4.3 Which bulls/breeds are most popular and why?

(Are there any constraints in your business? If any, please list and rank them?)

4.4 Do you provide semen other than frozen semen doses?
Yes ❑ ***No, only frozen ❑***

What type of straws do you provide?
Mini ❑ ***Medium ❑*** ***Both ❑*** ***Other ❑***

4.5 What semen extender is used for the semen you vend in this business?

4.6 What is the final sperm concentration in the straws of semen you sell to technicians?

4.7 Of the semen sold, what is the **minimum** sperm motility after thawing?

(Which organization monitors quality standards like a threshold value for accepting a semen operation regarding sperm concentration and motility?)

4.8 Do you have your own power plant for production of liquid nitrogen (LN2) or do you use a LN2 supplier? (How do you get your LN2?)

How often do you fill the LN2 tanks?

4.9 For how long do you normally store the semen doses before you sell them to the technicians– turnover rate?

4.10 Do you engage in advising AI-technicians on recommendations regarding the thawing procedure (temperature and time) at any time?
(YES/NO) Other
What do you recommend as thawing– temperature, time for semen in this business?
Temperature:
Time:

4.11 How much is the cost, on average, for a semen dose?

4.12 What influences the price? Are there some straws which are more expensive than others?

4.13 Is there any hygiene control / measure you recommend for technicians who purchase semen from your business? Using of antibiotic in the extender etc.

4.14 If you are a local producer of semen what type antibiotic do you use in the extender?

4.15 How do you ensure a hygienic procedure in the AI-process (from this station via technicians to the farm? Are there any problems in this chain of events?

4.16 Do you have any AI-technicians directly under your semen sales unit and if not how do you market/sell your semen?

4.17 How do you communicate the advantages of using AI and the semen you sell to farmers and AI-technicians or how do they know which bull semen are available?

4.18 What bull info is available for AI-tech and farmers and how do you disseminate it?

4.19 Do you arrange any information meetings regarding the use of AI for farmers?
(YES/NO)
What do you do to get into contact with the farmers in order to increase the use of AI?

4.20 Do you have" veterinary/reproductive health service back up" for your business? E.g. corrective mating, management of repeat breeders and reproductive pathology?
(YES/NO)

4.21 What competitive/financial advantages does AI have compared to using a bull in Uganda? Do you have any figures on that?

4.22 Any other?