BENCHMARKING THE KENYAN ARTIFICIAL INSEMINATION SERVICE SUB-INDUSTRY

FINAL REPORT

Submitted to

The Competition Authority of Kenya

July 2014

Table of contents

List of Tables

List of Figures

List of Annexes

List of acronyms

ABS-TCM	African Breeders Service – Total Cattle Management
ADC	Agricultural Development Corporation
ADHIS	Australian Dairy Herd Improvement Scheme
AHITI	Animal Health Training Institute
AI	Artificial Insemination
CAIS	Central Artificial Insemination Station
CAK	Competition Authority of Kenya
COMESA	Common Market for East and Southern Africa
DGEA	Dairy Genetics East Africa
DIY	Do It Yourself AI system
DLPO	District Livestock and Production Office
DTI	Dairy Training Institute
DVS	Directorate of Veterinary Services
EAAPP	East Africa Agricultural Productivity Project
EAC	East African Community
EADD	East Africa Dairy Development
GDP	Gross Domestic Product
ICAR	International Centre for Animal Recording
IEA	Institute of Economic Affairs
ILRI	International Livestock and Research Institute
KAGRC	Kenya Animal and Genetics and Research Center
KALT	Kenya Livestock Technicians Association
KDDP	Kenya Dairy Development Program
KDDP	Kenya Dairy Development Project
KEBS	Kenya Bureau of Standards
KI	Key Informants
KLBO	Kenya Livestock Breeders Organisation
KMT	Kenya Markets Trust
KVA	Kenya Veterinary Association
KVB	Kenya Veterinary Board
KVPA	Kenya Veterinary Paraprofessionals Association and
LRC	Livestock Recording Centre
PICO-EA	Institute of People Innovation and Change in Organizations – Eastern Africa
SDP	Smallholder Dairy Project
WWS-EA	World Wide Sires East Africa (ltd)

Executive Summary

The growing demand for Artificial Insemination (AI) in Kenya is a derived demand: driven by the demand for better dairy genetics which is in turn driven by the demand for more milk and milk products to feed a growing and urbanizing population. Artificial Insemination is an innovative substitute to natural mating and is among an interesting class of agricultural inputs that represents both the delivery of a product (bull semen) and a service (the insemination). Despite an increasing number of studies, not much has been analyzed from the perspective of the farmer as a consumer of these products and services.

What, for instance, are the consumer protection issues arising of the privatized AI delivery system we have in Kenya? Further, whereas Kenya boasts a competitive semen import, distribution and service delivery system; what are the challenges to a more competition, particularly in local production and distribution of semen? Finally an important question is how the sub-industry can develop progressively towards a more inclusive, broad based system.

This report describes the current status of AI in Kenya. Most cattle breeding services – at least 70% - are through natural mating; on a good year AI accounts for up to 37% of all mating. There are hundreds of private AI practitioners who deliver AI to farmers – having sourced semen from appointed distributors who are mostly located in high potential areas. The distributors in turn obtain semen, and Liquid Nitrogen (which is what preserves the viability of semen) from more than 10 importers and the sole, publicly-owned local producers. Underlying this system is a history of lessons and challenges.

Consumers (farmers) have little knowledge of the pricing mechanism, have nowhere to channel complaints about malpractice and rarely furnished with records reflecting their semen purchase and insemination services. Often, other than the declaration of the inseminator, consumers cannot ascertain independently their choice of semen was the one used. This problem is made worse by anecdotal evidence that well trained inseminators are competing with a plethora of unlicensed quacks who make no returns and have no incentive to provide reliable services as required by regulation. In some areas, geographical limitations are arbitrarily imposed on inseminators, limiting their practice and dampening competition.

The growing role of county governments in AI requires careful thought. Inseminators in some counties (Muranga being an example) are now competing against county government subsidized insemination operations. This is a potential throwback to the past where the government bankrolled insemination services ending with unsustainable costs and failing spectacularly. Careful consideration needs to be given to how public private partnerships

that support private enterprise can be encouraged as county governments roll-out these programmes.

This report uses data from a field survey of three representative counties and a review of international practice to develop a series of benchmarks and make a series of recommendations that, collectively, are designed to transform the AI service delivery into an efficient, inclusive and competitive sub-industry. Four areas are benchmarked:

Facilitating healthy competition in semen delivery –we review the practice in developed dairy systems and show that semen production in particular, unlike the case in Kenya, is largely a private enterprise. Subsidizing local, as is our case, production is anti-competitive, and in the long-run counter-productive. The Kenya Animal Genetics and Research Center (KAGRC), which operates consistently below capacity, should be exposed to competition for its own good: so that its management improves efficiency and prices competitively to survive. While local semen distribution and insemination services are more or less privatized we suggest benchmarks that could open up competition further (including demystifying AI and encouraging more do-it-yourself inseminations by elite farmers)

Increasing consumer access to AI services – AI penetration rates are decidedly low at between 18 – 27% depending on which study one looks at. Availability does not mean access when it comes to insemination: pricing, heat detection, choice and farmer knowledge are just a few of the issues that affect overall access. We have provided in this report, based on expert knowledge and analysis a way in which to target breeding services, noting that not every farmer necessarily needs or will benefit from superior semen and insemination services.

Improving quality of field delivery of AI service – this goes to the heart of consumer welfare. A series of critical qualitative and quantitative benchmarks that measure the quality of services are suggested. This includes how insemination is organized, the number of inseminations per conception, number of inseminators, and cold chain efficiency issues. A number of farm level productivity characteristics like calving interval (which is increased by poor AI services) are also considered.

Institutional Arrangements for AI Service Provision – A final area of benchmarking that is critical but could be easily overlooked is the institutional environment. A disorganized system where roles are unclear and stakeholders – regulatory, commercial, consumer – are not talking to each other is a recipe for chaos. Several measures are suggested to improve licensing, regulation, recording, reporting, training and supervision are suggested. In principle, a good, predictable, and fair operating environment allows business to flourish and the consumer to be protected against unscrupulous products and practices. A case in point that illustrates potential, unfairness is the use of use of the KAGRC to certify the quality of imported semen when it is a competitor to the private semen importers. The Department of Veterinary Services (DVS) and Kenya Bureau of Standards (KEBS) will need to develop independent capacity to regulate all players including KAGRC.

At the end of this report we suggest interventions designed to improve the operating environment for Artificial Insemination: these include encouraging private investment in semen production and distribution; the commercialization of KAGRC; the development of an innovation platform for the industry; clarity and harmonization of regulatory roles; developing a modern recording, evaluation and feedback system; farmer education and sensitization on aspects of AI (such as heat detection and record keeping); regular refresher and retooling course for AI technicians and the establishment of a complaints mechanism for farmers.

1 Introduction

This study was conducted PICO-Eastern Africa (PICO-EA) as part of market development work for the Kenya Markets Trust (KMT) and the Competition Authority of Kenya (CAK). CAK (hereafter referred to as the Authority) is established under section 7 of the Competition Act No. 12 of 2010 with the mandate of safeguarding competition in Kenya and protecting consumers from unfair and misleading market conduct. KMT, on the other hand, is a non-governmental organization founded with the objective of enhancing inclusive and equitable growth and employment creation among the poor by improving the performance of key market systems that are important for the poor people in Kenya. In addition, to this, the organization assesses and influences the broader debate on the extent to which markets work for the poor.

The objective of this study was to benchmark the environment in which private enterprise operates within the artificial insemination (AI) sub-value chain of the dairy value chain and identify opportunities to enhance the enabling environment and mitigate against competition constraints, assessing consumer protection issues as well as factors that negatively affect productivity and overall performance of the value chain.

While results of a benchmarking study of AI such as this have development implications way beyond industry or sector competition, the interpretations of the results of this study have a deliberate emphasis on the 'competition lens' that reflect the mandate of CAK pursuant to section 9 of the Competition Act No. 12 of 2010. Data came from three main sources: a) market inquiry carried out among AI service providers and users; b) review of literature and secondary data on AI in Kenya and other (reference) countries; and c) consultation workshop involving key actors in the AI sector sub-value chain, and other stakeholders in the dairy sector. The results presented are expected to assist CAK in looking into issues that affect competition and protection of consumer (farmer) interests, and factors that are affecting entry into and exit from the AI sub-value chain, especially semen production, importation and delivery. The report also improves the understanding of policies, procedures and programs of regulatory bodies within the AI sub-industry with the objective of assessing the effects of these on competition and consumer welfare.

It is expected that the implementation of this report will lead to public and private sector interventions aimed at creating an environment conducive to healthy private enterprises and improved consumer welfare. The information presented here will assist market players and specifically CAK to coordinate through entering into memorandums with relevant government agencies including county governments and advocate for an environment that will increase competition and efficiency in the industry, resulting in improved access to appropriate, affordable, quality and timely insemination services and products, especially to smallholder farmers.

1.1 Organization of the Report

The report is presented in six sections and a set of annexes. After the brief *introduction* (this section), the report examines the *landscape of the AI sub-industry* in the country so as to understand its operating framework, the organization and regulatory climate. This descriptive section has relied on secondary sources, interaction with industry players and PICO-EA's experience working in the dairy sector. The discussion is presented through the prism of competition and consumer welfare.

The third section covers the *benchmarking process*, summarizing candidate benchmarks and the approach used for the benchmarking. We subsequently present data and information from *household and trader surveys* carried out to provide a snapshot of 'where Kenya is' with regard to identified benchmarks. The fifth section presents the *chosen benchmarks* and the last section suggests a series of high level *candidate interventions* designed to move the market towards the desired benchmark.

2 Situational Analysis of the AI Sector

2.1 History and landscape of AI in Kenya

Our review of the landscape and history of AI in Kenya is drawn from an extensive review of literature. These include those which provide historical perspective of the industry (for example Meyen & Wilkins, 1973; Ocarssson and Israelsson, 1977 and 1988; Duncanson, 1977; and Foote, 2002). Wakhungu and Baptist (1992), Karanja (2002), Karugia *et al.* (2001) and Rep. of Kenya (2002) provide detailed analyses of the role of AI in the dairy industry. Okeyo *et al.* (2011), KDDP (2008), SDP (various); EADD (various) and Omore et al. (2002) and Muriuki *et al.*, (2003) provide articulation of institutional development issues in the sub-industry.

Artificial Insemination (AI) was introduced in Kenya in the 1940's and has risen to become the most important approach to breed improvement: AI allows a small proportion of really top performing bulls to become easily available in multiple places at the same time, removes the need to rear bulls at high cost, especially among smallholders and prevents the spread of venereal diseases that are common in natural mating. Bull services while viable for certain systems are often difficult to control leading to unplanned mating. Still, because of a myriad of reasons, bull services account for an estimated 80 percent of all services in Kenya[1]. The usage of AI services in Kenya improved gradually over a 30-year period, reaching a peak of 542,000 inseminations in the late 70's during an era of aggressive government-run, donor supported insemination services[2].

Figure 1 below captures the historical trend in AI usage up to 2009. The blue line represents the number of 'government' inseminations while the red line shows the early trend in private sector inseminations. In the 60's and 70's donor support (mainly Swedish) and government subsidies propelled uptake of AI among indigenous, primary smallholder Kenyans who were intensifying dairying. But the public-sector-run, donor-driven AI was ultimately unsustainable. Apart from wastage and mismanagement, budgetary constraints and the withdrawal of donor support led to the privatization in 1991[3]. The privatization of AI services was not done thoughtfully and systematically and, given the inexperience of the country in running private sector AI services, the milk marketing system collapsed in the 1990's which led to a drastic drop in the usage of AI.

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[1] Various cross-sectional dairy studies from the past 15 years (SDP, KDDP, and EADD) have produced results that average 80% bull services. However, the use of AI appears to be growing, albeit gradually

[2] The Kenya National Artificial Insemination Services was supported by various Swedish grants and expertise. There was also significant subsidy from the government (see Israelsson and Oscarsson (1977, 1988)

[3] Note that the Structural Adjustment Program – the result of the first Washington Consensus was beginning to take effect – with a heavy toll on public sector driven approaches.

After the initial challenges with private AI, competition amongst private sector inseminators gradually picked up. Today there is no AI services delivery provision by the government and about 1000 licensed private inseminators are available. However, there are still a number of important measures required to unlock the true potential to develop a fuller competition in the sub-industry.

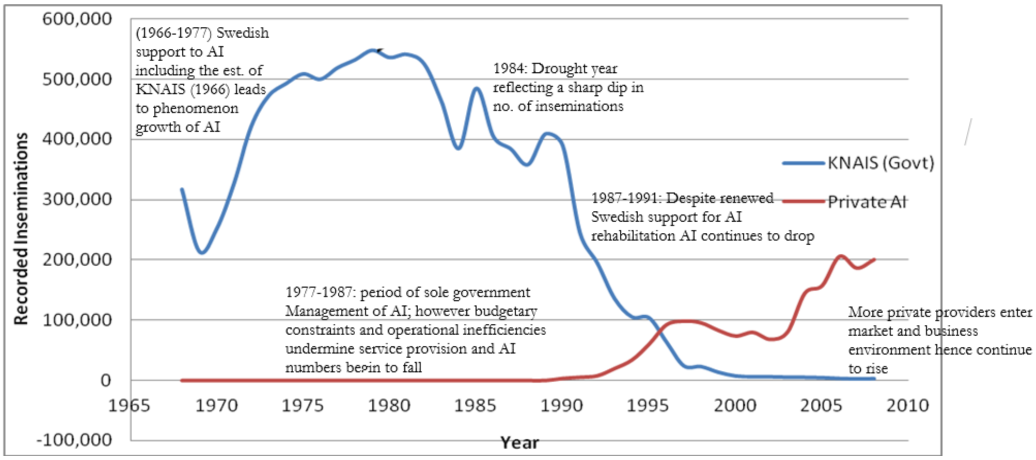

Figure 1: Performance of Artificial Insemination in Kenya over the years

Source: Central AI Station annual reports, 1966 – 2009, compiled by the authors.

2.2 AI demand, market structure, segments and trends today

The dominant breeding method applied by farmers is the natural service whereby cows are bred by local bulls. In 2010 natural service accounted for between 73 and 82 percent of breeding services in Kenya. These local bulls used could be owned by the farmer, borrowed or hired from neighbors. Within the AI option, there are two main sources of semen: *imports* (ready-to-use semen imported mainly from South Africa, Europe and North America) and *local production* (semen collected from locally bred bulls).

Most estimations agree that the demand for AI is big. According to studies carried out by DGEA[4], the potential market for AI in Kenya will rise from 2.2 in 2012 to nearly 3.5 million in 2025 (this figure excludes millions of cattle of lower genetic potential – such as the East African Zebu - that should nevertheless be targeted for upgrading by AI). In addition to these figures, there is significant potential to supply the regional export market with high

[4] DGEA is the Dairy Genetics East Africa project. The DGEA data is very conservative: Another project, the SDP showed that there is gross underestimation with official numbers of dairy cattle less than half what the actual numbers are.

quality semen. Despite this clear potential, there has not been any significant investment in local semen production and AI market development since independence.

Currently, all the local production of semen done by the government at what was previously called the Central Artificial Insemination Station, now called the Kenya Animal Genetic Resources Centre (KAGRC)[5]. Except for a small proportion of direct imports in the past, the bulls that produce semen at the KAGRC stud at Kabete are sourced through a 'contract mating scheme', where elite farmers breed bulls from dams (mothers) shown to be top performers and bred with semen provided by KAGRC from quality sires (fathers) with known pedigree. These resulting calves if male (i.e. bull-calves) and meeting certain set criteria, are 'purchased' from the farmers and raised by KAGRC until they are mature enough to start producing semen. A 'bull purchasing committee' meets to recruit farmers into the contracting scheme and to screen the resulting bull-calves. Whereas CAIS/KAGRC have enjoyed a monopoly since 1946, the establishment of a private bull stud is under way. At least 5 private sector organizations have expressed interest in investing in bull semen production and at least two of these firms have been licensed, have developed business plans and are in process of sourcing for finance to venture into semen production[6].

But it has taken more than 60 years for the private sector to consider investing. Why is it so difficult to set up a bull stud in Kenya? Initially the policy was unclear as to whether it was possible to get a license for bull semen production. Moreover, many potential investors found the existence of large, subsidized public entity threatening. Indeed, discussions with the prospective investors in bull stud, indicate that it is the government subsidy to KAGRC that represents the biggest threat to their (private sector) business plans. This is especially a major factor considering that fact that bull stud establishment requires significant capital investment which banks are reluctant to put into an 'unknown' business. Finally there has been limited local HR capacity for managing bull studs since only CAIS/KAGRC has had the experience of managing a over the years.

Through SAPs,[7] semen importation, distribution and delivery of AI services were liberalized. There are currently at least 45 importers, tens of distributors and about 1000 inseminators who collectively deliver semen (both local and imported) to Kenyan consumers (farmers).

Distributors – appointed as agents – bulk and store semen from KAGRC and the importers. From these agents, three types of AI technicians deliver the semen to farmers: individual

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[5] Formerly known as the Central Artificial Insemination Station – CAIS, since 1946 when it was started.
6 Personal communication from various businessmen and information from the Department of veterinary Services (DVS) which licenses players
[7] SAPS are policies implemented by the IMF and World Bank in developing countries to open up the markets in these countries with an aim of poverty reduction and conditions for lending. The "free" market policies include internal changes (notably privatization and deregulation) as well as external ones, especially the reduction of trade barriers.

private inseminators; cooperative groups; and in some places a small proportion of government extension agents. AI service is provided on-call basis: that is, the farmer, on detecting that his/her cow is on heat, calls the inseminator who then travels to the farm to provide the service. Figure 2 illustrates the AI movement with indicative proportions based on data from various surveys (SDP, KDDP, and EADD)

Figure 2 presents what may seem like a complex market structure. However, several elements of the AI sub-value chain are not reflected in this figure. These include transport systems, Liquid Nitrogen supply (the semen must be deep frozen in order to keep it viable until it is used - and therefore requires a cold chain system run on Liquid Nitrogen)[8], equipment supply and repair, among others.

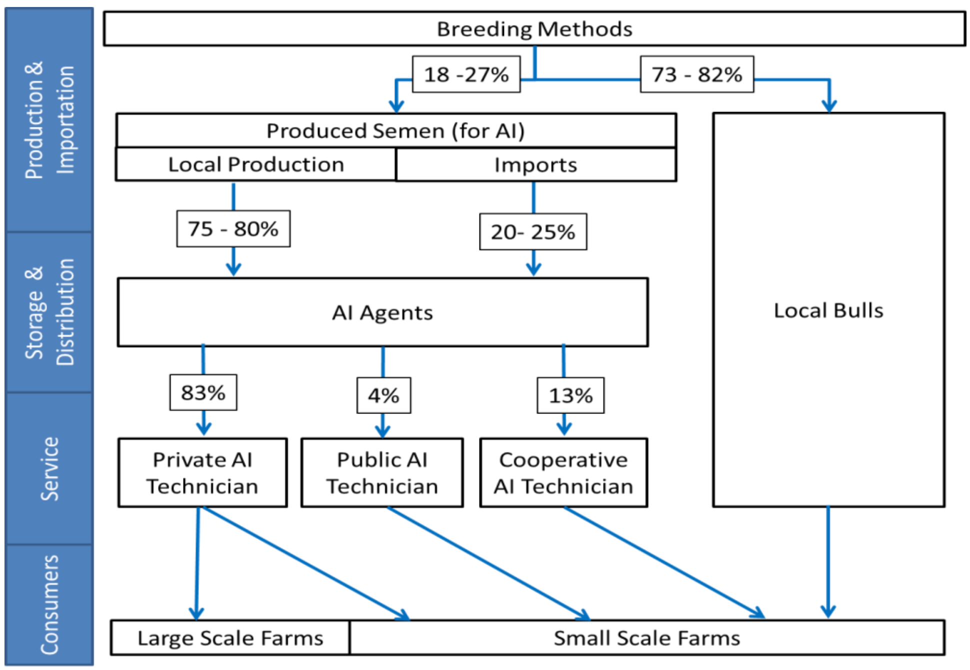

Figure 2: Semen Market Channels

Source: Estimations compiled by authors from dairy research projects

Cow pregnancy and calving is critical to restart the lactation cycle, and although farmers are interested in getting quality calves, getting the cow in-calf is often the focus of many farmers. Thus, although several studies[9] indicate that AI is the preferred breeding method by smallholder farmers, most farmers do not seek AI in order to improve the genetic potential

8 'Fresh' or room temperature semen has been tried in Kenya, but is not a feasible option for the Kenyan context because it must be used within a very short time.

9 See for example: Baltenweck et al, Artificial or Natural Insemination: The demand for breeding services by smallholders, 2004

of the progeny in every instance. Therefore, despite the fact that two-thirds of farmers raise replacement stock from their own herds[10], not every pregnancy requires high-value semen (from a genetic point of view). The average number of lactations for a dairy cow in Kenya is 4 cycles but could go up to 8 cycles or more in their productive life[11]. This means that for the majority of pregnancies, where the farmer is not targeting replacement, the farmer's primary concern is to impregnate their cow in the least expensive, but most effective manner available[12], with clear focus on just getting a pregnancy. In these cases, the pregnant cow, rather than the quality of the calf that will be born is of primary concern and preferences for AI stem from custom (years of government provided AI service), convenience (eliminates cost of keeping a bull) and disease avoidance (reduction in the spread of sexually transmitted diseases), and not the interest in getting a genetically superior calf (for eventual herd improvement). We address this issue in the recommendations section.

Farmers are willing to pay more for effectiveness and efficiency of AI rather than for quality of the bull. The smallholder is however unable to realize the potential of very high quality semen because of other limitations within their system. Interestingly, smallholder does not always mean poor. Many smallholders are able to buy the expensive semen and support the heifer calves, and 60-70% of imported semen is not that expensive with prices starting from as low as Kshs 350. A far bigger element of cost to the farmer is the AI technician costs and margin in the process of distribution to the farmer.

Our market analysis concludes that there will continue to be a market for high cost, differentiated semen, but it will make up a relatively small proportion of the overall sales volumes for AI (see Figure 3 : Consumer Clusters by price). Farmers who seek AI for its potential to improve the genetics of the herd are those who maintain larger herds and or breed replacement stock. Some farmers are willing to pay higher prices for effectiveness and efficiency of AI, rather than for quality of the bull.

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[10] Various Smallholder Dairy Project Surveys

[11] Various Sources: KDDP, SDP

[12] The Breeding News: Breeding Services and the Future of Smallholder Dairy Systems in Kenya, Kenya Dairy Development Program, 2004

Figure 3 : Consumer Clusters by price

Source: Authors analysis

The bulk of the customers for semen fall in the low price quadrant of Figure 3 : Consumer Clusters by price, above. This semen can be sourced either by KAGRC, low-cost imports, or bulls and presents the largest segment for growth of the private producers. The high cost, low volume market currently catered for by imports requires a different strategy.

For the lower-price semen, price estimates at each step of the distribution chain are outlined in Figure 4: AI Market Linkages and Price PointsSemen is sold from the producer for Ksh 200 to the agent, which represents 13% of the end price. The Agent sells to the AI service provider at 250, retaining 50 shillings representing 3% of the end price. The AI technician then sells the semen to farmers at 1500 Shillings, retaining 1250 Shillings gross profit which represents 83% of the end price. Although a firm seeking to compete on price can rightly strive to reduce costs at the production level, there is larger scope for reducing the price to farmers and becoming more competitive by increasing the efficiency of the distribution chain at the AI technician price point.

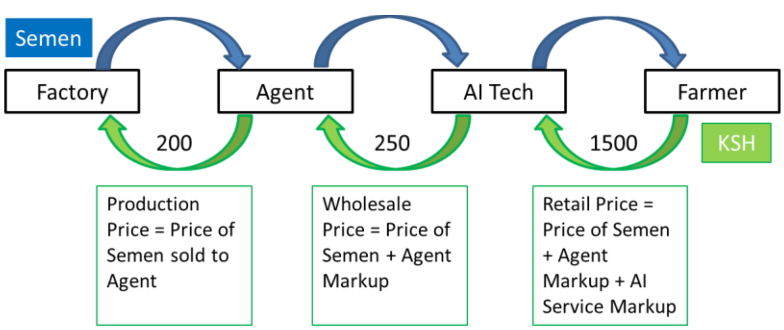

Figure 4: AI Market Linkages and Price Points

2.3 The actor space and regulatory framework for the delivery of AI in Kenya

This section summarizes the actor space and the regulatory framework, focusing on the extent to which this fosters or inhibits competition and consumer protection.

2.3.1 The actor space

Semen producers - There is only one local semen producer (KAGRC) in Kenya. There is nothing in policy preventing new entrants. The monopoly status of KAGRC has been attributed to the significant investments (about USD 3 million) required to set up a competitive stud and the risks associated with competing against a government-owned, highly-subsidized entity. However, as alluded in the previous section, at least two private players have obtained licenses and developed business plans to invest in semen production.

Perhaps due to lack of competition, the KAGRC stud is, on many fronts, an inefficient operation[13]. A mature bull has potential of producing up to 100,000 straws a year (ABS global report 2006)[14] instead of an average consistently less than 10,000 straws per bull achieved at KAGRC. Judged against its own targets, KAGRC appears to be doing rather well: For example, it produced 78% of its targeted 820,000 straws of semen (Republic of Kenya 2012)[15]. However these targets are too low and mask the huge potential that has not been achieved. Figure 5 shows the growth trend of locally produced semen since 2005. Viewed against the latent demand, this growth is very modest.

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13 Personal communication with farmers, researchers and businessmen involved in AI

14 Major advances in globalization and consolidation of the artificial insemination industry J Dairy Sci. 2006 Apr; 89(4):1362-8.

15 Agriculture and Rural Development Sector Report 2012 – This report by Treasury shows the medium term expenditures to 2014/2015 and captures the key performance indicators of the sectors

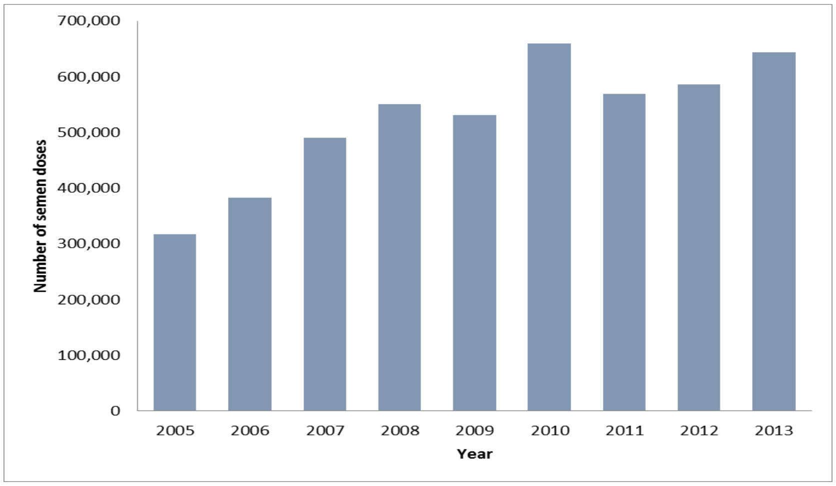

Figure 5: Doses of semen produced locally (2005 – 2013)

Semen importers: There are about 45 semen importers in the country – although this number fluctuates. Semen import which begun in the early 1990's by the World Wide Sires East Africa (WWS-EA) has led to an increase in availability and choice of semen in the market. Figure 6 illustrates the increasing trend of the quantity of semen imported rising to 365,000 straws in 2013. Most of this semen (31 per cent) comes from the USA with Netherlands and Canada contributing about 9 percent each. This simply reflects the affiliation of the major local semen importers who have distributorship deals with large semen companies based in North America.

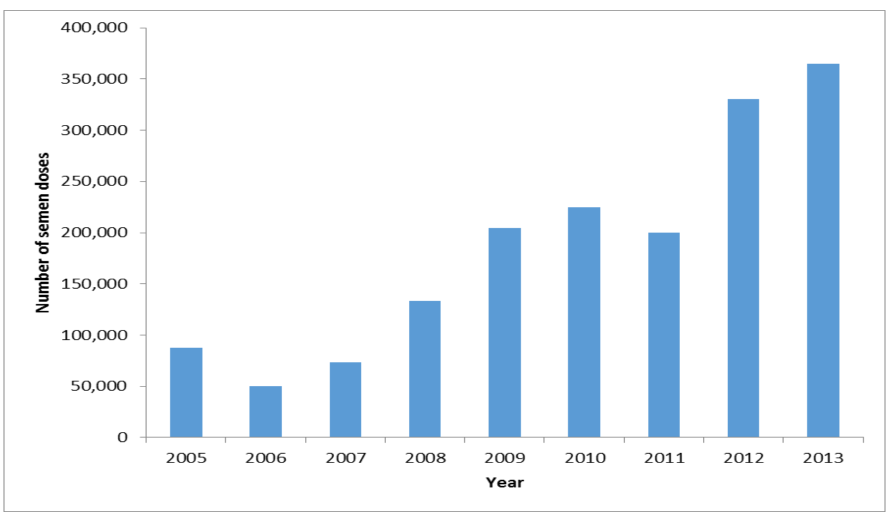

Figure 6: Doses of imported semen (2005 – 2013)

Source: DVS/ Central AI Station annual reports, 2005 – 2013, compiled by the authors

Semen distributors - Semen distribution agents who sell semen and liquid nitrogen to inseminators are shared (in terms of affiliation or business relationship) between KAGRC and semen importers. They are mostly located in the 'high potential' dairy districts (Figure 7 and Figure 8). The bulk of semen distribution agents are found in two main clusters, one north of Nairobi and the other West of Nakuru. These clusters broadly represent the two dominant smallholder dairy farming areas. The northern cluster is in the high-altitude, high production zone, characterized by increased intensification due to population growth and land pressure, and a preference for Holstein-Friesian breeds. Farmers in the western cluster, although also increasingly shifting to zero grazing, currently have more animals on semi-grazing regimes and tend to prefer Ayrshire breeds in order to increase production while maintaining hardiness[16]. The western cluster boasts a large proportion of the dairy animal population in Kenya. Demand for AI is positively related to price of milk in both areas, but land pressure is an increasingly important consideration in the northern area.

With the receding threat of trypanosomiasis and reduced threat to introduction of dairy cows increasing uptake of dairy in the coastal areas (Kilifi and Kwale) and parts of western Kenya (Kakamega, Bungoma, Busia, Vihiga, Kisumu, Homa Bay, Siaya and Migori), - see probability of adoption of zero-grazing in Figure 8: Probability of Zero Grazing:- there may be need to re-look at the semen distributor system with a view to enhancing availability of both semen and Liquid Nitrogen.

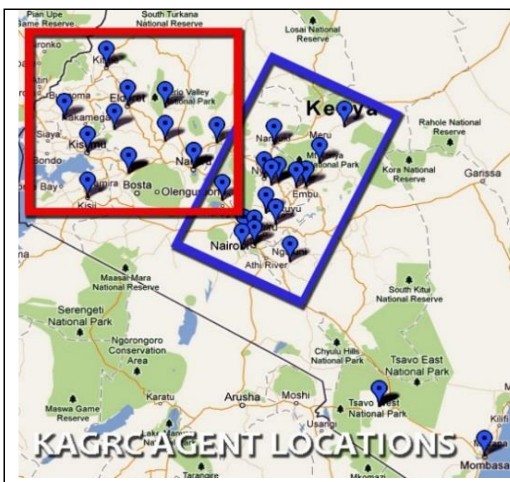

Figure 7: AI Agent Locations

Source: KAGRIC, *Map:* Google Maps

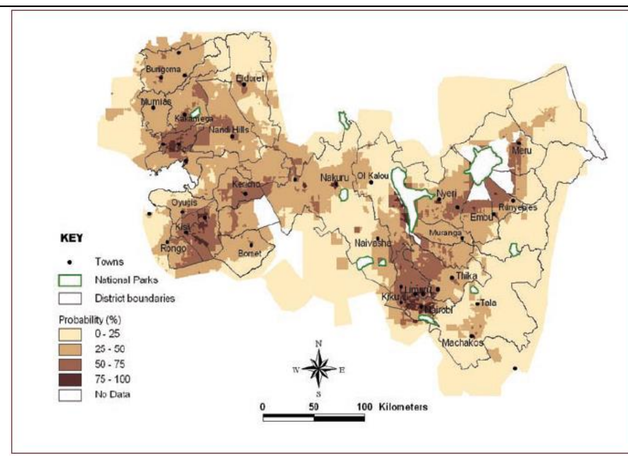

Figure 8: Probability of Zero Grazing:

Source: ILRI[17]

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[16] From interviews

[17] Targeting dairy interventions in Kenya; A guide for development planners, researchers and extension workers. R. Ouma, L. Njoroge, D. Romney, P Ochungo, S. Staal, and I Baltenweck. 2004. ILRI.

AI service providers – they are also known as arm service providers or simply, as inseminators. Currently, there are some 1000 licensed[18] (actual data in 2013 suggests the number is 950) AI service providers who serve consumers. To practice as an AI technician in Kenya, one must have taken an animal insemination course and obtained licensing from the Directorate of Veterinary Services. The training curriculum covers diverse competence (see Annex 3: Guidelines for training AI technicians) but AI service providers are not necessarily veterinary officers as many farmers assume, and are not by virtue of their AI license allowed to offer veterinary clinical services.

AI service providers can operate anywhere in the country under the supervision of the local Veterinary Officer, although in practice (and as can be expected of any business of this type) service providers tend to operate in defined geographical areas. Inseminators are required to submit monthly returns to their supervising vet. However, there are many 'quacks' who offer insemination services without licenses and under no supervision from vets. This poses some challenges for consumers, who may be unaware of genuine inseminators, and leads to high levels of malpractice and failure rates.

Other players – other critical players in the AI sub-value chain are Liquid Nitrogen production facilities. Currently most liquid Nitrogen is sourced from air separation by companies. The important players in Liquid Nitrogen supply include BOC, Welrods, ABS, and KAGRC. Also important is AI equipment supply and maintenance (e.g. by DeLaval, ABS, WWS-EA among others). Actors involved in training include local universities, AHITI, DTI and ADC.

The broader value chain typically includes players who act within the business environment. Therefore we consider the roles of industry regulators (government bodies), industry associations and consumer bodies (farmer associations) as critical to the general development of an inclusive, competitive sub-industry. Table 1, below, captures elements of the actual and potential roles that these groups could played in fostering a better industry.

We have also, in particular, highlighted the role of development partners and the projects they invest in. Often donor projects become market distorting, especially if they are designed to support on player. The World-Bank funded EAAPP project worked closely with KAGRC to develop its capacity. Similarly, the USAID-funded KDDP and KDSCP were developed with private importers ABS and WWS-EA as consortium partners. While we cannot comment authoritatively on whether and how these projects may have conferred advantage to specific companies; we believe that responsible donor investment should explicitly support wholesome market development.

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[18] Data from the DVS collected in 2013

The principles laid out in the Paris Declaration on Aid Effectiveness[19] which, for example, require that donors base their overall support on partner countries' national development strategies, institutions and procedures, could be a useful starting point for improving the intervention by external agencies.

[19] Paris Declaration on Aid Effectiveness (2005) - http://www.oecd.org/development/effectiveness/34428351.pdf

Table 1: Other actors and their potential or actual roles in improving consumer welfare

Stakeholder	Potential role in improving competition and customer satisfaction
Ministry of Agriculture (Department of Livestock Development) including agencies like KDB	The ministries role is in policy development and implementation. The Ministry could help foster business-friendly culture by setting the right policy. In addition the ministry regulatory functions should be closely tied to consumer welfare. It would help if the ministry saw the farmer as its ultimate client.
Kenya Veterinary Association (KVA); Kenya Veterinary Paraprofessionals Association (KVPA) and Kenya Livestock Technicians Association (KALT)	As professional associations with country wide networks the KVA, KVPA and KALT could provide leadership in setting up codes of practice for insemination and farmer service to improve welfare. These organizations could also punish errant members for malpractice. In addition, they can and should act as a lobby group for a strong, competitive environment for its members.
Breeders and farmers organizations (Kenya Livestock Breeders Organization, Kenya Dairy Farmers Federation etc.)	As producer and farmer organisations, KLBO, KDFF could help sensitize members, report experiences and lobby the industry for better services.
Training Institutions (AHITI, Universities, NGO's)	Develop curricula and train inseminators and other veterinary professionals to be more attuned to service orientation. In addition, these institutions should include entrepreneurship in the coursework to improve the viability and competitiveness of future AI business. .
Private practitioners	Private practitioners have the responsibility of observing the highest standards of ethical practice, following set rules for reporting and farmer service and practicing competitive behavior (avoiding cartel like behavior – for example, the LGS, an importer and producer association must not set prices to the detriment of farmers)
Regional Veterinary Boards	In order to improve the competitive environment, regional veterinary boards should collaborate in setting regional and regional industry standards, particularly to the extent to which they facilitate cross border trade and harmonize regulatory frameworks.
Print and electronic media	The print and electronic media can be an important ally in informing farmers of their rights – thus enhancing consumer awareness and empowering consumers. In addition, the media can expose anti-competition behavior and malpractice in service provision.
Development partners (including NGO's involved in livestock development)	Development partners could provide support to improve the industry. However, the support should be designed to achieve long term sustainability. Development support should develop local capacity and where practical enhance indigenous knowledge and skills. Development projects supported by donors should not cause market distortions or interfere with regulatory function.

2.3.2 Issues in the regulatory framework

Currently AI production and delivery is regulated by the government Department of Veterinary Services (DVS). However, the department of livestock production has a role in development of breeding policies.

Industry players have recently (i.e. Animal Diseases (Control of Breeding Diseases) Rules 2013) adapted a regulatory framework (breeding rules) for anyone interested in the production, distribution and delivery of semen and AI services. These rules are guidelines for approval of breeding centers, licensing of breeding service providers, health management of these breeding centers, welfare of animals in the breeding centers and prevention and control of breeding diseases in the centers.

Bull semen import is first self-regulated by industry - genetics importers and exporters under the aegis of the Livestock Genetics Society (LGS). Further, importers of semen are guided by regulations provided by the Kenya Bureau of Standards (KEBS) KS ISO 8607:2003 – Kenya Standard: Artificial Insemination of Animals. These guidelines (see Annex 2) indicate that for one to import bull semen, they must obtain an import permit from the office of the DVS and must have an original health certificate, duly completed in English and signed by a competent veterinary authority in the exporting country.

Any Kenyan can be authorized to import semen, and need not be an animal scientist or veterinarian. This obviously, carries the risk of allowing unscrupulous business people to carry on the trade. However, it also means that farmers can directly import – although they must then abide by rules governing actual insemination.

KEBS is mandated to ensure semen coming into the country, is of good quality and accepted genetic composition. But it does not have equipment and technical staff to analyze samples collected and has to rely on the certificate from the veterinary surgeon of exporting county to allow imports.

The DVS has the role of examining imported semen for disease and quality. However, the DVS does not have the capacity to evaluate imports and outsources the quality assurance role to KAGRC who analyze samples of imported semen. This creates a conflict of interest as KAGRC itself is a competitor in this business. We were not able to confirm if there is any entity mandated to do quality assessment on the semen that KAGRC produces locally. We note that this anti-competition practice has led to disputes and numerous complaints from importers. A case in point is a consignment by ABS/TCM Ltd deemed to be of poor quality by KAGRC but upon protest and independent verification at an international research centre was found to be acceptable. But this was after a needlessly large number of samples had been broken to provide material for testing leading to significant loss (personal communication with Nathaniel Makoni (ABS-TCM). Clearly, to address enhance transparency in regulation (with a focus on quality assurance), healthy competition and welfare of farmers (as the ultimate consumers), the roles, relationships and capacities of both the DVS and KAGRC need to be evaluated and redefined.

Despite these challenges, it is important to recognize that the government has put a framework to encourage importation of semen into the country. For instance, based on provisions of the VAT Act 2013, the East African Community Customs and Management Act and Customs and Excise Act; importation of semen and equipment designed for storing semen for purposes of AI is exempt from taxes. The extent to which these VAT exemptions are impacting on both volume and quality of semen imports into the country and the direct benefits accruing to farmers (as opposed to just the importers) need to be assessed.

At the local level, the county governments are being accused of anti-competitive practices as is the case of Murang'a County which has started offering low costs for inseminations to farmers hence lowering the costs to levels that make it unsustainable for other providers. The county government is currently charging Kshs 500 for AI to farmers which is half the cost charged by independent providers. The providers are therefore accusing the county government of anti-competitive practice in a market that should encourage private players.

3 Benchmarking: definition and process

This section summarizes the market inquiry and benchmarking approach. Our definition and process for the benchmarking followed a very specific methodology, which we briefly describe here.

3.1 What is benchmarking

We define benchmarking as the process of comparing performance measurements of an industry or sub-industry to standards that are widely accepted as best practice. In many cases a benchmark is only useful if the context and systems from which it is drawn are comparable to local situations. For instance, some very advanced technology and processes predominant in Europe and North America may be unsuitable for application in a developing country context. However, we have drawn relevant practice from these jurisdictions, where, in our considered opinion they represented realistic targets. In other cases we have relied upon practice from Asia, South Africa, Australia, Brazil and New Zealand which boast better dairy productivity and overall sector performance.

A benchmark needs to be aspirational. This has ruled out African neighbours whose dairy systems are not well-developed and perform worse than Kenya. Further, we contend that a good benchmark must be SMART – that is specific, measurable achievable, reliable and targeted – if it is to be useful.

The industry benchmarks we have chosen are proxies for important attributes that we are looking for in an ideal AI market – with respect to cost, quality, competition, consumer satisfaction. The relationship between the benchmarks and these attributes is hardly always direct, but is nevertheless, in all cases strong. For example, short calving intervals suggest an industry that is more efficient in getting animals pregnant and ultimately implies satisfied consumers.

Another important dimension of a benchmark is the issue of 'weight' or the amount of information it carries about industry performance. Not all benchmarks bear the same weight. For instance, the number of inseminations per successful conception is a composite benchmark that carries information about the delivery system, the farmer awareness and hence 'animal management', the semen quality, insemination quality, etc.

Too many benchmarks could be difficult to track and trace. Fewer, but 'weighty', benchmarks may be a more efficient way to benchmark an industry and monitor progress. Table 2 below, summarizes the key benchmarking parameters that we set out to develop for this study.

Table 2: Benchmarking parameters and indicators

Performance parameter	Indicators	Comments
Competition in the semen delivery value chain	▪ Number of local producers and ease of entry ▪ Number of importers and ease of entry ▪ Number and distribution of agents and inseminators – requirements for appointment. ▪ AI penetration rates ▪ Inseminations per conception	These factors go to the heart of competition in the delivery system. A significant number of players in each actor group or business-type suggests a competitive system. However, even with many players there could be practices that may be anti-competition (e.g. cartel-like behavior)
Consumer access to AI	▪ Number of different breeds and bulls on offer ▪ Geographical spread of inseminators ▪ Price ranges for AI services ▪ Level of consumer awareness	We distinguish between access and availability. Semen may be available but not accessible because of institutional factors, price, illiteracy etc. These matters go to the heart of consumer protection issues.
Quality of field delivery	▪ Timeliness of AI service provision ▪ Distance covered by AI providers ▪ Number of inseminations per conception (repeat rates)	Of critical importance is how AI is organized at the 'last mile'. This efficiency is also a factor of the regulatory framework which supervises inseminators. Competition and consumer satisfaction is affected by the quality of delivery.
Institutional arrangements supporting the AI delivery system	▪ Training, licensing and regulatory systems ▪ Recording, evaluation and feedback systems	Overall, the institutional environment will have direct impacts on the competitive environment, the quality of service and the customer (farmer satisfaction)

3.2 How we did the market inquiry and benchmarking

To develop an incisive knowledge of the AI market, determine the benchmarks and suggest interventions, we used a staged methodology. Our approach accumulated, triangulated and analyzed data in a systematic way. A significant amount of the information collected has been presented in previous sections of this report.

The process we have followed is detailed below:

1. **Step 1:** Identifying factors which underlie competition and inclusive growth through stakeholder consultation (including a stakeholder meeting) and literature reviews. This included a focus on understanding the actor landscape and roles. We also drew upon

primary data that we collected through a household and trader survey. We then analysed these factors to try and get deeper insight on each

2. **Step2** - Defining international best practice comparators –by reviewing dairy systems in a selected set of countries to unearth the practice.
3. **Step 3** - Characterizing the actual practice in Kenya– primary and secondary data was collected and analyzed to quantify the state-of-the-art in the country. The primary data was collected through household and trader surveys. We carried out a cross-sectional household survey in sampled sub-locations within three counties (Kiambu, Nyandarua and Kakamega).

   A detailed description of the methodological approach is presented in Annex 4 shows the sample areas. At the specific sub-locational level, systematic random sampling method was used to select households, where only households with cattle were included in the sample. We used a transect walk methodology to select specific households to include in the sample. Landmarks like churches, schools, bridges were identified and assigned random numbers and then a transect line sampling criterion used to determine a path for enumeration. This entailed randomly selecting two of the drawn random numbers (representing two landmarks) and drawing a line transect connecting them. Along this line every fifth dairy-farming household was selected for interview alternately from the left and from the right.

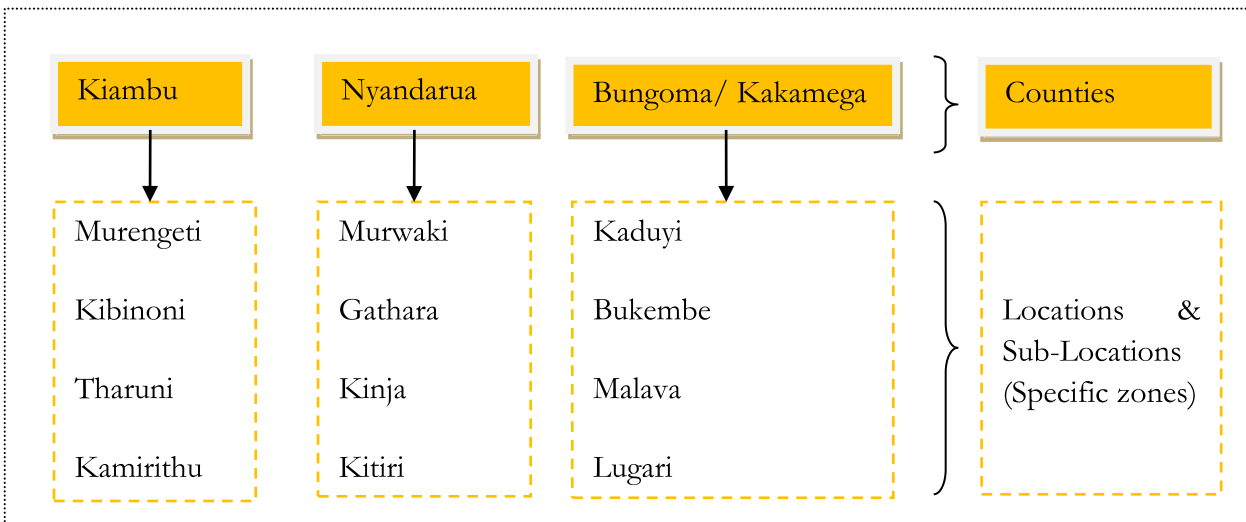

Figure 9: Schematic diagram of the study sites and sub-sites

4. **Step 4**: - we then analytically determined a series of interventions to drive the AI sub-industry forward, paying particular attention to competition and consumer welfare/satisfaction issues.

Annex 4 presents, in greater detail, the household and trader survey methodology used to collect critical primary information. In the next section we present key findings from these surveys, with particular focus on the four broad parameters (drawn from Table 2) that underlie a competitive and inclusive sub-industry as described above, namely:

1. *Competition in semen delivery*
2. *Access of AI to consumers*
3. *Quality of field delivery of AI service*
4. *Institutional Arrangements for AI Service Provision*

4 SURVEY RESULTS ON BENCHMARKING PARAMETERS

The methodology behind the data presented in this section is annexed to this report (see Annex 4: Details on methodology). We have organized the information according to the benchmarking parameters identified in section 3. We interviewed dairy farmers who, on average, rear 5 animals. But this herd size is extremely skewed by system of production. Smaller herds and in particular very few bulls are kept in the more intensive systems (due to the high cost of maintaining a bull that does not give milk on-farm).

We focus first on findings that touch on the state of competition in semen delivery, mainly from a consumer (farmer perspective), before moving to other aspects.

4.1 Competition in semen delivery

4.1.1 Natural breeding versus AI

We present a descriptive summary of breeding services and production system characteristics in Table 3. Nearly 50% of farmers practice zero grazing compared to other grazing systems. In purely zero grazing, AI is the more appropriate breeding method, since bulls would be expensive to keep. However, hired bulls are also a possibility, especially if the threat of inbreeding addressed. Farmers therefore have a practical, competitive choice between AI and natural mating in these systems.

While our data only covered three counties, the proportion of farmers who used bull services in the last 5 years was 41%. This figure, nationally, is reported to be much higher (closer to 80%) when more extensive production systems are considered. From our data, about 82% of farmers reported that they exclusively use AI instead of bulls in the first service of their cows. Failure of AI services leads them to use bulls. On the basis of observations by Otieno (2011)[20] that five years ago, breeding costs per animal were US$20 and US$80 for use of bulls and AI, respectively, it is clear that competition between natural breeding and AI depends on other factors beyond price.

Corroborating these findings, Baltenweck *et al.,* 2004[21], in a study of three districts found that farmers prefer AI service in view of its ability to maintain and/or upgrade their dairy herd but main constraints to use of AI services are low availability and perceived high costs. This study shows that

[20] Otieno, D.J. (2011). Economic analysis of beef cattle farmers' technical efficiency and willingness to comply with disease-free zones in Kenya. PhD Thesis, Newcastle University. Available online: https://theses.ncl.ac.uk/dspace/bitstream/10443/1248/1/Otieno.pdf.

[21] Baltenweck I.; R. Ouma; F. Anunda, O. Mwai; A. Wokabi and D. Romney (2004) Artificial or natural insemination: The demand for breeding services by smallholders. KARI conference Paper, 2004

the observed high use of natural service over AI recorded in previous studies may not reflect farmers' choice but the unavailability of the alternative service types, cost considerations, information gaps and misinformation amongst farmers, historical reasons among other constraining factors.

Conclusion on natural breeding versus AI: AI is more popular, even though not always more economical or advisable. Despite its popularity; poor access to, ignorance of and ineffectiveness of AI services may have worked to limits is reach and use. There is clear need to improve consumer awareness on the one hand and significant ramp up the numbers of AI service providers providing effective service in especially in areas previously considered marginal. These issues can be resolved somewhat by addressing bottlenecks that constrain the success of AI service businesses. Whereas entry into AI service provision market is relatively open, once basic entry conditions have been met. The biggest challenge after training is obtaining a semen tank (e.g. a 10 liter semen tank costs between KES 35,000 – KES 45,000) and a means of transport (usually a motorcycle).

Table 3: Dairy production systems and breeding services

Features		% of farmers (n=227)
Main grazing system used		
	Grazing only (free range or tethered)	6.2
	Grazing with stall feeding	19.2
	Stall feeding with grazing	25.9
	Zero grazing	48.7
Source of first dairy cow		
	Purchased	82.5
	Reared	17.5
Source of foundation/starting breeds		
	Inherited gift	11.9
	Project support	1.3
	Bought from large-scale private farm	4.0
	Bought from government farm	1.3
	Bought from smallholder farm	30.1
	Bought from cattle market	11.1
	Bought from individual private farm	39.8
	Loan from project	0.4
Source of replacement herd		
	Inherited gift	2.8
	Project support	0.5
	Bought from large-scale private farm	2.8
	Bought from government farm	1.8
	Bought from smallholder farm	16.5
	Bought from cattle market	3.2
	Bought from individual private farm	35.3
	Obtained as dowry	30.3

Features	% of farmers (n=227)
Upgrading of Zebu using AI	6.8
Intention with female calves	
Sold after weaning	6.6
Rear on-farm as replacement for breeding	77.9
Rear on-farm and sell when adult	13.7
Other	1.8
Intention with male calves	
Sold after weaning	54.0
Rear on-farm as replacement for breeding	3.1
Rear on-farm for replacement for commercial AI	3.5
Rear on-farm and sell for slaughter	35.0
Rear on-farm and sell for breeding	2.7
Other	1.8
Main mating method for first service	
AI only	82.4
Hired bull only	14.5
Own bull	3.1
Use of natural breeding/bull services in the last 5 years	40.9
Prefer imported semen	50.6

4.1.2 Sources of foundation breeds and the fate of calves

Very few farmers start dairy production through upgrading of local cattle; over 80% of farmers purchase their foundation dairy cows. This suggests a failure of AI on indigenous animals for upgrading purposes. The alternative sources of foundation breeds include about 40% of the farmers buying from individual private farms while another 30% of them purchasing from other smallholder farmers. This suggests the need to have an efficient AI system delivering quality semen to smallholder farmers.

Slightly over three quarter of farmers rear female calves on-farm as replacement for breeding, while half of the farmers sell male calves after weaning.

Conclusion on sources of foundation breeds and the fate calves: The findings in this section are logical. Female calves will go into milk production, possibly replacing ageing cows or adding to the milking herds while male calves will not yield returns. The results of this section, which inform some of the benchmarks later, suggest that umbrella recommendations will not do. Whether people use high quality AI, ordinary AI or bull services depends on their breeding objectives. From a consumer welfare point of view, information becomes key to guiding decisions about choice vis-à-vis pricing.

4.2 Access to AI services

From the farmers' perspective, access to AI services can be measured by indicators such as type of provider, number and type of bulls and breeds available to the farmer and cost of service provision. Some of these indicators are about choice, others are about availability while others are about affordability but they all affect access to these services.

4.2.1 Source of AI services

Our survey of dairy farmers shows that 93% of them receive the services from private AI practitioners (84% from individuals and 9% through cooperatives); only 5% indicated that they are served by government agents. However, this, upon enquiries, was found to be the result of government officials engaging in private practice since (officially, at least) the government does not offer AI services in the areas we sampled. The availability of AI services in peri-urban areas is much higher than in rural areas. We note that AI service providers charge for transport and the further a farmer is from their base, the higher the total cost of service. This militates against AI use, the further you move from urban centres where AI practitioners are based.

Conclusion about the source of AI service: Regulatory effort and analyses of competitive behavior should focus on the more used channel – private individual inseminators. Whereas it has taken about 25 years for the AI service profession to become ubiquitous in peri-urban Kenya, low numbers and rough terrain limits availability in rural areas. On our evidence, other models of service provision have not picked up as well. In order to expand access to AI services in rural areas, cooperative AI and farmer-driven or community based AI schemes could be promoted.

4.2.2 Pricing and payment for AI services

The average cost of each insemination varies from area to area with Kiambu recording the lowest at Kshs 1,181, followed by Nyandarua at Kshs 1,239 while Kakamega is Kshs 1,398. Two aspects of distance factor into the price of AI. How first is how far an area is from Kabete (where KAGRC is located) – which affects how much it costs to deliver Liquid Nitrogen and semen to the area. The second is how far then farmer's home is from the inseminator's office – which determines what she will be charged for transport. Another important issue is the density of farmers as inseminators can combine several insemination on one trip and reduce costs. As can be observed from Table 4 below, the AI service providers in Kiambu travel the shortest distance at 15.1 km which could explain the relatively lower costs for AI in the region while those in Kakamega travel the longest distance at 52.1 km which could be indicative of the difference in costs in the regions reviewed (Table 4 : Cost of AI per region

All the areas studied showed that farmers could either be in organized farmer groups like cooperative societies or operate in isolation. Farmers who are in cooperatives however seem to have an advantage when it comes to the cost they incur on AI since their charges in all the areas are lower than those who don't belong to cooperatives. Usually, farmer groups like cooperative societies engage AI service providers to serve their cows and heifers to ensure quality service is maintained in terms of getting quality semen with required genetic makeup, keeping records and competitive prices. Farmers who are generally in cooperatives are charged less by the AI service providers compared to those who are not. This is because the farmer groups are able to negotiate better rates for the farmers because of numbers. In Kiambu for instance, farmers in cooperatives are charged Kshs 1,000 as compared to Kshs 1,500 to those who are not. In Nyandarua farmers in cooperatives are charged Kshs 1,000 while those who are not Kshs 1,500 while in Kakamega the charge to cooperative members is Kshs 1,200 on average compared to Kshs 1,500 for those who are not members (Table 4 : Cost of AI per region).

Table 4 : Cost of AI per region

County	Average cost of AI (Kshs)	Average cost of AI for farmers in groups (Kshs)	Average cost of AI for farmers not in groups (Kshs)	Average distance travelled by an AI provider (km)
Kiambu	1,181	1,000	1,200	15.1
Nyandarua	1,239	1,000	1,500	17.2
Kakamega	1,398	1,200	1,500	52.7

On average, each insemination, using local semen, costs between Kshs 1,191 (AI providers' calculations) to Kshs 1,274 (based on farmer estimation). Slight discrepancies in these figures could be due to under-or over-estimation by service providers and farmers. But, generally the cost of AI at farm-level has declined considerably from a high of US$80 (about Kshs 6,400) that was charged five years ago (Otieno, 2011) – which is a cost that factors repeats; this result is attributable to the increased use of motorcycles rather than cars or other motor vehicles and the entry by more service providers increasing the degree of competition and farmer access to the services. In depth look shows that the cost of AI per insemination has remained stable over the last 5 years in the country, with a sampled outlook of the prices of AI in Murang'a and Kakamega showing that the price is stable with recent decline in Murang'a where costs are going down because of county government subsidies. Table 5: AI price variations from 2010-2014 shows the price variation over the last 5 years in the 2 areas with results showing price has been stable.

Table 5: AI price variations from 2010-2014

Year	Average cost of AI (Kshs) (Murang'a)	Average cost of AI (Kshs) (Kakamega)
2014	1,000	1,600
2013	1,200	1,500
2012	1,200	1,500
2011	1,000	1,500
2010	800	1,000

With a greater number of inseminations per month, an inseminator is more likely to accept a lower margin. The main payment method for AI services is per insemination (95% of farmers), while a significantly smaller proportion of farmers pay per conception. About 40% of the farmers usually pay in full after service, but nearly two thirds of them prefer instalment payments where they are allowed to pay up to half of the cost upfront (Table 6: Providers and payment methods for AI services.

Table 6: Providers and payment methods for AI services

Main provider of AI/breeding services	% of farmers (n=227)
AI private inseminator	83.7
AI government	5.0
AI cooperative	8.6
Own bull	1.4
Hired bull	1.4
Current payment method	
Upfront in full	23.4
Instalments	31.0
Full payment after service	39.6
Preferred upfront payment levels	
Full amount	15.3
Up to quarter	11.5
Up to half	62.0
Up to three quarter	11.2

Further review of AI operations show that farmers have little recourse if the inseminator does a poor job. If the cow does not conceive, then the money paid to the inseminator is 'lost' and a fresh payment must be made for a subsequent service at least 21 days later. On the other hand, AI service providers (78% in Nyandarua and 19% in Kiambu) complain of payment delays or non-payment by farmers. Services however seem to be improving especially with the onset of devolution which has brought in new developments in the AI sub-value chain with regards to price. A good example is the county government of Murang'a which is subsidizing AI in the county. The county government has in the last few months started offering low prices for AI to farmers with AI being carried out in a farmer's home costing KShs 600 and where the AI is carried in the roadside crushes established by the county government costing Kshs 500. The county government is making use of county government employees to provide the service and buying the equipment to promote dairy farming in Murang'a. The impact of this has been the recent reduction of private AI services to farmers to Kshs 1,000 in the area with some AI providers stating that it is increasingly becoming unsustainable to fully engage in this service.

Conclusion on pricing and payment systems: in a free market the price will be determined by market forces. With greater numbers of inseminations, we can predict a gradual decrease in price. However, this must be based on clear description of the product. AI service pricing should be clearly separated from semen price so that it is clear to farmers what the semen costs (given its quality) and what the inseminator is charging for arm service. This clarity will allow farmers to choose easily between inseminators. Farmers who are members of cooperative societies tend to be charged lower rates for AI and have an assured value for money compared to those that are not members. This means that farmer groups are a good avenue for safeguarding consumer rights and enhancing consumer satisfaction as these groups negotiate on behalf farmers and ensures better record keeping which results to reduction of inbreeding as proper tracking mechanism is maintained. It also ensures farmers are served by AI providers who are registered by the DVS resulting to a well-established consumer review and complaints mechanism to the ethical board of the association which the AI providers belong.

4.3 Quality of field delivery services

Another important aspect of analysis was the quality of field delivery which we have assessed on the basis of a set of metrics. We asked inseminators to tell us how they judged their services compared to other inseminators within their locality. On average, about half of the AI service providers felt that their competitors' services were comparable to those they (the respondents) were providing in terms of affordability, availability, reliability, success rates (chances of achieving conception after an insemination) and professionalism in service provision (Table 7).

Table 7: Comparison of competitor services with providers' services

Parameter	better	comparable	worse
	% of AI service providers (n=81)		
Affordability	24.7	65.4	9.9
Availability	39.5	45.7	14.8
Reliability	35.9	47.4	16.7
Success rates	32.9	46.1	21.1
Professionalism in service provision	33.8	55.8	10.4

4.3.1 Intensity and geographic coverage of AI service provision

On average, each AI technician provides services to 50 farmers per month, but with an extremely wide variation (a standard deviation of 40), suggesting that some inseminators are doing extremely well while others are struggling (Table 8). Our data shows that about half of the AI practitioners serve between 10 to 50 cows per month, while another 27% serve 50 to 100 cows per month (Table 9). The distance between nearest and farthest farms range from 0.7 to 30km. There is considerable competition in terms of number of providers on the same clients; an average of 7 AI providers overlap in terms of clients served.

Table 8: AI service providers and distances covered

Parameters	Mean	Standard deviation
Number of farmers served per month	49.8	40.0
Distance to nearest farm (Km)	0.7	2.0
Distance to farthest farm (km)	30.0	28.0
Number of competing service providers	6.7	5.9

From our analysis, it appears that the most viable geographical area of coverage by an individual AI Technician must be an administrative 'Division' or larger. Less than 10% of AI service providers are confined within administrative 'Location' or smaller areas. But even within their geographical areas of operations, service providers do not serve all the farmers. A large number (43%) estimated that they serve less than 25% of all the farmers that they could serve in their areas of operation (Table 9). In addition, 53% of AI service providers in Nyandarua and 34% in Kiambu reported that they are overwhelmed by the number of farmers to be covered. We note that, perhaps because of the relative unpredictability of the AI business, AI providers are also engaged in other income generating activities that compete for their time; 47% in Nyandarua and 17% in Kakamega are involved in dairy farming, while 27% in Kiambu are agro-vet dealers.

Conclusion: These data suggest room for competition – the market is still wide open and there is considerable overlap in geographies and farms served by AI practitioners. There is also notably wide variability in the numbers of monthly inseminations per inseminator. This variance calls for further investigation. We hypothesize that this difference is due to differences in quality of service as perceived by consumers and pricing. However, this possibility also implies that gaps in quality of service should be addressed through feedback systems with farmers that would allow the regulator (DVS) to implement remedial action.

Table 9: Geographic coverage and number of animals served by AI providers

Parameters	**% of service providers (n=81)**
Normal area of operation by AI service provider	
County	25.1
District	32.1
Division	35.8
Location	2.5
Sub-location	2.5
Village	1.2
Need permission to provide AI services outside normal area of operation	4.9
Proportion of farmers served in the normal area of operation	
< quarter	43.2
Between quarter to half	45.7
Between half to three-quarter	8.6
More than three-quarter	1.5
Number of cows served by AI providers per month	
< 10	7.4
10 – 50	49.4
50 – 100	27.2
100 – 500	14.8
500 – 1000	1.2

4.3.2 Number of inseminations per conception

Inseminations per conception as an indicator of system performance carries a lot of weight since it is an indicator of efficiency in both service, information and quality. Farmers reported that, on average, 1.86 inseminations are needed per conception in their herds. The conception rates however, vary across the study sites: it was found that on average Nyandarua has the best conception rate (1.6 inseminations per conception). Farmers in Kakamega and Kiambu reported higher inseminations per conception; 1.92 and 2.07, respectively. Though unexpected, the high number of inseminations per conception in Kiambu (a peri-urban county with close proximity to the capital city, Nairobi) could be due to high demand for AI service that overstretches service providers' ability and possibly resulting in tendencies to low quality service in the rush to cover more animals and/or farms. This is supported by observations in previous studies that show infiltration of AI service provision by 'quacks' who often interfere with semen quality through dilution (Irungu et al., 2006)[22].

Conclusion: In general our figures (the average of 1.86) is better than the national average from other studies which point to a 2.3 inseminations per conception rate. This is likely because of our focus in areas with significant dairy tradition. We believe that a razor-sharp focus on fluctuations in inseminations per conception will be a good indicator of competition and consumer welfare in the AI sub-industry because a lower rate implies faster inseminations and a lower cost of breeding to the farmers.

4.3.3 Heat detection and timeliness of AI service provision

Proper heat detection for instance through the use of heat detection calendars and timely insemination (within the same hour of heat occurrence) are crucial for conception to occur in dairy cows. However, only 14% of the farmers sampled reported that they use/know about the heat detection calendar. Over half of farmers usually contact AI providers within the same hour when a cow is on heat. Slightly over 70% of the farmers reported that the AI providers do not respond until some hours later in the day (Table 10). This is the correct practice, even if the farmers do not understand it. Insemination is optimally done roughly 12 hours after the first signs of heat. The lack of knowledge on heat detection among farmers contributes to repeat inseminations because unscrupulous inseminators seeking to re-coup transport inseminate anyway, even when it is clear that insemination is not warranted. This would happen less (if at all) if farmers were more knowledgeable.

Conclusion: It is clear that a knowledgeable consumer can help improve competition. If farmers know all they need to know about AI, their rights and options; they would not be easily deceived by private players bent in making a quick buck. We address consumer information and awareness in the recommendation section.

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[22] Irungu, P., Omiti, J. M. and Mugunieri, L. G. (2006). Determinants of farmers' preference for alternative animal health service providers in Kenya: A proportional hazard application. Agricultural Economics, 35(1): 11-17.

Table 10: Timeliness of AI service providers

Parameter	% of farmers (n=227)
If cow is on heat when is AI provider contacted	
Within same hour	54.9
Same day	37.4
Next day	1.7
Other time	6.0
When AI technician visits farmer to provide the service	
Next day	3.4
Same day	72.0
Within half day	19.6

About half of the AI technicians also confirmed that their response to farmers' calls for inseminations is usually variable and delayed. Although 84% of the AI technicians reported that they usually confirm that cows are on heat before insemination, about 5% of them appear to engage in professional misconduct by inseminating cows that have not shown heat signs (Table 11).

Conclusion: Effective monitoring and penalties are necessary to deter misconduct. Misconduct, as we have already seen includes inseminating too early or too late; inseminating already pregnant cows or inseminating without clear evidence of heat (from farmer or inseminator observations) or in general, inseminations carried out when it is clear, from a professional standpoint, that such insemination will not result in pregnancy.

Table 11: AI provider's response to farmer's call to inseminate cows

Parameter	% of service providers (n=81)
When does the provider visit the farm when called to inseminate	
Highly variable	48.1
Next day	2.5
Same day	25.9
Confirm heat before insemination	84.0
What does the AI provider do in case the cow is not on heat	
Doesn't inseminate	88.9
Inseminates the cow	4.9

4.3.4 Facilities, methods and hygiene in insemination

About 80% of the service providers use both small and medium sized straws for insemination. Up to 84% of the service providers use thermometers to check temperature before thawing the semen and three-quarter of them use the counting method to check thawing time. Further, three-quarter of the providers insert semen into the body of the uterus during AI. Slightly over 50% of them insert the insemination gun after emptying the rectum while rest do it before emptying the rectum. In addition, more than three-quarters of the service providers ensure hygiene practices during AI such as use of protective coat, disposable gloves, cleaning and disinfection of equipment. However, only 42% of them clean and disinfect their footwear between farms – this could possibly lead to high levels of infections across farms (Table 12).

Conclusion: The high variability in what inseminators do while at farms is troubling. These statistics re-emphasize the need to develop clear codes of practice regarding the sequence of procedures that should be followed while carrying out inseminations. In addition, it should perhaps be a requirement of licensing that AI equipment is inspected for quality and proper functionality on an annual basis.

Table 12: AI delivery methods and hygiene

Practice	% of AI service providers (n = 81)
Type of straws used in insemination	
Mini	11.1
Medium	3.7
Both mini and medium	81.5
Other	3.7
Method of checking temperature before thawing	
Thermometer	84.0
Finger	8.6
Other	6.2
Not at all	1.2
Method of checking thawing time	
Stop watch	18.5
Counting	77.8
Other	3.7
Where semen is usually deposited during AI	
In cervix	9.9
Body of uterus	74.1
One uterine horn of uterus	8.6
Both uterine	3.7
Other	3.7
When insemination gun is inserted	
Before emptying rectum	46.9
After emptying rectum	53.1

Practice	% of AI service providers (n = 81)
Hygiene practices during AI	
Use of protective coat	79.0
Use of disposable gloves	100.0
Cleaning and disinfection of equipment	80.2
Cleaning and disinfection of footwear between farms	42.0

4.3.5 Record keeping

Records are absolutely essential for quality control and performance measurement. The AI service providers keep various types of records, with over three-quarters saying that they keep records on number of times a farmer is served and number of successful conceptions. These records are supposed to be transmitted to the district veterinary officers, other AI providers, cooperatives and the Ministry of Livestock (Table 13). But anecdotal evidence from stakeholders suggests that, contrary to the assertions by inseminators, record keeping and filing of returns has been dogged by inefficiency, non-reporting and failure to analyze and feedback results to stakeholders.

Conclusion: Effective competition requires that AI performance information is shared with all the concerned stakeholders, i.e., to reduce information asymmetry. In this case, there is no evidence that AI providers and the DVS avail feedback to farmers. This limits farmers' decision making ability for instance on choice of service providers.

Table 13: Types of records kept by AI service providers

Record type	% of AI service providers (n=81)
Number of times farmer is served	76.5
Number of successful conceptions	81.5
Number of failed conceptions	71.6
Health and management records	42.0
Payment schedule	63.0

Three quarters of AI service providers stock semen while the rest buy upon order. The semen is usually stored in liquid nitrogen containers. However, most providers complained that liquid nitrogen cannot be easily obtained when needed because Liquid Nitrogen distributors are stationed far away. Generally, distribution of semen and related services is concentrated in areas nearer Nairobi and other urban centers.

Conclusion: The liquid Nitrogen cold chain has emerged as a clear constraint to efficient delivery. To help protect farmers, a system to monitor regularity of Liquid Nitrogen top-up purchases by inseminators could help. But such efforts must be supported by investments in production and transport of Liquid Nitrogen. We make further suggestions on cold chain improvements later in this report.

4.4 Institutional arrangements for semen delivery

We have defined institutions broadly to mean 'rules of the game'. So this carries the meaning of established norms of practice or codes of relationship. Institutional arrangements therefore have an important bearing on how competitive the semen market is and how efficient AI services are.

4.4.1 Choice of breeds and bulls

Competition in AI service provision requires free interaction between demand and supply, including the freedom to choose service providers and sharing of decision-making power. More so, the consumer (in this case the farmer) must have considerable room to decide the kind of semen to be used on his/her cows. Our sample suggests that this is not an issue since about 81% of farmers reported that they usually decide which breeds and bulls should be used in inseminating their animals, while the rest depend on decisions made by AI technicians (Table 14). However anecdotal evidence suggests that while farmers may ask for the breeds (e.g. Friesian or Ayrshire) by referring to their colors, they have scant information on the actual bulls, and even less knowledge about the genetic quality of the animals that they chose.

Conclusion: The choice of breed and bull must remain the farmers' prerogative. This is a clear consumer welfare issue. A truly competitive environment will support farmers to make their own choices on products – and this allow appropriate quality to prevail.

Table 14: Choice of breeds

Who decides breeds	% of farmers (n=227)
AI technicians	18.7
Farmer	81.3
Request for pregnancy confirmation test after AI	35.7
Request for AI services individually (not as groups of farmers)	95.0

4.4.2 Organization of AI services

Sourcing and managing insemination as a group could reduce costs significantly and increase uptake. This is because of economies of scale and institutional rationale for groups, which bring down transactional costs of AI service provision. Farmer groups might share a Liquid Nitrogen tank and buy Liquid Nitrogen together. They could also synchronize their cows for AI service at the same time and pay lower arm service and transport costs. However, it was noted in the survey that nearly all farmers usually request for AI services as individuals rather than through groups (Table 14). Moreover, only 6% of AI practitioners belong to AI cooperatives/groups. Structuring AI service provision in group or cooperative approach would help streamline the services and reduce overhead costs.

Another important element of AI service is the practice of pregnancy diagnosis (PD), before and after service to confirm effectiveness of service. It is not clear, if and what proportion of inseminators conduct PD before insemination but our results suggest that from this sample, only 36% of the farmers routinely request for such tests after AI service. Without post service diagnosis (and without effective recording and reporting systems) service providers are not under sufficient pressure to deliver quality services. The lack of competitive pressure from farmers could be partly responsible for delayed response by AI providers and the consequently the high number of inseminations done per conception.

Conclusion: the evidence of this sub-section offers further insight into how AI service delivery might be improve. Group AI and PD are institutional and technical innovations respectively cost reduction and better quality services. But they are used dismally.

4.4.3 Skills competence of service providers

Up to 94% of AI practitioners surveyed have some AI-related skills acquired through training in animal science (mostly at Animal Health Training Institutes – AHITI). None of them has specifically undergone refresher AI training. This is a surprising result, because of the fast paced technological advancements in the cattle breeding sector to include sexed semen, embryo transfer, synchronization, heat detection technology among others.

Conclusion: While about 36% of the AI providers interviewed have over 10 years' experience while another 22% have practiced AI service provision for between 6 to 10 years; competition in the sub-value chain would be enhanced if the impressive years of service are blended with regular AI-specific professional 're-tooling' and refresher training.

4.4.4 Mode of transport

Nearly 90% of the AI service providers use motor cycles as the main mode of transport to the farms (Table 15). Motorcycles are relatively cheaper to use (than vehicles) and can be driven through rough farm terrains that cannot be easily accessed through other motorized means of transport. Thus, use of motorcycles increases competition since more farmers can be reached across a wider geography. In addition, then typical insemination material can be easily carried on motorbikes.

Table 15: Transport by AI service providers

Mode of transport to reach farms	% of service providers (n=81)
Bicycle	1.2
Walk	2.5
Car	4.9
Motorcycle	88.4

4.4.5 Legal requirements for AI service provision

The AI service providers surveyed reported that the key legal requirements for participation in the AI service provision are a professional certificate of practice, registration by the national/county veterinary officials, and business licenses from county government offices. Across the three sites, less than three-quarter of service providers believe that business licensing is important; this points to the possibility of unregistered providers operating in the field and confirms results from KDDP and SDP studies which encountered hundreds of 'illegal' inseminators serving animals across the country.

The DVS needs to enhance monitoring of AI service delivery (especially in Kiambu County, where less than half of operators consider licensing to be important). Further, it is surprising to note that occupational insurance certificate which is an important aspect in AI provision is not considered to be a requirement in Kenya. It is also important to note that some county governments zone or restrict participation in AI service provision by those from outside their counties. This limits competition in service provision particularly in Kakamega and Kiambu (see Table 16). It is not clear, to what extent, this exclusionary practiced by counties across the country.

Conclusion: a facilitating licensing regime for AI service providers that is uniform across counties would be the more desirable outcome

Table 16: Legal issues in AI provision

Legal requirement	% of AI service providers			
	Nyandarua (n=32)	Kiambu (n=26)	Kakamega (n=23)	Total (n=81)
Professional certificate of practice/ registration	96.9	100.0	100.0	98.8
Business license	75.0	42.3	69.6	63.0
Occupational insurance certificate	0	0	4.3	1.2
Taxes/levies	0	0	4.3	1.2
Zoning by AI practitioners	0	3.8	13.0	4.9

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5 Benchmarking Kenya's AI performance with standard practice

In section 3 we defined benchmarks and presented the broad market attributes that we wanted to benchmark and in section 5 we have summarized findings from research as they related to these four attributes; semen delivery, consumer access, quality of service and institutional arrangement.

We now juxtapose and compare domestic practice with the best practice globally. In addition, we have carefully carefully selected benchmarks that are achievable in Kenya, taking cognisance of the best practice from various countries (where we could obtain reliable data). Where we have seen that a parameter being used in an advanced economy is not relevant, achievable or workable in Kenya's context, we have disregarded it.

The unavailability of reliable data from many countries limits the proper use of benchmarks. In Africa, only South Africa has reliable data and an advanced enough dairy system from which we could borrow. We also use both quantitative and qualitative benchmarks, where they apply. In some cases an ideal system description or process is enough, whereas in other cases data is provided.

5.1 Facilitating healthy competition in semen delivery

In order to improve the competitive pressure, and along with it increase efficiency in bull semen production, we propose opening up the space to private sector investment. Currently, only KAGRC produces semen locally but there are advanced entry plans that may increase number of private investors in the industry. But in speaking to the investors, they cite a number of challenges including slow response to request letters, difficulties in securing import permits to bring in bulls. It is therefore important that legislation and guidelines are published to make the process of investment predictable.

In the more advanced dairy systems, breeding services (including semen production and delivery) are considered private goods. Table 17 provides a comparative status analysis on the ownership of semen production companies. We note that advanced dairy systems (India, US and Australia) are characterized by predominance of more than one private sector bull semen production. The same is true for South Africa, Brazil, Canada, and New Zealand among others.

Table 17: Ownership of bull semen production

Parameter	Kenya's current performance	Selected comparator country	Chosen comparator benchmark
Number of privately owned semen producing companies (bull stud companies)	0	India – 42 USA – 5 Australia > 20	Should have at least 1 private sector player within 5 years[23]
Number of public sector producers of semen	1	India – 7 USA – 0 Australia – 0	May retain the current public sector player – but commercialize operations and de-link from DVS

Notes on bull ownership benchmark:

1. **USA** - As the AI industry in the United States evolved from regional to national to international businesses, the industry simultaneously went through various consolidations, acquisitions, and mergers. A noticeable change from 1981 is the reduction in the number of major AI companies in the United States. In 1981, 11 AI companies produced 90 percent of the semen processed in the United States, as reported to US National Association of Animal Breeders (NAAB). Today, that same 90 percent of the semen produced and reported to NAAB is from only 5 AI companies. These 5 companies include 3 large cooperatives (Select Sires, Genex Cooperative, and Accelerated Genetics), 1 privately held company (Alta Genetics, with ownership in the Netherlands), and 1 publicly traded company (ABS Global, traded on the London Stock Exchange as Genus plc). (Source, Funk, 2006)
2. **India** – India has 49 semen collection. Seven of these are controlled by the public sector organizations including 3 by the National Dairy Development Board (NDDB). The rest (42) are run by cooperatives, NGO's etc. However a Central Monitoring Unit manages the organization of AI and the system is heavily subsidized by the Indian Government (Source NDDA, India).
3. Only **South Africa** has a privately owned semen production and AI company in sub-Saharan Africa (Taurus Genetics)

The semen industry has moved from progeny testing to genomic selection[24] in recent years but there is a big misconception amongst farmers that genomically tested bulls necessarily means there are genetically superior [Table 18].

[23] 2 private firms have registered to start. However the huge capital investment required- estimated at $3,000,000 and lack of human capital has slowed the process. This is despite registration 2 years ago. We need to come up with mechanisms to assist in ease of access of finances for this and training of geneticists and animal scientists to facilitate operations of a private player. If operations do not start, it shows the business environment is not conducive for private players.

Table 18: Improving the quality of genetics

Parameter	Kenya's current performance	Selected comparator country	Chosen benchmark / market target
Number of proven/ progeny tested bulls per year average last 5 years	None?	**Brazil** - 16 – 19 bulls a year (dairy cattle population 40 million) **India** – +700 (dairy cattle population 119 million) **South African** company, Taurus progeny tests an average of 15 jersey and 25 Holstein Friesians annually, although this number is going down with genomic selection	A proper, industry driven progeny testing system that evaluates at least 5 bulls annually
Genomic selection	None	Genomic selection done by: USA & Canada (N.A.) Collaboration New Zealand (LIC) Netherlands (CRV) Netherlands (CRV) Australia (ADHIS & co.) Denmark and Sweden (Viking genetics)	It is cheaper, more accurate and faster than traditional selection approaches. Industry associations such as the LGS should pursue this approach in place of the outdated bull purchase and contract mating schemes
Semen quality standards, assurance and testing procedures	The DVS has outsourced testing for motility and disease to KAGRC	OIE published standards (Chapter 4.5) on management of semen extraction and handling	Adapt OIE chapter 4.5 requirements Capacitate DVS to provide services

Notes on quality of genetics benchmarks

1. We have adopted a free market system where farmers make their own choices on breeds and bulls. This is what happens in advanced systems and it means that limiting the breeds offered to different agro-ecological zones is not recommended. All that farmers need is information to help them make the right choices.
2. Farmer capacity to make appropriate breed/genotype choices that match their respective circumstances should therefore be enhanced through provision of relevant breed

[24] Genomics is defined as the sequencing of genetic material in cattle DNA, and using that information to better understand how genes are expressed, controlled, what relationships they have with each other, and where they are physically located on the chromosome
Progeny Testing: It is used in the breeding of both plants and animals, but is most commercially important in animal breeding to determine the true breeding value of an animal esp. males which are used extensively for propagation of best germplasm

information by researchers and extension agents. Government or private AI service providers and NGOs must not make blanket choices for farmers or 'promote' certain breeds, as is currently often the case.

The farmer cooperative movement could play a critical role in providing feedbacks on breeding performance

5.2 Increasing consumer access to AI services

Depending on what study one looks at, AI accounts for only between 18 and 27 percent of all inseminations in Kenya. These studies also suggest that AI is predominantly used only in first inseminations. The balance of inseminations are carried out through natural services (73 percent – 82 percent). In most developed countries the AI penetration rate in dairy is above 50 percent. In the presence of a good bull service, this statistic is of no concern. However, in the absence of such a market – as is the case in Kenya – then a greater penetration of AI would be necessary. We are proposing a target, moving from the current (18 – 27 percent national penetration) to a 50 percent penetration rate in 5 years. The implication of this benchmarking is that the number of straws sold must more than double within the same period.

Table 19: Benchmarking AI in Kenya versus other countries

Parameter	Kenya's current performance	Selected comparator country	Chosen benchmark / market target
Dairy AI penetration rates	Kenya – 20% (various sources)	US – 50% Sweden > 90% New Zealand – 76% India ~ 12%	Target 50% penetration in 5 years
Number of doses available (local production + net imports)	Total semen availability 1,005,000 comprising 640,000 (local production) + 365,000 (imports)	International comparisons are not useful since this figure depends on dairy herd sizes, local production, production systems etc.	Target benchmark calculated as: 2,625,000 straws by 2015 based on a doubling of penetration to 50% [25]from the current 20%

Notes on benchmark:

We note that not every farmer should necessarily use AI, and the following guideline should benchmark recommendations for AI development and promotion (Ouma/KDDP, 2004).

[25] The growth to by 30% is based on the recommendation of the Agricultural Sector Development Strategy – Medium Sector Investment Plan 2010-2015.

1. In some areas AI may not be sustainable and use of bulls and bull schemes may be more appropriate, although such schemes need to be vigilant to avoid problems of disease and long-term sustainability without external support. These areas include:
    - Where the disease challenge is high and farmers don't keep dairy cattle
    - Where the market for milk is low so farmers don't want to increase their milk production
    - Where the cattle density is too low to support viable AI provision
2. Some farmers could benefit from using AI services but do not use AI because:
    - They don't understand the benefits of using it and consider the price too high
    - There's no AI provider in the area
    - They had previous bad experience (repeats needed to achieve pregnancy)

   These farmers should be targeted through several channels:
    - Train the farmers on the long term benefits of using AI services
    - Lower its cost by channeling the supply through cooperatives and SHG to benefit from economies of scale and deliver AI services concurrent to the milk delivery
    - Improve the availability of AI services through:
        - Better semen and liquid nitrogen storage and distribution
        - Better training of more inseminators
    - Improve the quality of AI services by enhancing regulatory activities; including institutionalization of professionally based self-regulation by the AI providers associations.
3. High quality semen from high potential animals may not benefit farmers in areas:
    - Where farmers do not value the calf highly, because they do not rear their own replacements and where calf sale price is not affected.
    - Where farm level constraints prevent farmers managing animals to realize the benefits of the high potential.
4. Improving the penetration rate to 50% can be achieved through:
    - Improving on distribution channels to arid and semi-arid areas as there is huge demand and potential in these areas
    - Improving on consumer (farmer) relations which are critical
    - Improving access to farmer information which yields market power through working with milk cooperatives and county government officers since agriculture has been decentralized
    - Pushing for continuous commercialization of beef farming among pastoral communities so that they can demand AI service

5.3 Improving quality of field delivery of AI service

Quality of services offered to the consumers of AI service to farmers is very critical as it measures the extent the service meets consumer expectations. Indicators of this parameters include timeliness of service, number of inseminations per conception, distance covered by providers among others. This should enable the industry continuously improve performance level and service delivery. These are summarized in Table 20 and Table 21.

Table 20: AI service delivery system benchmarks

Parameter	Kenya's current performance	Selected comparator country	Chosen benchmark / market target
Structure of delivery mechanisms – i.e. how semen moves to the farmers	Currently about 950 registered inseminators who collect semen from distributors	**US, South Africa, Australia and New Zealand -** There is no network of inseminators providing services. Most insemination is by farmers, do-it-yourself. The rate of DIY AI is close to 100% and all farms inseminate their cows themselves. Every month representatives of semen companies top up the nitrogen **India** – about 50,472 registered AI provider	In the long term elite farmers should be trained in insemination to support farmers around them. Progressively, a DIY system of insemination is much more predictable, efficient and cheaper.
Cold chain efficiency – liquid Nitrogen supply system	Fluctuating supply – main supply BOC gases to KAGRC which resells to distributors	Two models are observed in the west: 1. Many companies producing and supplying liquid nitrogen to farmers as is the case in Australia 2. Semen companies refilling the tanks of farmers in DIY systems on periodical basis	High electricity costs and lack of diversification of LN makes small-scale production highly uneconomical in Kenya. It is recommended that semen companies pursue vertical integration to include the regular distribution of LN to farmers and inseminators.
Cost of liquid Nitrogen	From KES 199.75/liter up to KES 400/litre	**Botswana** – Kshs 196.8/liter **India** – Kshs 63.85/liter	The cost of liquid Nitrogen is driven by the high cost of electricity and losses during transportation. The supply will remain costly as long as electricity is expensive.

Parameter	Kenya's current performance	Selected comparator country	Chosen benchmark / market target
Total cost of insemination	On average costs Kshs 1191-Kshs 2300 per insemination for local semen (accounting for repeats and non-conception). Imported semen costs up to KES 10,000 depending on quality (Technician fee + other costs – 1250; Semen – 250) – Higher depending on bull quality.	**USA** – Kshs 3,724 (Technician fee – 649; Semen – 1,731; other costs- 1,344) – higher depending on bull quality. **UK** – Kshs 6,048 (Technician fee - 2,160; semen-2,520; other costs 1,368) **India** – Kshs 70.94-Kshs 141.90	Need to consider real prices and weight semen against Potential to move to conception based pricing
Inseminations per conception	2.3	Zimbabwe – 1.64 India – 1.35 New Zealand – 1.34 Ireland– 1.69 UK-	1.5

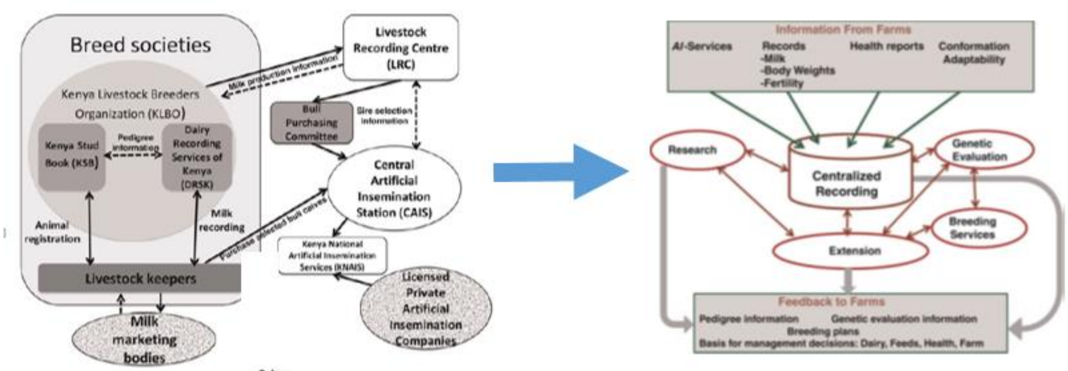
Table 21: Farm level reproductive performance targets

Parameter	Kenya's current performance	Selected comparator country	Chosen benchmark / market target
Average age at first calving	30.5 months	Brazil – 36.4 months India – 44.7 months (for indigenous breeds) but about 24 months for exotics. South Africa – 20.06 months Ireland – 26.6 months Australia – 24 months USA – 20 months	24 months
Calving intervals	17.5 months	India- 14.1 months South Africa – 13.02 months Ireland – 13.23 months UK – 13.47 months USA – 13.1 months	13 months (biologically a cow can give a calf every year)

5.4 Institutional Arrangements for AI Service Provision

Several issues in the institutional set up need to be resolved if the delivery of breeding services is to improve in Kenya, and if we are to be comparable to international standards.

1. The roles and responsibilities of the different organizations (DVS, KAGRC, KLBO, LRC, Breeding Societies, Private Semen Importers) involved in the organization and supply of breeding services need to be harmonized to avoid duplication of effort and enable information gathered to be used more effectively. In most advanced countries there are private sector led industry organizations that manage recording, animal ID, evaluation and feedback systems. The recording and feedback function in particular needs to be well organized if there are to be significant genetic gains and farmer satisfaction. Figure 10, below illustrates the transformation require: from a haphazard uncoordinated system to a predictable, self-sustaining system with feedback loops.



Current disjointed, largely private sector driven actor landscape with poor feedback system

A better-coordinated, self-sustaining, private-sector driven system with feedback

Figure 10: The transformation that should occur to a better coordinated recording and feedback system

(Adapted from Kosgey et al., 2011[26])

2. Further to the point made in (1.) above, recording and reporting of insemination is important for planning, control, monitoring and evaluation purposes. The process of reporting needs to be streamlined to ensure that it is accurate and to strengthen feedback mechanisms to those that need the information. There is need for a legal

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[26] Kosgey, I.S., Mbuku, S.M., Okeyo, A.M., Amimo, J., Philipsson, J., Ojango, J.M., 2011. Institutional and organizational frameworks for dairy and beef cattle recording in Kenya: a review and opportunities for improvement. Animal Genetic Resources © Food and Agriculture Organization of the United Nations 48, 1-11.

review to see if the laws on reporting are adequate. We recommend that Kenya joins and adapts international standards on recording developed by the International Centre for Animal Recording (ICAR, 2002, 2004[27])

3. The cattle semen industry needs to determine, which, between a predominantly Do-it-yourself (DIY) AI service delivery system (common in the North America and Europe) and a more efficient version of the current service provider driven system should be promoted. Regulations that make it difficult for farmers to inseminate their own animals or those of their neighbors are unnecessarily prohibitive. AI service is, strictly speaking, an animal husbandry exercise that farmers might undertake in the same way they spray or dehorn animals. The supply and refilling of Liquid Nitrogen is organized by industry groupings or the private sector in Northern dairy systems. Our context is much more similar to India's where smallholders are predominant in the AI system. In India, over 50,000 inseminators are active in addition to significant DIY AI. Most of these smallholders lack the knowledge and capacity to carry out insemination but could be trained.
4. Smallholders need to have access to individual inseminators' performance in order to make informed decisions. These records could be made available at the DVS office.
5. The regulatory role of the DVS needs to be strengthened to enable better supervision, planning and development of the breeding industry. The DVS should also focus on overall policy formulation, monitoring and evaluation. At the district level, the dialogue between private inseminators and government officers needs to be encouraged.
6. A more predictable cold chain should be developed, almost like a 'public good' for AI delivery. In DIY systems, it is representatives of semen companies who make monthly trips to refill farmers' semen tanks; thus maintaining the cold chain.
7. All stakeholders involved in training inseminators need to work together to develop a common syllabus/ curriculum so that it is acceptable nationwide. Anybody (training institutions that are duly registered by the ministry of education on the advice of the regulatory body) should be allowed to train as long as they are using an agreed syllabus and their trainees will be subjected to a common exam set and supervised by an independent body.
8. Licenses should only be issued to individuals passing the inseminator exams. Even if the training includes an understanding of physiological aspects the license should only authorize them to operate as inseminators.
9. The formation of associations of private and public inseminators needs to be encouraged to self-regulate the profession. The association would have the moral authority to exclude any "bad" inseminators, thus encouraging good ethical behavior. These associations could ensure that only honest/ good inseminators operate by publishing the list of inseminators who do not comply with the law so that smallholders get the information. Such efforts could reduce the cost of AI services by decreasing the number of repeats needed to achieve pregnancy.

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[27] ICAR. 2002. Technical series no 8. Development of successful animal recording systems for transition and developing countries, edited by J.B.J. Mäki-Hokkonen, T. Vares & M. Zjalic. Rome, Italy.
ICAR. 2004. Technical series no 9. Development of animal identification and recording systems for developing countries, edited by R. Pauw, S. Mack & J. Maki-Hokkonen. Rome, Italy.

6 Candidate interventions to improve competition and customer satisfaction

We summarize here interventions[28] that have the potential to improve the operating environment and transform the sector, bringing key metrics closer to good practice. Of particular importance is the question of interventions that will enhance consumer protection in the AI sub-value chain. Consumers need protection, *inter alia*, from the following; inappropriate genetics, poor quality semen (low motility/ dead semen), delayed insemination, overpricing and misinformation. Improving competition leads to better services for consumers, but regulatory safeguards also need to be strengthened to protect consumers.

However, it is important to note that the interventions we have outlined in this section often go beyond the confines of consumer protection and competition, precisely because these issues are interrelated with the broader development agenda for the sub-industry.

We start here by outlining potentially important roles that the Competition Authority of Kenya (CAK) could play in improving the market for semen in Kenya. However, these do not remove CAK's other roles that may be implied in the specific recommendations we make to improve the market for AI.

6.1 Some potential roles for CAK in streamlining the AI service provision environment

1. CAK should participate in, or commission, regular (rapid) assessments of the AI market to track developments in the competition environment and consumer issues. The dairy cattle semen market is undergoing significant structural changes with the impending entry of a second bull stud and rapid advances in breeding technology. New technology such as sexed semen, in vitro-fertilization and embryo transfer, as they are rolled out in larger scale, will raise new issues around consumer protection which need to be identified and addressed. In other words, regulation of competition will need to evolve with the increasing sophistication of services, including technological and institutional changes.
2. In general, dairy stakeholders appear to be unaware of CAK's mandate and the role that it could play in the sub-industry. CAK will need to develop greater outreach capacity to create awareness of its mandate and potential role in helping achieve a better more competitive industry. CAK-convened stakeholder forums for the dairy

[28] We note that a significant number of suggestions and recommendations have already been expressly or indirectly implied in other sections of this report

industry is one way of creating rapport and proactively engaging the industry in positive ways.

3. CAK could play an important role in triggering and coordinating corrective action by stakeholders, especially in cases where it is clear that flagrant disregard of consumer welfare has or is occurring. Or in situations where anti-competition practices are taking root, whether deliberate or inadvertent. Clarifying roles of critical industry players and dealing taking action to address possible conflicts of interest by value chain actors is an example of such corrective actions
4. The apparent lack of proper structures for complaints is a serious gap in the semen and AI services market. Since CAK is well versed with mechanism that could enhance consumer welfare and satisfaction, it could initiate Memorandum of Association (MOA) with government agencies that coordinate or participate in the AI sub value chain – including the DVS – to set up systems for receiving and responding to consumer complaints in a judicious manner.

6.2 Recommendations to facilitate greater competition in the sub-industry

One of the key findings of this study is that whereas there are many AI technicians (about 950 in 2013) in the country, this number is still far less than optimal. Further there is no strong competition at the production level. The policy environment for better AI services provision needs to hew very closely to private sector approaches. The ability of any private bull semen providers to grow rapidly depends to a large extent on the ability of companies to market and deliver their products efficiently. That, in turn is dependent on enabling policies and functioning institutions. The following recommendations are designed to help increase the competitive environment in the AI sub-industry

1. Commercialize the Kenya Animal Resource Genetics Centre (KAGRC) in order to make it independent of government grants and subsidies, allowing fairer competition with private players.
2. Remove all regulatory responsibilities delegated CAIS/KAGRC as long as they are also involved in semen production and sale.
3. Facilitate the operational entry of private sector bull studs to collect semen (already the stage for this is set to some extent with the acceptance by the government that semen production is a private business). The establishment of a bull is an expensive, and risky enterprise that requires patient funding, technical support and a helpful policy environment. Private investors are complaining of slow response to letters and lack of clarity on guidelines on bull stud establishment mechanism. The government can help unblock these 'roadblocks'.
4. Work with industry stakeholders to develop and demonstrate new business models can help spur innovation within the AI sub-industry. This activity can be performed

within the context of the innovation platform approach which we recommend below.

5. Supporting the flow of finance earmarked for the establishment of businesses in the dairy genetics industry and dairy sector at large. The lack of access to finance, in general for agriculture, inordinately affects the livestock sector which is seen as more unpredictable and subject to more risk associated with the long payback periods.
6. Support competitive market regimes for dairy products (especially the pricing system) to enable farmers earn commensurate returns that enhance their ability to pay for AI services.
7. Develop regulation to prevent unnecessary zoning of some areas by AI service providers. This will improve competition and improve efficiency in service provision.
8. Facilitate processes which help develop demand for AI (as opposed to use of bulls) in Kenya – to enhance dairy profitability for farmers and overall industry performance for the nation

6.3 Farm-level improvements

1. Facilitate farmers' training and information on heat detection (including use of cow reproductive calendars and other efficient technologies for heat detection.), record keeping, benefits of AI and other related information. Extension and advisory information should be designed to empower the consumer to interact more knowledgeably with AI service providers
2. Facilitate consultations with AI service providers and other industry stakeholders on how to implement instalment payment system for AI services and payments for conception rather than for insemination.
3. Train more farmers to implement do-it-yourself inseminations

6.4 Recommendations to improve AI distribution and service

1. *Promote bundling services for efficient delivery and supervision* - In previous sections we have noted the difficulty of providing stand-alone AI services because of lower than optimal numbers of insemination. AI services could be improved if they were bundled together with other services (animal health, advisory, recording and information, feeds supply, etc.). Bundling of services simply means providing a suite of services on the same platform, in order to increase efficiencies and reduce costs. With the reduced overheads, these services would be more affordable to the consumer; thus increasing access. In addition, bundling would make AI businesses more sustainable with multiple revenue streams.

   From the demand side, consumers (farmers) could also be better organized to buy in bulk and negotiate better terms (e.g. lower prices, staggered payment), thereby reducing cost and ensuring better quality. Still, despite these 'business opportunities', organizing a sustainable, scalable business model for this last mile delivery challenge for input service delivery has been an elusive challenge. However, there are a few examples of potential successful models:

a) Dairy hub model[29]- This bundled service approach brings together multiple enterprises that deliver farm supply and other services to the community. For example many dairy hubs in the rift valley, have developed around the collective cooling (Chilling Hub – CH) and marketing of milk but have also provided feeds, agro-vet supplies, advisory services, AI among other services. The hub model allows for economies of scale, reducing transaction costs, but also acts as a one stop shop. The hub is therefore an organizational approach as well as an intervention. With regard to AI service provision, the hub model provides avenues for centralized record keeping and the management of inbreeding. Typically a dairy hub begins with a milk cooler or a feed store and expands to provide other services. The main investments required in developing dairy hubs are in institutional development, including group development, facilitation, and organizational support.
b) Franchised, quality-assured systems: (e.g. the 'Sidai Model') which is composed of branded livestock service centres[30]
c) Innovative 'taxi-cab models' for control of AI service provision – where a centralized call center handles all farmer calls for service

Possible key implementing partners in Kenya: Heifer International under their East Africa Dairy Development Project and Technoserve

2. *Improving cold chain efficiency* - About 78% of the AI service providers in this study cited the lack of good supply of Liquid Nitrogen as a business constraint. In some cases, businesses had to import Liquid Nitrogen to sustain the AI businesses. Our research

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[29] For a case study of this model see: http://www.cop-ppld.net/fileadmin/user_upload/cop-ppld/items/Chilling_Hub_Case_Study_Final_4.pdf . Also see: http://www.disasterriskreduction.net/fileadmin/user_upload/drought/docs/2%20%20ILRI%20dairy%20EADD%20hubs%20Final.pdf.

[30] Sidai Africa is a social enterprise operating in the livestock sector in Kenya. The aim is to revolutionize the provision of livestock and veterinary services to pastoralists and farmers in Kenya by creating a more sustainable service delivery model. Founded in 2011, the company aims to establish a network of at least 150 franchised and branded Livestock Service Centres in Kenya by 2015. Each franchise is equipped to provide quality animal health products and professional technical advice to farmers and pastoralists. All Sidai centres are owned and run by qualified veterinarians, livestock technicians and other livestock professionals. Sidai guarantees the highest quality of products and services to our customers. Over time new products (vaccines and feeds) and new services (diagnostic tests, financial services and livestock insurance) will be introduced. (www.sidai.com)

also shows that farmers are paying more because of this inefficiency in the cold chain. Liquid Nitrogen is not only too expensive but not readily available.

The best way to deliver Liquid Nitrogen is when it is harvested as part of air separation processes. Companies that produce and sell oxygen and other gases would therefore produce LN more and efficiently. More specifically we recommend:

a) That industry stakeholder groupings (such as the Livestock Genetics Society (LGS)) and the Ministry of Agriculture explore Public Private Partnership with private companies (such as BOC gases and Welrods) to facilitate the manufacture and distribution of LN
b) A feasibility study, including a review of operations management be commissioned to look into the potential and viability of small scale decentralized LN storage facilities; producing LN is very expensive and perhaps such studies might look into any production processes or alternatives that would reduce cost and allow viable set-up of small-scale production plants in partnership with other users such as hospitals and labs.
c) Innovations in cold chain technology: partnering with research & development institutions to innovate better semen tank technology for both transportation and storage. In addition, technology that gives alerts when liquid nitrogen levels are dangerously low, will greatly improve the viability of semen that finally reaches the farms. Lastly, we recommend as part of the research, color coding techniques to indicate semen that may have been exposed for too long.
d) Efforts to lobby/promote dialogue with relevant stakeholders to support public investments in local county-level storage facilities for good quality semen.

Potential stakeholder partners: NARS system, IARCS, Private sector, NGO's and the GoK and County Governments

6.5 AI service provider supervision, training, re-tooling and certification system

We found that many of the AI service providers are neither properly certified nor licensed. And in the cases where they are properly licensed, they are not properly supervised. A cadre of efficient and effective AI technicians that are able to coordinate visits to reduce travel costs, improve efficiency in terms of time management and communications, and increase sales volumes and spread marketing messages will reduce costs to farmers and increase penetration of locally produced semen.

1. We propose as an intervention, an ongoing, and process to re-educate AI service providers and inculcate a 'service orientation'. The currently training program is highly technical and does not have a strong focus on entrepreneurship and soft skills.

Inseminators should also be trained on the economics of an AI service to avoid them setting up their businesses in areas that are not viable. In addition many of the AI service providers do not provide regular reporting of insemination; a factor which is made worse by a poor reporting system. These gaps require a constant process of re-tooling. We propose that AI service providers must as policy undergoes refresher courses at least once every three (years). This condition should be tied to the renewal of their licensing.

2. Only duly trained and qualified inseminators should be licensed. Any inseminator who can pass the single exam should be licensed irrespective of the training institute. Training should be based on a common, relevant and comprehensive curriculum (this has already been developed). The AI syllabus should be reviewed in a participatory way every 3 years.
3. Review the code of conduct for the AI service delivery to ensure effective penalties for misconduct, for instance, to prevent insemination of cows that are not on heat.
4. Inseminators should be licensed separately as inseminators so that farmers are aware of their role and do not over-estimate their abilities. In some cases farmers believe that all inseminators are trained veterinary officers. It is also important that inseminator licensing should be limited to a well-defined geographical area to facilitate easier supervision.
5. There will be need for regular convening of stakeholder forums to discuss necessary reviews/modifications of AI training curricula in various education institutions to align them with changing farmers' needs, industry evolution and market reality. Perhaps this process can be undertaken under the aegis of the innovation platform we propose below.

Potential stakeholder partners: The DVS (policy and regulation), the Kenya Veterinary Board (KVB) – registration, curriculum and training oversight. Training institutions (AHITI, universities, Agricultural training colleges, private organizations)

6.6 Develop an industry innovation platform

The innovation platform is a unique, participatory, inclusive, facilitated approach to developing actor consensus and action on common or systemic challenges and opportunities. The core assumption in innovation systems thinking is that challenges are essentially the result of institutional failures and/or inefficiencies. An innovation platform is a safe space for stakeholders to work together to solve industry problems. It is safe because it is usually facilitated and designed to allow trust, honesty, and openness, encouraging and supporting the emergence of often deep-seated, complex, underlying issues and solutions to be co-created by the platform membership. Under these circumstances, institutional dysfunctions and personality attributes that normally prevent real issues from being confronted and addressed are broken down. Players can then think outside the proverbial box and innovate. The actors collectively identify challenges, develop strategies and implement solutions together. For instance government officials and private sector are able to share frustrations related to policy and jointly work on solutions. Business competitors in the private sector are also able to identify areas for positive collaboration without necessarily compromising their competitive strategies.

We recommend the establishment of an industry innovation platform focused on genetics or with genetics as a key plank. This platform will be responsible for collective and continuous resolution of emerging challenges. Perhaps this platform could be developed from the Dairy Genetics Innovation Platform that was supported facilitated by the Bill and Melinda Gates Foundation over a 2 year period and created a slew of businesses to respond to industry challenges.

Key stakeholder partners: CAK, KMT, PICO-Eastern Africa

6.7 Develop recording, data management and feedback systems

AI works best if there is an efficient feedback system that shows how inseminators, farmers, breeds, bulls are performing both in terms of conception rates but also genetic quality. This M&E system allows for consistent improvement.

Reporting of insemination and failures is therefore important for planning, control, monitoring and evaluation purposes. The process of reporting needs to be streamlined to ensure that it is accurate and to strengthen feedback mechanisms to those that need the information. There is need for a legal review to see if the laws on reporting are adequate. Standardization of AI reporting, inseminator evaluation formats and computerization of the reports database are some of the suggestions for improvement.

This data management function, in the developed world is carried out by industry associations or lobbies that comprise of breeding societies and breeders, semen companies (Importers + Producers) and other industry players. It is the feedback system that assures of continuous improvement. The current recording system has serious shortcomings. It only reaches 4% of the farmers and only focuses on purebred lines. Further, it is hobbled by institutional capacity shortcomings and a general lack of feedback mechanism.

We commend the revamping of the current recording system, with a view to encouraging the increased recording amongst farmers, AI service providers; and appropriate feedback mechanisms to show performance. In a good system, consistent improvement in performance is the incentive for recording. Thus our insistence on feedback mechanisms.

Smallholders need to have access to individual inseminators' performance in order to make informed decisions. These records could be made available at the DVS office.

Key stakeholder partners: Kenya Livestock Breeders Organization (KLBO), DVS, Private sector

6.8 Recommendations to improve regulation and protect consumer welfare

1. Modernize and regularly revise clear industry standards for collection, handling and distribution of semen. There are significant gaps in the rules.
2. The roles and responsibilities of the different organizations (DVS, KAGRC, KLBO, LRC, Breeding Societies and Private Semen Importers) involved in the organization and supply of breeding services needs to be harmonized to avoid duplication of effort.
3. The regulatory role of the DVS needs to be strengthened to enable better supervision, within the breeding industry. However, there is critical role for the Department of Livestock Production (DLP) in the development and planning of breeding programs.
4. At the district level, regular dialogue between private inseminators and government officers needs to be encouraged. At this level, regulation should focus on reporting, customer feedback and the weeding out of unlicensed/ illegal service providers.
5. Develop an effective customer (farmer) complaints system at county level. This system could be run by District Veterinary Officers (DVOs).
6. Support regular awareness campaigns amongst service providers and farmers on the gains that they stand to achieve by timely response to farmers' calls; show them how to ensure win-win outcomes for themselves and farmers alike when honesty and good practice is encouraged. Better practice leads eventually to higher numbers of inseminations available for the inseminators.
7. Develop insurance schemes that protect both consumer and service provider against the risks that come with the insemination process.

Key stakeholder organizations - DVS, KAGRC, KLBO, LRC, Breeding Societies, Private Semen Importers)

6.9 Other Recommendations

The field data shows that the farmers are not able to distinguish between local and imported semen. This results to farmers paying more for local semen which is marketed as imported that is usually more expensive and of higher quality which is not necessarily the case. We therefore recommend that it becomes mandatory for AI technicians to produce and leave documentation detailing the source of semen and type of bull that is being used. For tracking purposes and to seal any loophole by unscrupulous traders, these documents should be serialized. This ensures substantiation of the semen being used and proper costing of services being provided to farmers. The office of the DVS should make this mandatory to both the technicians and the suppliers/importers of semen. The capacity of farmers should be built on this with a budget line expropriated by the government.

Key stakeholder organizations - DVS, KAGRC, KLBO, LRC, Breeding Societies, Private Semen Importers)

Annexes

Annex 1: List of semen importers in kenya and primary origins of semen (2005 – 2013)

	COMPANY	2013	2012	2011	2010	2009	2008	2007	2006	2005	SOURCE
1	ABS/TCM LTD			5,380	23,820	8,950	18,990	17,915	4,900	13,800	U.S.A.
2	WORLD WIDE SIRES	15942	10,885	52,732	55,581	57,550	48,589	20,500	12,780	36,330	U.S.A.
3	HIGH CHEM	27743	83,380	15,610	31,090	20,510	23,450	10,360	12,786	23,160	USA
4	TWIGA CHEMICALS	70010	63,565	53,665	50,725	25,745	13,750	13,455	10,706	6,335	CANADA
5	KILIFI PLANTATIONS					900				605	NEWZEALAND
6	MARULA ESTATE	500	4,615		300	2,200			1,840		ITALY/U.S.A.
7	GOODWILL ST ORES LTD							3,538	2,100		AUTRALIA
8	ALTA GENETICS						830		4,400		U.S.A. CANADA
9	OL PAJETA RANCHING										
10	UNIVERSAL GENETICS					2,000	2,000	2,000	500		SOUTH AFRICA
11	COOPER K. BAND LTD	40880	33,431	12,663	27,935	7,836	7,135	1,210			NETHERLANDS
12	MAKONGI FARM						1,300	1,000			FINLAND
13	PETER FRANCIS THIRU							100			U.S.A.
14	DAIRY ENTERPRISES	6230			8,000	10,000	11,900	3,300			U.S.A.
15	ILRI				150	300	300				BRAZIL
16	LIVESTOCK & LIFESTYLE				10,400	4,200	4,200				U.S.A.
17	MIGOTIYO PLANTATIONS						330				U.K.
18	MRS P.H. REES						220				NEWZEALAND
19	DR. TITUS T. NAIKUNI					30					SOUTH AFRICA
20	HOMELINE CO. LTD			250		50					SOUTH AFRICA
21	KAGRC			2,450		30,000					GERMAN
22	SALOME MORAA										CANADA
23	POKEA DAIRY	45000	15,000			23,000					GERMAN

24	JOHN FRANCIS DYER				60	60					IRELAND
25	FLECKVIEH	3100	4,000	4,750	4,750	4,000					GERMAN
26	SUPERSIRES LTD		7,000	3,540		2,450					FINLAND
27	NAIROBI MEGA AGROVET				2,250	1,230					U.K.
28	POVU KENYA				4,510	2,000					NETHERLANDS
29	SYLVIA R MAKITOSHFARM				100						BRAZIL
30	KOISAMOS M. DAIRIES			1,700	1,570						U.S.A.
31	DANIEL HINGA MUREITHI				2,500						ISRAEL
32	AMBAR LTD. GENETICS				1,200						U.S.A
33	BEST FARM GENETICS	95000	81,900	35,300							SPAIN
34	DAIRY ENTERPRISE TRUST FUND		15,700	12,100	8,000						U.K.
35	ASIA ANIMAL HEALTH LIMITED.		10,050								CANADA
36	AGRIBIZ CONSULTANTS		150								U.S.A
37	TRANS OVA GENETICS		150								U.S.A
38	REFORMED INSTITUTE		150								U.S.A
39	FR. FERNANDO AGUIRRE	250	150								Spain
40	THOMAS KINYUA MBEU		30								Israel
41	MEDICAL RELIEF ALLIANCE		30								U.S.A
42	HOMA LIME GENETICS		20								GERMANY
43	AYRSHIRE BREED SOCIETY OF KENYA	3618									NETHERLANDS
44	BIMEDA	55,750									CANADA
45	INDICUS E.A. LTD	1,000									DENMARK
	TOTALS	365023	330206	200140	232941	203011	132994	73378	50012	80230	

Annex 2: Veterinary requirements for various businesses in the AI value chain

1. **Import certification**

The consignment must be accompanied by a permit and certificate signed by a ***Veterinary Surgeon of the Government of the Exporting Country*** to the effect that:

a) The District or area from which the semen is derived is free from any disease of cattle notifiable by Law to the Ministry responsible for Veterinary Administration.
b) The Bull(s) from which the semen was collected were healthy and free from diseases, which are transmitted via semen.
c) The semen was collected at an approved Artificial Insemination Center, which is under the sanitary supervision and control of a Veterinary surgeon.
d) The Center is under overall supervision of a Veterinary Administration that is responsible for routine visits to check the health and welfare of the bulls and the procedures and records at the Center at least once every six months.
e) Adequate and approved measures have been taken against introduction of Bovine Spongiform Encephalopathy in accordance with Terrestial Animal Health Code of O.I.E.

2. **AI Station bull requirements**

a) The bull(s) must have been continuously resident at the A.I. Center for the period of semen collection and in that time had not been used for natural mating.
b) The bulls were subjected to a virus identification test for Blue tongue Disease according to the Terrestrial Manual on blood samples collected at commencement and conclusion of and at least every 7 days (virus isolation test) or at least every 28 days (PCR test) during semen collection for this semen consignment with negative results.
c) The bull(s) must have been tested and shown no Campylobacter infections on both immunofluorescent and culture examination of semen and prenuptial washings before entry into an E.U approved A.I. Station.
d) The bull(s) must have been tested serologically, with negative results to Leptospira serotype prevalent in cattle in the exporting country or been injected twice with an approved drug for the treatment of Leptospirosis according to the manufacturers' directions within three months prior to collection of this semen batch.
e) The bull(s) must have been tested for Tuberculosis with negative results within twelve months prior to the semen collection if the exporting Country is not free from Bovine Tuberculosis.
f) The bull(s) were examined for IPV/IBR virus with negative results.

Other Requirements

a) The bulls have been progeny tested with positive results. A copy of pedigree and progeny test values must be attached to Veterinary Health Certificate.
b) The bulls have no genetic defects nor carriers of CVM gene.

c) The Semen exporter will include 2 doses of semen for motility check using a Stereomicroscope at x 40 magnification.

Semen packaging and transport

a) Each semen straw must have been identified with the name and identification number of the donor bull and the date of collection.
b) The semen must be packed hygienically and under adequate Liquid Nitrogen in containers which were cleaned and disinfected under veterinary surgeons supervision.
c) The Semen must be consigned by Air and through the fastest route possible to The Director of Veterinary Services, Private Bag Kabete, Code: 00625, KANGEMI, NAIROBI, KENYA. Details of arrival of the consignment must be communicated to the Director of Veterinary Services in good time.
d) On arrival the consignment will be detained by the Director of Veterinary Services until documents and the semen have been inspected by the Veterinarian in charge, Artificial Insemination Division – Veterinary Laboratory. If the Director of Veterinary Services is not satisfied with the fulfillment of the requirements, the semen may be ordered re-exported or destroyed at the expense of the importer.

No semen shall be distributed or sold except under the Authority of a License issued by the Director of Veterinary Services and in accordance with such conditions as may be attached thereto.

NB: Any person, who imports, distributes or sells bull semen without having first obtained a license to do so or who imports, distributes or sells bull semen in breach of any condition attached to his/her license is guilty of an offense.

The original copy of this permit must accompany the consignment to Kenya and be presented to an officer of this Department at the airport.

Annex 3: Guidelines for training AI technicians

1) The theoretical component of the course should be designed so that the trainees will acquire a comprehensive knowledge of:
    i) Anatomy and physiology of bovine male and female reproductive systems
    ii) Heat detection methods and importance of correct timing of AI
    iii) All steps involved in the AI technique and the hygienic requirements
    iv) Hygienic and safe handling of semen
    v) Types of AI equipment, their use and cleanliness
    vi) Semen production procedures at AI centres
    vii) Factors influencing AI results, errors and inefficiencies
    viii) Herd fertility and its economic importance
    ix) Nutrition and its effects on fertility
    x) Maintaining good working relationships with farmers and other service providers
    xi) Legislation relating to livestock breeding in his/her country
2) It should also provide them with an *understanding* of:
    i) Selection of breeding stock, interpretation of indices and progeny testing
    ii) Good record keeping and reporting
3) The practical component of the course should include:
    i) Examination and handling of specimens of reproductive organs of the cow, both directly and using a simulated cow where available
    ii) Palpation *per rectum* of the reproductive organs in live cows to assess their reproductive status
    iii) Handling and manipulating AI equipment
    iv) Handling semen correctly and performing all steps in transferring semen from the transport container to the cow
    v) Restraining and handling cows
    vi) Passing the insemination pistolet/gun through the cervix of live cows easily and safely, and correctly placing the semen
    vii) Accurately filling in the records required
4) For "Do-it-Yourself" technicians (DIYs) who do not require registration, all the above should be included, *except* the following theoretical components:
    i) Semen production procedures at AI centres
    ii) Herd fertility and economic importance
    iii) Nutrition and effects on fertility
    iv) Maintaining good working relationships with farmers and other service providers
    v) Legislation relating to livestock breeding in his/her country
    vi) Selection of breeding stock, interpretation of indices and progeny testing
5) For AITs who will be involved in farmer services based on milk progesterone assay, the following components should also be included:
    i) Hormonal changes during the oestrous cycle of the cow
    ii) Basis of the progesterone measurement for assessing reproductive status
    iii) Collection, transport, processing and storage of milk samples and factors influencing progesterone concentration
    iv) Records necessary at the time of insemination
    v) Interpretation of progesterone levels in milk samples

    vi) Advice to be given to the farmer based on progesterone results

6) Evaluation of the trainee's knowledge and competencies on the above course components should include both theoretical and practical examinations.
7) Where possible, trainees completing the course should obtain field experience by inseminating a minimum of 30 cows under appropriate supervision of an experienced AIT before commencing independent work.
8) Refresher courses and continuing education are encouraged, and should be designed according to the above objectives and guidelines.

Annex 4: Details on methodology for generating benchmarking information

Below we provide detailed information on various methods we used to collect information that has informed this report

1. Literature review

Over the last 30 years, there have been many research and development (R&D) projects in the dairy industry in Kenya that have generated analysis and data. This information is useful as it helps fill gaps critical for this task and builds the knowledge base which is important in developing a robust 'index' for AI benchmarking. Literature review brings out issues raised on the AI sub-value chain that are important to researchers, businessmen, investors, smallholder farmers and policy makers. The literature review was narrowed down to issues that affect growth, inclusivity and competitive performance of the AI sub-chain.

2. Stakeholder consultation

In addition to literature reviews, we consulted stakeholders through a variety of platforms: Key informant (KI) discussions and a stakeholder brainstorming workshop. The brainstorming session, with a set of carefully selected, representative stakeholders, involved roundtable groups where provocative questions on the AI sub-value chain were discussed. Deliberations centered on the trends, opportunities, strengths and challenges in the AI sub-value chain. Other issues looked into were the stakeholders' views on competitiveness and level of consumer protection in the AI sub-value chain.

The brainstorming sessions and KI discussions allowed an initial analysis of the competitive situation within the AI sub-value chain and a greater understanding of the market structure. These interactions were linked to the next stages of the study: questionnaire development, household and trader surveys. Information from the deliberations was fed into the questionnaire and was also useful in site selection. For instance, Nyandarua was identified as one of the areas to conduct the study because it was said to offer the lowest cost of AI service in the country.

3. Household and trader surveys

We collected data from Nyandarua, Kiambu and Bungoma/ Kakamega. These sites were selected purposefully to represent a rising gradient of AI use and variations in the intensification of dairy production systems. The study areas were identified from information gathered from the stakeholder meeting and literature reviews carried out on the AI sub-value chain, including SDP characterization surveys, KDDP and EADD baseline surveys to select the three areas on the basis of intensity of AI usage and dairy activities (production system). Choice of the study areas is further determined by the adoption of AI usage. Previous studies (for example, Njoroge et al, 2004) show that there is less adoption of AI usage in Western Kenya compared to Central Kenya and the Rift Valley regions. Central

Kenya – Kiambu, Nyeri, Muranga, Kirinyaga and adjacent counties – have consistently high utilization of AI service.

4. Survey Area

We characterized AI use in the country into three: Kiambu representing intensive dairy production systems that have high AI usage but with minimal bull service; Nyandarua is semi-intensive those with a mixture of AI usage and bull service. Kakamega-Bungoma has lower AI usage with many of households relying on bull service for breeding. Some unique aspects of these AI markets were also discussed by stakeholders prompting their selection: for example, the relatively lower costs of AI in Nyandarua and the near universal use in Kiambu. Table 22, below, presents the distribution of the survey respondents across the sites.

Table 22: Household and trader survey structure

County	Dairy production system	AI usage	HH Survey numbers targeted	AI Trader numbers targeted
Kiambu	Intensive	AI usage historically high	73	30
Nyandarua	Semi-intensive	AI usage historically high	72	30
Kakamega-Bungoma	Extensive	Historically higher levels of bull service	77	20
	Total		222	80

5. Kakamega-Bungoma site

This area was purposively selected to represent areas where there is mixture of AI service and bull service – as well as high proportion of indigenous zebu alongside crossbreeds with exotic cattle. In Kakamega, data was collected from Malava and Lugari sub-districts [which have high intensity of dairy farming based on crossbreeds]. Further, data was collected from Mumias in Kakamega and two key sites in Bungoma [Kanduyi and Bukembe] which are characterized by high bull service compared to AI – but, with an interesting transition/positive trend in use of AI services. Compared to other study sites [Central Kenya], the sites in Western Kenya have relatively large farm-family land sizes and relatively low population densities.

6. Nyandarua site

Nyandarua County represents areas with a high proportion of AI usage but with some bull service albeit at a low proportion. The dairy production systems, while more extensive than, say, Kiambu, rely on a higher proportion of *Bos Taurus* genetics in the dairy cattle population. The choice of divisions and sub locations to administer the surveys was based on a review of information from key informants and data (including from the local District Production and

Livestock Office (DPLO) and the tertiary office). Data was collected from four sub locations; Murwaki, Gathara, Kinja and Kitiri. Among the four Murwaki has the lowest rate of use of AI while the other three have relatively high use of AI. Nyandarua is not densely populated with relatively larger land holdings compared to Kiambu.

7. Kiambu site

Kiambu County has the highest use of AI in the country. The county is dominated by exotic cattle with relatively small land sizes and high population densities. Four areas were purposefully selected for data collection - Murengeti, Kibinoni, Tharuni and Kamirithu. These areas were identified based on discussions with the District Agricultural office and literature review. Some of the factors that have contributed to the high use of AI in Kiambu include (but not limited to) small land sizes which make it expensive to keep larger herd sizes, proximity to the AI production station at Kabete (KAGRC) and proximity to high value Nairobi milk markets which make dairy industry more profitable. An often overlooked factor behind the intensity of dairying in the region is the presence of several large dairy cooperatives as well as private milk processing plants.

8. Data collection and analysis platform

The structured, mainly pre-coded questionnaires were used to collect data on:

1) Farmer characteristics - age of farmer, years of schooling, major economic activity, marital status, size of household, farming experience,
2) Farming and production systems – Herd sizes, feeding systems, general animal husbandry, farm structures, extension services etc.
3) Breeding and AI – breeding methods, choices, experiences with AI and bulls, distance to nearest AI technician, cost of AI services, constraints to use of AI etc.

The questionnaires were pre-tested before the actual survey was carried out after which it they were refined and administered by carefully trained enumerators. The enumerators were animal health and livestock professionals from the relevant counties. The data was then entered into an MS ACCESS database in readiness for cleaning and analysis and analyzed using SPSS.

In the next sections, we begin to systematically present results from these surveys, literature reviews and our analysis. For ease of understanding, this begins with a conceptual presentation of the dimensions of competition within the AI sub industry.

Annex 5: Some AI Experiences in Kenya

Despite the research being carried out in three regions in Kenya, the challenges and success resonates with other regions as well. As mentioned in the report, not everyone who practices as an AI service provider is trained in the course. In Nyandarua for instance (Kitiri) , there is an instance where on of the providers in a verterinary doctor. His charges are also significantly lower than other players yet farmers interviewed claim that his success rate is higher than the rest. This lower cost could be attributed to the fact that this particular provider is not dependent of AI service exclusively for his livelihood and this practice should be encouraged.

Higher conception rates is also reported where the AI provider is also the farmer - with the trend showing lower failure rate when they service their own cattle. This shows that DIY system could significantly alter the dynamics which the AI environment operates as long as the farmers' capacity is built towards knowing how to detect heat, keep records and maintain hygene. This is also seen in the authors' experience in Oyugis in Kenya.

In Murwaki-Nyandarua county, the field experience showed that AI providers from other regions are prevented from servicing heifers and cows in Murwaki. The inseminators are usually located in one place at the town center and send reports whenever there is news of an an inseminator from another place who has come to service animals in the area. While there has not been a report of anyone being hurt by this through beatings or confistication of equipment to the best of our knowledge, it cannot be discounted and shows the anti competitive environment some areas operate under.

Perharps a good example on how AI can change the lives of farmers is the story of the 9,000 members Rukuriri tea factory company Ltd in Embu. The challenge they faced was unpredictable climatic conditions and ongoing fluctuations of market prices of tea. Tea farmers at the Rukuriri Tea Factory became aware of the risks associated with over-dependence on their tea harvest. Management encouraged farmers to expand their revenue base by engaging in other income-generating projects and especially coming up with and AI project.

With Kenya being one of the largest consumer of milk on the continent, they decided to improve their dairy animals, hence increasing milk production. After the farmers endorsed the proposal to start the project, the Kenyan Ministry of Livestock was consulted to find out the necessary requirements to kick-start the project. The setup process proved to be simple and the right equipment was bought, which included:

- liquid nitrogen and a container for semen storage
- semen for fertilisation
- a *pistolet*, for inserting the semen into the cervix of the cow

- plastic socks as gloves, to avoid contamination by the animal
- scissors, to cut straws which contain semen
- a thermometer, for measuring the temperature of the semen
- a haversack, to carry all the required materials for insemination
- a motorbike for the inseminator

With assistance from the Ministry of Livestock, they identified a professional inseminator, who is on stand-by 24 hours a day. The farmers are continually being trained to detect when an animal is in heat — as timing is essential for a successful insemination process. Farmers at Rukuriri have an advantage, since they buy quality seeds at subsidized rates.

The result has been positive with 60% of Rukuriri's farmers declare that their livelihood has improved through higher sales, generated from increased milk production. Some of the farmers even make more money in dairy than in tea farming. In the future, farmers at Rukuriri plan to further invest in animal treatment and to buy a milk cooler to store milk surpluses.

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